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TECHNICAL SPECIFICATION

FOR,

6.3 MVA and 10MVA, 33/11KV, 3-PHASE POWER

TRANSFORMERS,

WITH ON LOAD TAP CHANGER

Prepared By	Checked by	Checked by	Checked by	Approved by
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Specification No: CE/P&P/SPEC/2022/33/11kV power transformers/003			Date of Issue: 12-08-2022	Revision: 0

SECTION

CLIMATIC AND ISOCERAUNIC CONDITIONS (CIC)

CLIMATIC AND ISOCERAUNIC CONDITIONS (CIC)

1.	The climatic and Iso-ceraunic conditions at the site of work are approximately given as under:																	
	<u>Description</u>	<u>Kashmir</u>																
i)	Max. temp of air in shade	30.6 ⁰ C																
ii)	Min. temp of air in shade	-20 ⁰ C																
iii)	Max. temp of air in sun	45 ⁰ C																
iv)	Height above sea level (App.)	1600 Mtrs																
v)	Max. relative humidity	90%																
vi)	Min. relative humidity	15%																
vii)	Average no. of thunder storm days per year	54																
viii)	Average rainfall	80 cm																
ix)	Wind Zone	WZ – 3																
x)	Average number of rainy days per year	106																
xi)	Seismic Zone	SZ – 5																
xii)	Area of installation	Heavy Snow Zone																
2.	Communication and Transport																	
	<p>The nearest railway station is Jammu on the broad gauge line and is connected to the Divisional Stores by a metal road. The equipment is required to pass en-route through various tunnels on NH-44/1A (Nandni, Nashri and Jawahar Tunnel). The weights and maximum dimension of the packages suitable for transportation through tunnel route are as follows:-</p> <table style="margin-left: 40px;"> <tr> <td style="text-align: right;">1.</td> <td style="text-align: right;">Length</td> <td style="text-align: center;">=</td> <td style="text-align: right;">7.0 m</td> </tr> <tr> <td style="text-align: right;">2.</td> <td style="text-align: right;">Width</td> <td style="text-align: center;">=</td> <td style="text-align: right;">3.0 m</td> </tr> <tr> <td style="text-align: right;">3.</td> <td style="text-align: right;">Height</td> <td style="text-align: center;">=</td> <td style="text-align: right;">4.55 m</td> </tr> <tr> <td style="text-align: right;">4.</td> <td style="text-align: right;">Weight</td> <td style="text-align: center;">=</td> <td style="text-align: right;">40 Ton (metric)</td> </tr> </table> <p>The supplier shall get the permissible weight and dimensions confirmed from the Highway Authorities before proceeding with the manufacture of the equipment. It will be the responsibility of the supplier to ensure timely and proper delivery of the equipment on door delivery basis, at Srinagar, through road transport. The supplier shall also ensure that the weights and dimension of the packages which are suitable to be carried by road transport up to Srinagar.</p>		1.	Length	=	7.0 m	2.	Width	=	3.0 m	3.	Height	=	4.55 m	4.	Weight	=	40 Ton (metric)
1.	Length	=	7.0 m															
2.	Width	=	3.0 m															
3.	Height	=	4.55 m															
4.	Weight	=	40 Ton (metric)															

Sd/-
JE

Sd/-
AEE

Sd/-
AEE

Sd/-
Executive Engineer
Sd/-
Superintending Engineer
Planning, (KPDCL)

SECTION
TECHNICAL SPECIFICATIONS

TECHNICAL SPECIFICATIONS FOR 6.3MVA and 10MVA, 33/11KV, 3-PHASE POWER

TRANSFORMERS WITH ON LOAD TAP CHANGER

1 SCOPE

- 1.1 This Specification provides for design, engineering, manufacture, assembly, stage inspection, final inspection and testing before dispatch, packing and delivery at Consignee stores of 6.3MVA and 10 MVA, 33/11 KV, Outdoor Type, 3-Phase, two windings, Copper Wound, Oil Immersed Power Transformer(s) with ON Load Tap Changer (OLTC), Remote Tap Change Control (R.T.C.C) panel with SCADA Compatible, complete with all fitting & accessories, associated equipments, NCT on LV side, etc., Spares, required for its satisfactory operation in any of the sub-stations of the Purchaser.
- 1.1.1 The Transformer offered shall be complete with all part and accessories which are necessary for their efficient and satisfactory operation. Such parts and accessories shall be deemed to be within scope of this specification whether specially mentioned or not. Packing of various accessories & fittings, shall be provided as per relevant IS to avoid any damage during transient.
- 1.2 The core shall be constructed from BIS Certified high grade, non-aging, Cold Rolled Grain Oriented (CRGO) silicon steel laminations conforming to Hi-B grade with lamination thickness not more than **0.23mm to 0.27mm** or better (Quoted grade and type shall be used). The maximum flux density in any part of the cores and yoke at rated voltage and frequency shall be such that the flux density with +12.5% combined voltage and frequency variation from rated voltage and frequency shall not exceed 1.9 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.
Prior to the inspection and testing of transformer the supplier shall submit on request following curves of the core manufacturer:
- a) Flux Density vs Core loss.
b) Flux Density vs Excitation.
- 1.2.1 The core shall have magnate coating as insulation. The assembled core shall be securely clamped on the limbs and yoke with uniform pressure so as to minimize the noise emission from it. The insulation structure for the core to the bolts and core to the clamp plates shall be such as to withstand a voltage of 200V at 50Hz for 1 min.
- 1.3 The scope of supply includes the provision of type test. The equipment offered should have been successfully type tested from any of the NABL accredited laboratories/CPRI/ERDA within five years from the date of publication of tender. Compliance shall be demonstrated by submitting authenticated copies of the type test reports. Performance certificates from the users Center / State Govt. or their undertakings for past supplies, if any.
- 1.4 The Power Transformer shall conform in all respects to highest standards of engineering, design, workmanship, this specification and the latest revisions of relevant standards at the time of offer and the Purchaser 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 the commercial order or not.

1.5 The Purchaser reserves the right to reject the transformers if on testing the losses exceed the declared losses or the temperature rise in oil and / or winding exceeds the value, specified in technical particular or impedance value differ from the guaranteed value including tolerance as per this specification and if any of the test results do not match with the values, given in the guaranteed technical particulars and as per technical specification.

1.6 **ALTITUDE FACTOR**

The necessary correction factors for **altitude beyond 1000 m as given in IS-2026 (Part-1, 2 & 3)** for oil temperature rise, insulation level etc. shall be applied to the Standard Technical Parameters given below.

2 SPECIFIC TECHNICAL REQUIREMENTS

- | | | |
|-------|---|---|
| i. | A. Rated MVA | 10 MVA |
| | B. Rated MVA | 6.3 MVA |
| ii. | No. of phases | 3 |
| iii. | Type of installation | Outdoor |
| iv. | Frequency | 50 Hz (<u>± 5%</u>) |
| v. | Cooling medium | Insulating Oil |
| vi. | Type of mounting | On Wheels, Mounted on rails. |
| vii. | Highest continuous system voltage | |
| | a) Maximum system voltage ratio (HV / LV) | 36KV / 12 KV |
| | b) Rated voltage ratio (HV / LV) | 33KV /11 KV |
| ix. | No. of windings | Two winding Transformers |
| x. | Type of cooling | ONAN (Oil natural/Air natural) |
| xi. | MVA Rating corresponding to ONAN Cooling system | 100% |
| xii. | Method of connection: | |
| | HV : | Delta |
| | LV : | Star |
| xiii. | Connection symbol | Dyn 11 |
| xiv. | System earthing | Neutral of LV side to be solidly earthed. |
| A. | Percentage impedance voltage on normal tap and MVA base at 75 deg C corresponding to HV/ LV rating and applicable tolerances: (For 10 MVA) | % Impedance Tolerance %
8.35% 10%
(No negative tolerance will be allowed) |
| B. | Percentage impedance voltage on normal tap and MVA base at 75 deg C corresponding to HV/ LV rating and applicable tolerances: (For 6.3 MVA) | % Impedance Tolerance %
7.15% 10%
(No negative tolerance will be allowed) |
| xvi. | Intended regular cyclic overloading of windings | (as per IEC-76-1, clause 4.2) |

xvii.	a) Anticipated unbalanced loading	Around 10%	
	b) Anticipated continuous loading of windings (HV / LV)	110 % of rated current	
	c) Anticipated long term emergency loading	150% of rated current	
xviii.	a) Type of tap changer	ON-load tap changer.	
	b) Range of taping	+ 5% to – 15% in 17 equal steps (16 tap positions) with equal steps of 1.25% each on HV winding	
xix.	Neutral terminal to be brought out	On LV side only	
xx.	Over Voltage operating capability	112.5% of rated voltage	
xxi.	Maximum Flux Density in any part of the core and yoke at rated MVA, 112.5% of rated voltage, i.e. 33/11kV and system frequency of 50 HZ	1.9 Tesla	
xxii.	Insulation levels for windings:	33KV	11KV
	a) 1.2 / 50 microsecond wave shape Impulse peak)	170	75
	b) Power frequency voltage withstand (kV rms)	70	28
xxiii.	Type of winding insulation		
	a) HV winding	Uniform	
	b) LV winding	Uniform	
xxiv.	Withstand time for three phase short circuit	2 Seconds	
xxv.	Noise level at rated voltage and frequency	As per NEMA Publication No. TR-1.	
xxvi.	Permissible Temperature Rise over ambient temperature of <u>45°C</u> as per IPDS		
	a) Of top oil measured by thermometer.	50°C	
	b) Of winding measured by resistance.	55° C	
xxvii.	Minimum clearances in air (mm):-	Phase to Phase	Phase to ground
	a) HV	400	320
	b) LV	280	140
xxviii.	Terminals		
	a) HV winding line end	36 kV <u>oil filled</u> porcelain bushings with plain sheds as per IS: 3347 (Anti-fog type)	
	b) LV winding	12 kV porcelain bushings with plain sheds as per IS: 3347 (Anti-fog type)	
xxix.	Insulation level of bushing	HV	LV
	a) Lightning Impulse withstand (kVP)	170	75
	b) 1 Minute Power Frequency withstand voltage (kVrms)	70	28
	c) Creepage distance (mm) (minimum)	1116	372

xxx.	Material of HV & LV Conductor	Electrolytic Copper
xxxi.	Maximum current density for HV and LV winding for rated current	2.4 A/ mm ²
xxxii.	Polarization index i.e ratio of megger values but 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 and less than or equal to 5.
xxxiii.	Core Assembly	Boltless
xxxiv.	Temperature Indicator	
	a) Oil	One number
	b) Winding	One number
xxxv.	Losses at 75°C shall not exceed the values given below	
	A. No Load Loss: 7 kW (for 10MVA)	
	Load Loss: 50kW (for 10MVA)	
	B. No Load Loss: 4.6 kW (for 6.3MVA)	
	Load Loss: 36 kW (for 6.3MVA)	

2.1 MARSHALLING BOX

- 2.1.1 A metal enclosed, 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, shall be provided with each transformer to accommodate temperature indicators, terminal blocks etc. The box shall have slopping roof. The degree of protection shall be IP-55 or better as per IS: 2147.
- 2.1.2 The schematic diagram of the circuitry inside the marshalling box be prepared and fixed inside the door under a propane sheet.
- 2.1.3 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 750 mm above ground level.
- 2.1.4 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.

2.1.5 All incoming cables shall enter the kiosk from the bottom and the gland plate shall be detachable.. The gland plate and associated compartment shall be sealed in suitable manner to prevent the ingress of moisture and dust from atmosphere.

2.3 **PERFORMANCE**

2.3.1 Transformer shall be capable of withstanding for two seconds without damage to any external short circuit, with the short circuit MVA available at the terminals.

2.3.2 The maximum flux density in any part of the cores and yoke at rated voltage and frequency shall be such that the flux density with +12.5% combined voltage and frequency variation from rated voltage and frequency shall not exceed 1.9 Tesla. And at rated voltage and frequency 1.69 Tesla.

2.3.3 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.

2.3.4 The transformer may be operated continuously without danger on any particular tapping at the rated MVA \pm 1.25% of the voltage corresponding to the tapping.

2.3.5 The thermal ability to withstand short circuit shall be demonstrated by calculation.

2.3.6 Transformer shall be capable of withstanding thermal and mechanical stress caused by any symmetrical and asymmetrical faults on any winding. (This shall be demonstrated through calculations as per IS:2026

2.3.7. The transformer shall be capable of being operated without danger on any tapping at rated KVA with voltage variations and \pm 10 % corresponding to the voltage of the tapping.

2.4 **DRAWINGS/ DOCUMENTS INCORPORATING THE FOLLOWING PARTICULARS SHALL BE SUBMITTED WITH THE BID ON AT LEAST A3 SIZE (420 X 297) mm PAPER**

2.4.1 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.

2.4.2 Assembly drawings of core, windings etc. and weights of main components / parts.

2.4.3 Height of center line on HV and LV connectors of transformers from the rail top level.

2.4.4 Dimensions of the largest part to be transported.

2.4.5 GA drawings / details of various types of bushing

- 2.4.6 Tap changing and Name Plate diagram
- 2.4.7 Type test certificates of similar transformers.
- 2.4.8 Illustrative & descriptive literature of the Transformer.
- 2.4.9 Maintenance and Operating Instructions.

2.5 **MISCELLANEOUS**

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

2.6 **DELIVERY**

The full quantity of the equipments shall be delivered as per the delivery schedule mentioned in Standard Bidding Document.

2.7 **SCHEDULES**

All Schedules annexed to the specification shall be duly filled by the bidder separately.

3.0 **NAME PLATE**

Transformer rating plate shall contain the information as given in Clause 7 of IS-2026 (Part-I):2011. The details on rating plate shall be finalized during the detailed engineering. Further, each transformer shall have inscription as **“CE P&P KPDCL”**. 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 75° C (normal tap only),
- (iv) D.C resistance of each winding at 75° C.

4.0 **SYSTEM CONDITIONS**

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

Frequency		50 Hz± 5%
Nominal system voltages		33 KV 11 KV
Maximum system voltages	33KV System	<u>36.3 KV</u>
	11 KV System	12 KV
Nominal short circuit level (Basing on apparent power)	33KV System	31.5KA
	11 KV System	13.1KA

Insulation levels : 1.2/50 μ sec impulse withstand voltage	33KV System	170KV (peak)
	11 KV System	75 KV (peak)
Power frequency one minute withstand (wet and dry) voltage	33KV System	70KV (rms)
	11 KV System	28KV (rms)
Neutral earthing arrangements	11 KV System	Solidly earthed

4.1 CODES & STANDARDS

4.1.1 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 i.e., Kashmir Province of UT of J&K.. The equipment shall also conform to the latest applicable standards and codes of practice. Nothing in this specification shall be construed to relieve the supplier of this responsibility.

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

IS:5/104/2932	Colour for ready mixed paints
IS:325	Three Phase Induction Motors
IS:335	New insulating oil for transformers, switch gears
IS:1271	Classification of insulating materials for electrical machinery and apparatus in relation to their stability in services
IS:2026 (Part I to VIII)	Power Transformer
IS:2071	Method of high voltage testing
IS:2099	High voltage porcelain bushings
IS:2147	Degree of protection
IS:2705	Current Transformers
IS:3202	Code of practice for climate proofing of electrical equipment
IS:3347	Dimensions for porcelain Transformer Bushings
IS:3637	Gas operated relays
IS:3639	Fittings and accessories for power Transformers
IS:5561	Electric Power Connectors
IS:60076/IS-2026 Part VII	Guide for loading of oil immersed Transformers
IS:10028	Code of practice for selection, installation and maintenance of transformers, Part I. II and III
C.B.I.P. Publication	Manual on Transformers (Latest edition)

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.

5 DRAWINGS

- 5.1 The Supplier 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 on at least A3 size (420 x 297)mm paper.
- 5.2 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.
- 5.3 Assembly drawings of core and winging and weights of main components / parts.
- 5.4 Foundation plan showing loading on each wheel land jacking points with respect to centre line of transformer.
- 5.5 GA drawings details of bushing and terminal connectors.
- 5.6 Name plate drawing with terminal marking and connection diagrams.
- 5.7 Wheel locking arrangement drawing.
- 5.8 Transportation dimensions drawings.
- 5.9 Magnetization characteristic curves of PS class neutral and phase side current transformers, if applicable.
- 5.10 Interconnection diagrams.
- 5.11 Over fluxing withstand time characteristic of transformer.
- 5.12 GA drawing of marshalling box.
- 5.13 Control scheme/wiring diagram of marshalling box.
- 5.14 Technical leaflets of major components and fittings.
- 5.15 As built drawings of schematics, wiring diagram etc.
- 5.16 Setting of oil temperature indicator, winding temperature indicator.
- 5.17 Completed technical data sheets.
- 5.18 Details including write-up of tap changing gear.
- 5.19 HV conductor bushing.
- 5.20 Bushing Assembly.
- 5.21 Bi-metallic connector suitable for connection to appropriate size Cable/Conductor. To be finalized at the time of approval of Drawings. i.e., For 200mmSq ACSR on HV side and 630/400 mmsq XLPE Cable on LV side suitable for horizontal takeoff.
- 5.22 GA of LV cable Box.
- 5.23 Radiator type assembly.
- 5.24 All drawings, documents, technical data sheets and test certificates, result calculations shall be furnished.
- 5.25 Details of CT particulars of neutral & WTI CT.

- 5.26 Any approval given to the detailed drawings by the Purchaser shall not relieve the Supplier of the responsibility for correctness of the drawing and in the manufacture of the equipment. The approval given by the purchaser shall be general with overall responsibility with Supplier.

6. GENERAL CONSTRUCTIONAL FEATURES

- 6.1 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.
- 6.2 Similar parts particularly removable ones shall be interchangeable.
- 6.3 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.
- 6.4 Nuts, bolts and pins used inside the transformers and tap changer compartments shall be provided with lock washer or locknuts.
- 6.5 Exposed parts shall not have pockets where water can collect.
- 6.6 Internal design of transformer shall ensure that air is not trapped in any location.
- 6.7 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.
- 6.8 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.
- 6.9 All internal connections and fastenings shall be capable of operating under overloads and over-excitation, allowed as per specified stands without injury.
- 6.10 Transformer and accessories shall be designed to facilitate proper operation, inspection, maintenance and repairs.
- 6.11 No patching, plugging, shimming or other such means of overcoming defects, discrepancies or errors will be accepted.
- 6.12 Schematic Drawing of the wiring, including external cables shall be put under the propane sheet on the inside door of the transformer marshalling box.

6.13 Painting

- 6.13.1 All paints shall be applied in accordance with the paint manufacturer's recommendations. 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.
- 6.13.1.1 All paints, when applied in normal full coat, shall be free from runs, sags, wrinkles, patchiness, brush marks or other defects.

6.13.1.2 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 Purchaser.

6.13.1.3 The supplier shall, prior to painting protect nameplates, lettering gauges, sight glasses, light fittings and similar such items.

6.13.2 Cleaning and Surface Preparation

6.13.2.1 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.

6.13.2.2 Steel surfaces shall be prepared by Sand/Shot blast cleaning or Chemical cleaning by Seven tank process including Phosphate to the appropriate quality.

6.13.2.3 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.

6.13.2.4 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.

6.13.3 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.

6.13.4 Painting 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.

6.13.5 Painting Procedure

6.13.5.1 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.

6.13.5.2 Particular attention shall be paid to the manufacturer'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.

- 6.13.5.3 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.
- 6.13.5.4 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.
- 6.13.5.5 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.

6.13.8 Damages to Paints Work

6.13.8.1 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.

6.13.8.2 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 applied, followed by a full paint finish equal to that originally applied and extending 50mm around the perimeter of the originally damaged.

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

6.13.9 Dry Film Thickness

6.13.9.1 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.

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

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

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

S.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 Paint (Finish Coat)	Out side	02	35 micron
	c) Hot Oil paint	Inside	01	35 micron

7.0 DETAILED DESCRIPTION

7.1 Tank

7.1.1 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.

7.1.2 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.

7.1.3 All breams, flanges, lifting lugs, braces and permanent parts attached to the tank shall be welded and where practicable, they shall be double welded.

7.1.4 The main tank body of the transformer, excluding tap changing compartments and radiators, shall be capable of **withstanding pressure of 760mm of Hg.**

7.1.5 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.

7.1.6 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.

7.1.7 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.

7.2 Tank Cover

- 7.2.1 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.
- 7.2.2 A ladder (with anti-climbing lock arrangement) shall be provided for tank above **3m height**.
- 7.2.3 Lifting and Haulage facility: Tank shall be provided with, **i)** Lifting Lugs suitable for lifting of transformer complete with oil. and **ii)** Minimum of four jacking lugs in accessible position to enable the transformer complete with oil to be raised or lowered using hydraulic or screw jack. Minimum height of lugs above base shall be **300mm** for transformers up-to and including ten tones weight and **500mm** for transformers above ten tones weight, **iii)** suitable haulage holes shall be provided.

7.3 UNDER CARRIAGE

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.

The Transformer provided with **bi directional flanged wheels shall be suitable for use on 1435mm gauge track**; same however shall be subject approval of drawings. Suitable locking arrangement shall also be provided to prevent the accidental movement of the transformer.

7.4 CORE

- 7.4.1 Each lamination shall be insulated such that it will not deteriorate due to mechanical pressure and the action of hot transformer oil.
- 7.4.2 The core shall be constructed from BIS Certified high grade, non-ageing, Cold Rolled Grain Oriented (CRGO) silicon steel laminations conforming to Hi-B grade with lamination thickness not more than **0.23 mm to 0.27 mm** or better (Quoted grade and type shall be used). The maximum flux density in any part of the cores and yoke at rated MVA, rated voltage i.e., 33/11kV and system frequency of 50Hz shall not be more than 1.69 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. **CRGO steel for core shall be purchased only from PGCIL approved vendors, list of which is available at PGCIL website.**
- 7.4.3 The bidder should offer the core for inspection starting from the destination port to enable Purchaser for deputing inspecting officers for detail verification as given below and approval by the Purchaser 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 its sub-vendor's premises as per approved design drawing.

- a) Purchase 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.

Please refer to "Check-list for Inspection of Prime quality CRGO for Transformers" attached at Annexure-A. It is mandatory to follow the procedure given in this Annexure.

- 7.4.4 The laminations shall be free of all burrs and sharp projections. Each sheet shall have an insulting coating resistant to the action of hot oil.
- 7.4.5 The insulation structure for the core to core bolts and core to clamp plates, shall be such as to withstand 2000 V DC for one minute.
- 7.4.6 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.
- 7.4.7 All steel sections used for supporting the core shall be thoroughly shot or sand blasted, after cutting, drilling and welding.
- 7.4.8 The finally assembled core with all the clamping structures shall be free from deformation and shall not vibrate during operation.
- 7.4.9 The core clamping structure shall be designed to minimize eddy current loss.
- 7.4.10 The framework and clamping arrangements shall be securely earthed as per standards.
- 7.4.11 The core shall be carefully assembled and rigidly clamped to ensure adequate mechanical strength.
- 7.4.12 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.

- 7.4.13 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.
- 7.4.14 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 assembly shall be so fixed in the tank that shifting will not occur during transport or short circuits.
- 7.4.15 The temperature gradient between core & surrounding oil shall be maintained less than 20 deg. Centigrade. The manufacturer shall demonstrate this either through test (procurement to be mutually agreed) or by calculation.

7.5 INTERNAL EARTHING

- 7.5.1 All internal metal parts of the transformer, with the exception of individual laminations, core bolts and their individual clamping plates shall be earthed.
- 7.5.2 The top main core clamping structure shall be connected to the tank body 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 loop structure on the same side of the core as the main earth connection to the tank.
- 7.5.3 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.
- 7.5.4 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.

7.6 WINDING

- 7.6.1 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.

- 7.6.2 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.
- 7.6.3 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.
The conductors shall be of electrolytic grade copper free from scales and burrs. The conductor insulation shall be made from high-density (at least 0.75 gm/cc) paper having high mechanical strength. The barrier insulation including spacers shall be made from high-density pre-compressed pressboard (1.1 gm/cc minimum for load bearing and 1 to 1.3 gm/cc minimum for non-load bearing) to minimize dimensional changes.
- 7.6.4 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.
- 7.6.5 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.
- 7.6.6 Winding and connections shall be braced to withstand shocks during transport or short circuit.
- 7.6.7 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.
- 7.6.8 Terminals of all windings shall be brought out of the tank through bushings for external connections.
- 7.6.9 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.
- 7.6.10 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.
- 7.6.11 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.

- 7.6.12 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.
- 7.6.13 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.
- 7.6.14 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.
- 7.6.15 Magnitude of impulse surges transferred from HV to LV windings by electromagnetic induction and capacitance coupling shall be limited to BIL of LV winding.
- 7.6.16 The current density adopted in all winding shall not **exceed 2.4 A/mm²**. The total net cross sectional area of the strip conductors for calculating current density for each winding shall be obtained after deducting the copper area lost due to rounding up of the sharp edges at the rectangular conductors.

7.7 INSULATING OIL

- 7.7.1 The insulating oil for the transformer shall be of EHV grade, generally conforming to IS: 335. No inhibitors shall be used in the oil.
- 7.7.2 The quantity of oil required for the first filling of the transformer and its full specification shall be stated in the bid. Transformer shall be supplied complete with all fittings, accessories and new transformer oil required for first filling along with the oil required for the radiator banks.
- 7.7.3 The 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.
- 7.7.4 The Supplier shall warrant that oil furnished is in accordance with the specifications as per Table-1 of IS 335 with latest amendment.

7.8 VALVES

- i) Valves shall be of forged carbon steel up-to **50mm size** and of gun metal 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 Supplier 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 the specifications.

7.9 ACCESSORIES

7.9.1 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 630A 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 bushing terminal and the Purchasers specified conductors. The connector/clamp shall be rated to carry the bushing rated current without exceeding a temperature rise of 55 deg. C over an ambient of 50 deg. 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.
 - xii) The extended bushing bus bars shall be used for termination of 11 KV cables. LV bushing shall be housed in completely sealed metallic enclosure.
 - xiii) Sheet steel, weather, vermin and dust proof cable box fitted with required glands, locks, glass door, terminal Board, heater with switch, illumination lamp with switch, water- tight hinged and padlocked door of a suitable construction shall be provided with each transformer to accommodate 11 KV cables 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. 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. All incoming cables shall enter the kiosk from the bottom and the minimum 4mm thick, non-magnetic, gland plate shall not be less than 600 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. **For those transformers which are used in partly indoor substation.**

7.9.2 Protection & Measuring Devices

i) Oil Conservator Tank

- a) The Conservator tank shall have adequate capacity between highest and lowest visible levels to meet the requirement of expansion of the total cold oil volume in the transformer and cooling equipment.
- b) The conservator tank shall be bolted into position so that it can be removed for cleaning purposes.
- c) The conservator shall be fitted with magnetic oil level gauge with low level electrically insulated alarm contact.
- d) Plain conservator fitted with silica gel breather.

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) OTI and WTI shall be a compact system where both local and remote instrument are integrated and supplied as Hybrid Instrument and a self-powered local indication with switch controls and an externally powered remote indication for SCADA purposes.
- b) Both the OTI and WTI should have remote reading capability compatible to be connected to SCADA system.
- c) It should have no change in overall dimension of OTI and WTI and no additional Thermometer pockets are required.

- d) OTI/ WTI shall have embedded PT-100 sensors in the sensing bulb of the local OTI/ WTI and Current Converter Unit (CCU) shall be mounted inside the Local OTI/WTI. The output from which can be connected to remote indicator or SCADA to provide a standard single or dual 4-20mA DC current output corresponding to measured temperature.
- e) The WTI instruments shall have a built in Thermal imaging system for transformer's hot spot indication and shall be provided with gradient adjustment through a shunt for CT 5A secondary input. For the WTIs additional Winding temperature simulator should be provided.
- f) Remote indicator for both OTI and WTI shall be digital type with minimum 4 digits LED display and resolution shall be within limit of 0.10C. Remote indicators should have minimum 2 sets of 4 - 20mA DC output -RS 485- for SCADA connection.
- g) Oil temperature indicator and winding temperature indicator with two electrical contacts for alarm and trip purposes and repeater for remote indication shall be provided with anti-vibration mounting. All switch contacts are potential free micro switches. The oil temperature indicator shall be housed in the existing marshalling box.
- h) The oil and winding temperature indicator should be of 'Pecimeasure' or 'Perfect Control' only. The scale on the dial of the thermometer should be 0-150°C. The angular displacement of thermometer should be 270°. The signaling contact of WTI & OTI shall be set to operate at the following temperature:
 - i) **OIL : Alarm-80 deg. C, Trip – 90 deg. C**
 - ii) **WINDING : Alarm-85 deg. C, Trip – 95 deg. C**
- i) The tripping contacts of indicator shall be adjustable to close the winding temperature indicator between 60°C and 120°C. The alarm contacts of indicator shall be adjustable to close between 50°C and 100°C. All contacts shall be adjustable on a scale and shall be accessible on removal of the cover. The temperature indicators shall be so designed that it shall be possible to check the operation of contacts and associated equipments.
- j) Accuracy class of both OTI and WTI shall be $\pm 1\%$ or better and weather Proof Protective Class IP-55

7.9.3 Oil Preservation Equipment

7.9.3.1 Oil Sealing

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 isolate 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.

7.10 ON LOAD TAP CHANGER

- 7.10.1 The tapping range of On Load Tap Changer shall be **+5% to -15% in steps of 1.25%** each. The No. of taps shall be 17. The On Load Tap Changer shall be supplied with RTCC panel and AVR (Automatic Voltage Regulating Relay). The Continuous current rating of the tap changer shall be based on connected winding rating and shall have liberal and ample margin. Lower rated tap changers connected in parallel are not acceptable.

- 7.10.2 The on-load tap changing equipment shall have the provision for mechanical and electrical control from a local position and electrical control from a remote position. For local mechanical operation, the operating handle shall be brought outside the tank for operation from floor level with provision to lock the handle in each tap position. Remote electrical operation shall have an AUTO-MANUAL selection at the remote location. When selected AUTO, the tap changing gear shall maintain steady voltage within practical limit on the transformers secondary bus from which the reference shall not respond to transient variation of voltage due to grid disturbance and system fault. The required voltage relay shall not be sensitive to frequency variation and shall be suitable for sensing voltage from the secondary of potential transformers mounted on the 66KV, 33KV, or 11KV bus.
- 7.10.3 The tap changer shall be provided with over-current protection in order to prevent the tap-change operation during a short circuit, which would to greatly stress the contacts of the diverter switch. The function of protection shall be arranged as follows;
- (i) Whenever over current occurs, the control circuit for commanding OLTC motor operation shall be blocked by the normally close contacts of the over current relays.
 - (ii) If during tap change over current occurs, the OLTC motor circuit shall be blocked through the mechanical cam switch, which is close from the very beginning to the very end of every tap change operation and to the normally open contacts of the over current relays. The stop action of the motor shall be made through the motor brake contactor. The motor shall be suitable for operation with three phase 400 Volts 50 cycles external power supply.
- 7.10.4 The design of the tap changing equipment shall be such that the mechanism will not stop in any intermediate position; however, if the mechanism through faulty operation does stop in an intermediate position, the full load must be carried by the transformer without injury to the equipment. The mechanical position indicator shall be equipped in the motor drive cubicle. The motor shall be designed to be of step control. In any case the operation shall be of step by step.
- 7.10.5 The **voltage regulating relay** shall be supplied together with the timer and under voltage relay. The signal order from the voltage regulating relay to execute the tap changer operation, when the regulating voltage is out of the voltage regulating level shall be designed to be delayed by the adjustable timer. If the control voltage abnormally falls, the movement of the tap changer shall be locked by the contact of the under voltage relay, even if the contacts of the voltage regulating relay are working.
- 7.10.6 The control circuit of the transformer shall be completely designed and provisions shall be made for parallel operation with another transformer.
- 7.10.7 The following accessories, control and selector switches and other necessary accessories shall be furnished.
- i) Remote tap changer control board (Placed in the control room)
 - a) Voltmeter
 - b) "AUTO-MANUAL" control switch
 - c) "RAISE-LOWER" control switch
 - d) Tap position indicator

- e) Tap changer operation program indicator.
- ii) Transformer Tap Changer driving mechanism control cubicle
 - a) “REMOTE-LOCAL-TEST” selector switch
 - b) “AUTOMATIC-MANUAL” control switch
 - c) “RAISE-LOWER” control switch
 - d) Tap position indicator
 - e) Tap changer operation program indicator
 - f) Voltmeter
 - g) Tap change operation counter
 - h) Means for manual operation when power supply is lost

7.10.8 The OLTC should be Type Tested from CPRI/NABL/Govt. approved Laboratories.

7.11 **REMOTE TAP CHANGER CONTROL (RTCC) PANEL**

- A) The supplier shall furnish, in addition to the equipment above, the following accessories mounted on a separate Remote Tap Changer Control (RTCC) panel to be installed in the Control Room for remote operation.
- i) Relays in the control circuit for the operation of the transformers in parallel.
 - ii) Raise and Lower Push Button Switch
 - iii) Remote tap position indicator and other required devices. One chart showing the voltage corresponding to tap position indicator shall be engraved on a metal sheet and the same shall be fixed near the tap position indicator on the RTCC (panel).
 - iv) An indication lamp showing tap changing in a progress
 - v) Tap change in progress lamp (white color) with circuit interrupter for blinking.
 - vi) Lamps (white) showing healthy auxiliary supply from 240/110 Volts Center point earthing transformer.
 - vii) Master, Follower and Independent selecting switch and other accessories required for complete operation of tap changer.
 - viii) Signalling apparatus for out-of-step alarm.
 - ix) Time delay contactors 1-5 Seconds for tripping due to incorrect coupling in master position (out of step tripping). The desired time delay for tripping will be 50 Seconds.
 - x) Remote Push Button for Lower & Raise Tap.
 - xi). Alarm cancellation Push Button.
 - xii) Name plate of each component
 - xiii) Winding & Oil temperature (0 degree – 150 degree) repeaters, to be connected to winding and oil temperatures meters housed in the main Transformer Marshalling Box at outdoor.
 - xiv) An under voltage relay shall be incorporated to monitor the 110 Volt AC control circuit voltage circuit supply Similarly audible and visual indication shall be provided in RTCC panel.
 - xv) Multifunction Transducer shall be provided with RTCC panel.
 - xvi) Remote Digital type OTI with 4 -20 mA DC output (RS 485) for SCADA Connection
 - xvii) Remote Digital type WTI with 4 -20 mA DC output (RS 485) for SCADA Connection
 - xviii) In addition to the, Transformer tap change control panel shall have an audible and visual annunciation system for the following alarms.
 - a) Surge relay trip (OLTC gear) Low oil level alarm .
 - b) Tap changer out – of – step alarm.

- c) Failure of control supply alarm.

B) Provision for SCADA Operation:

The following features are to be added in DM/ RTCC panel for interfacing SCADA signal :-

- a) Separate terminal Block (STB) is to be provided for SCADA operation.
- b) OLTC Control Supply 110 V AC is to be wired to the STB.
- c) At least one NC auxiliary contact from MCB of OLTC 3 phase motor is to be wired to the STB for motor supply failure indication.
- d) NC contact of under voltage relay is to be wired to the STB for OLTC control supply failure indication.
- e) 110V AC relay/contacter actuated by contacts of raise and lower contractors is to be provided for tap changer-in-progress indication to SCADA end NO contact of the relay is to be wired to STB.
- f) Necessary wiring from SCADA selector switch are to be terminated to the STB both for operation of tap changer as well as indication.
- g) NO contact of OSR/TDR is to be wired to STB for tap changer out-of-step indication.
- h) 3 nos. of wires are to be wired up from remote Tap position indicating device at DM to STB to facilitate tap position indication to SCADA end.

7.12 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 up to 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 with handling holes at fore corners.
- 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 Purchaser's grounding strip. Bi-directional flagged rollers with locking and bolting device.
- xx) Marshalling Box (MB)
- xxi) Shut off valve on both sides of flexible pipe connections between radiator bank and transformer tank.
- xxii) 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
- xxiii) Terminal marking plates for Transformer
- xxiv) ON- Load Tap Changer
- xxv) Oil Preservation Equipment
- xxvi) Oil Temperature indicator
- xxvii) Transformer shall be supplied with all control cable, SCADA compatible WTI & OTI, sensing cable, glands, lugs etc (complete control).
- xxviii) The transformer shall be provided with bi metallic terminal contacts on both side H.V and L.V, suitable for conductor size of 200mm sq /100mm sq ACSR on H.V side and 630mm sq power cable on L.V side for 10MVA and 400mm sq power cable on L.V side for 6.3MVA (same however shall be finalized while approving of drawings.)

Note:

1. 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.
2. 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.

7.13 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 marshaling boxes, they shall be adequately screened and **400 volts Danger Notice** must be affixed to the outside of the junction boxes or marshaling box. Proper colour code for Red, Yellow, Blue wires shall be followed.
- vi) All box wiring shall be in accordance with relevant IS. All wiring shall be of stranded **copper (48 strands) of 1100Volt 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 coloured 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 multi core cable tails.
- xvii) Terminal blocks shall have pairs of terminal for incoming and outgoing wires. Insulating barriers shall be provided 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 marshaling 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 propane sheet on the inner side of the marshaling box cover.
- xx) To avoid condensation in the Marshaling Box, a space heater shall be provided with an MCB and thermostat.
- xxi) Suitable MV, CFL light shall be provided in the Marshaling Box for lightning purpose.

7.14 **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 minimize interference with communication circuits. Transformer noise level when energized at normal voltage and frequency shall be as per NEMA stipulations.

7.15 **PROVISION OF CURRENT TRANSFORMER IN LV SIDE OF POWER TRANSFORMER**

In order to achieve restricted earth fault in star connected L.V side of power transformer, Current transformers having following particulars shall have to be provided between neutral terminal and neutral bushing of L.V side **of 6.3MVA** power Transformer and in the bushing turret of r, y and b phases and neutral terminal of L.V side of **10 MVA** transformers.

CT Particulars	For 10MVA Transformer	For 6.3 MVA Transformer
i) Type	Suitable for installation in L.V. side of power transformer for REF protection	Suitable for installation in L.V. side of power transformer for REF protection
ii) Ratio	600/5A at all phases and neutral	400/5A at all phases and neutral
iii) Accuracy Class	PS	PS
iv) Knee point Voltage	Vk >250volt	Vk >250volt
v) RCT at 75 degree Celsius at lower and higher taps.	RCT,4 Ohms at 75 degree Celsius	RCT,4 Ohms at 75 degree Celsius
vi) Magnetizing current at knee point voltage	<30mA at VK	<30mA at VK
vii) Additional winding for testing of the CT	Not Required.	Not Required.

8. INSPECTION AND TESTING

- i. The Bidders shall state, the place of manufacture, testing and inspection of various items of equipment included in these specifications.
- ii. All materials shall comply with the requirements of tests specified in the governing standards and additional such other tests as are stipulated in the contract.
- iii. Duplicate copies of manufacturer's tests certificates shall be submitted to the Department as soon as the tests are complete.
- iv. In addition to the aforesaid tests and those included in the contract, the Department reserves the right of having an inspection or tests of reasonable nature carried out on raw materials to ascertain if the same comply with the conditions of the specifications/contract.
- v. All materials and equipment covered under these specifications shall be offered for inspections to the Department and or his authorized agent/agents during various stages of their manufacture.
 - a) Raw materials for manufacture of component at manufacturer's premises.
 - b) The component manufactured from the inspected raw materials before these are finally assembled.
 - c) Timely notice for inspection shall be given by the contractor so that inspection can be carried out in accordance with stipulated schedule. No portion of the work shall be considered complete and in accordance with the terms of the contract unless the Department and its authorized agent have certified in writing that the same has been inspected and duly approved.
- vi. The supplier shall provide the Department and / or authorized agents of the Department, full and free access at any reasonable time during the execution of the contract to make

arrangements for inspection of items. The contractor shall provide without any extra charges all materials, tools, labour and assistance of any kind which the authorized agents of the Department may demand for carrying out inspection and testing.

To and fro charges, i.e., air tickets and surface transport, Boarding and lodging etc., for stage and final inspection shall be borne by the Supplier for which charges shall be inclusive in the quoted prices only.

8.1 **INSPECTION**

Transformers not manufactured as per Type- Tested design shall be rejected.

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 90 deg. 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,
- 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.

Please refer to “Check-list for Inspection of Prime quality CRGO for Transformers” attached at Annexure-A. It is mandatory to follow the procedure given in this Annexure.

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 Supplier 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) ON Load 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 Supplier in accordance with relevant IS . If such requirement is purchased by the Supplier on a sub-contract, he shall have them tested to comply with these requirements.

8.2 TESTS

- i) All standard routine tests in accordance IS: 2026 & IEC-60076 with dielectric tests corresponding as per latest amendments to IS: 2026 & IEC-60076 shall be carried out.
- ii) All auxiliary equipment shall be tested as per the relevant IS/IEC. 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

All tests shall be carried out in accordance with the latest addition of IS 2026 amended upto date.

8.2.1 Type Test

8.2.1.1 The measurements and tests should be carried out in accordance with the standard specified in each case as indicated in the following table, if the same tests were not conducted earlier at CPRI or any NABL accredited Laboratory on the transformers of the offered design, without any cost implication to the Purchaser.

Table: Transformer type tests

Type Tests	Standard
Temperature Rise Test	As per IS 2026 (Part-2)
Lightening Impulse Voltage Withstand Test, including Full Waves and Chopped Waves	As per IS 2026(Part-3)/ IEC 60076-3
Noise Level Measurement	IEC 60551
Short circuit test	IEC76/IS 2026

In accordance with IEC 60076-3/ IS 2026 the following sequence of impulses should have been/ should be applied;

- One full wave at 50% BIL;
- One full wave at 100% BIL;
- One chopped wave at 50% BIL
- Two chopped waves at 100% BIL and
- Two full waves at 100% BIL.

8.2.1.2 If the type test report(s) submitted by the bidder do not fulfill the criteria, as stipulated in this technical specification/ Bidder's offer, the relevant type test(s) has/ have to be conducted by the Bidder at his own cost in CPRI/ NABL accredited laboratory in the presence of Purchaser's representative(s) without any financial liability to Purchaser in the event of order placed on him.

8.2.1.3 The offered transformer must be manufactured as per type tested design. The equipment offered should have been successfully type tested from any of the NABL accredited laboratories/CPRI/ERDA within five years from the date of publication of tender. Compliance shall be demonstrated by submitting authenticated copies of the type test reports.

8.2.1.4 The supplier shall furnish calculations in accordance with IS: 2026 to demonstrate the Thermal ability of the transformers to withstand Short Circuit forces.

8.2.1.5 STAGE INSPECTION

The supplier shall offer the core, windings and tank of each transformer for inspection by the purchaser's representative. 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 Purchaser.

8.2.2 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 resistance.
- (ii) Measurement of Voltage ratio, polarity and check of voltage vector relationship.
- (ii) Measurement of Impedance Voltage at all tapings.
- (iii) Magnetic circuit test as per relevant ISS or CBIP manual or latest standard being followed.
- (iv) Measurement of Load losses at normal tap and extreme taps
- (v) No load losses and no load current at rated voltage and rated frequency, also at 25% to 120 % of rated voltage in steps.
- (vi) Absorption index i.e insulation resistance for 15 seconds and 60 seconds (R 60/ R15) and polarization index i.e Insulation Resistance for 10 minutes and one minute (R 10mt / R 1mt).
- (vii) Short Duration induced AC withstand Voltage test (ACSD) with partial discharge measurement.
- (viii) Separate source AC withstand Voltage Test.
- (ix) Tan delta measurement and capacitance of each winding to earth (with all other windings earthed) & between all windings connected together to earth.
- (x) Measurement of zero sequence impedance.
- (xi) Tests on ON LOAD TAP CHANGER as per latest issue of CBIP Manual on Transformers.
- (xii) Auxiliary circuit tests
- (xiii) Oil BDV tests
- (xiv) Measurement of neutral unbalance current which shall not exceed 2% of the full rated current of the transformer.
- (xv) Magnetic balance test
- (xvi) 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 Employers evaluation of the tests without charge to the Employer.

8.3 TANK TESTS (Mechanical 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**

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 (Latest Edition) without affecting the performance of the transformer.

8.5 **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.

8.6 **INSPECTION AND TESTING AT CONSIGNEE STORES**

On receipt of transformer at Consignee Stores, detailed inspection shall be performed as given below.

8.6.1 **Receipt and Storage Checks**

- i) Check and record conditions of each package visible parts of the transformers etc for any damage.
- ii) Check and record the gas pressure in the transformer tank as well as in the gas cylinder.

8.7 **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.

8.8 **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.

8.9 **WITNESSING OF TESTS AND EXCESSIVE LOSSES**

The Purchaser reserves the right to reject the Transformer if the losses exceed the values guaranteed by the tenderer or if temperature rise of oil and winding exceed the values specified in this specification.

9 **LIQUIDATED DAMAGES FOR EXCESSIVE LOSSES**

There is no positive tolerance on the guaranteed losses offered by the bidder. However, the transformer(s) shall be rejected out rightly, if any of the losses i.e. no load loss or load loss or both exceed (s) the guaranteed maximum permissible loss figures quoted by the bidder in the Technical Data Schedule with the bid.

10. **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 Purchaser to fabricate or procure spare parts from other sources.

10.1 **Mandatory Spare Parts**

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

- i. H.V. & L.V. Bushing & Studs – Each 2 Nos.
- ii. Bimetallic connector for H.V & L.V. Bushings – Each 2 sets
- iii. Any other spares for transformers as recommended by the Tenderer.
- iv. OTI (1Nos)
- v. WTI (1Nos)
- vi. PRV (1Nos)
- vii. Buchholz Relay (1Nos)

10.2 **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.

10.3 **Center of Gravity:** Center of gravity of assembled transformer shall be low and as near the vertical central line as possible. The transformer shall be stable with or without oil. If center of gravity is eccentric related to the track either with or without oil, its location shall be shown on outline drawing.

10.4 Warranty / Guarantee:-

The bidder shall be responsible for replacing at site free of cost any part or parts of the equipment that may prove faulty or fail manufacturing defects on one or more of the reasons **within 3 (Three)** years commencing from the date of commissioning.

In case of failure of the transformer, the supplier shall take back the faulty transformer from its plinth for repair at their own cost (or replace the transformer with a new transformer) and deliver, at their own cost, unload at the destination sub-station transformer plinth within 45 days, from the date of intimation of defects to the satisfaction of the owner, **at free of cost**. If the repair/replacement will not be completed within 45 days, then the supplier shall pay penalty @ 0.5% of the contract price for each calendar week of delay from the end of 45 days from the date of intimation of defects. Also, the Purchaser reserves the right for forfeiture of the total Composite Bank Guarantee and all the Securities, available with KPDCL/Purchaser, in case the Supplier fails to pay the penalty by one month before the expiry of the guarantee period. Also, this will be taken as adverse in all future tenders.

10.5 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 extra charges. The equipment shall be complete in all details whether such details are mentioned in the specification or not, without any financial liability to the Purchaser under any circumstances.

10.6 CHALLENGE CLAUSE:

Purchaser reserves the right to have the material, received after the inspection by the authorized inspecting officer, again tested for any parameter(s) from approved/NABL Accredited testing house/ in house technique of the Purchaser. The results if found deviating/ unacceptable or in non-compliance with the approved GTPs, the lot shall be rejected and bidder shall arrange to replace the rejected LOT within thirty (30) days of such detection at his cost including to & fro transportation.

Sd/-
JE

Sd/-
AEE

Sd/-
Asstt. Ex. Engineer

Sd/-
Executive Engineer

Sd/-
Superintending Engineer
Planning, Srinagar

Check-list for Inspection of Prime quality CRGO for Transformers

During inspection of PRIME CRGO, the following points needs to be checked by the Transformer manufacturer. The Inspector/Representative nominated by the department shall verify all these points during inspection:-

I) In case PRIME CRGO cutting is at works of Transformer Manufacturer:**1. Review of documents:**

Purchase Order (un-priced) to PRIME CRGO supplier/Authorized Agency

Manufacturer's test certificate

Invoice of the Supplier

Packing List

Bill of Lading

Bill of Entry Certificate by Customs Deptt.

Reconciliation Statement as per format below

Certificate of Origin

BIS Certification

2. Format for Reconciliation/Traceability records

Packing List No./date /Quantity of PRIME CRGO received

Name of Manufacturer

Manufacturer test certificate No./date

Serial No.	Details of Package	Drawing Reference	Quantity Invoiced	Cumulative Quantity Consumed	Balance Stock

3. Inspection of PRIME CRGO Coils:

- a. PRIME CRGO-Manufacturer's Identification Slip on PRIME CRGO Coils
- b. Visual Inspection of PRIME CRGO Coils offered as per packing list (for verification of coil details as per Test certificate & healthiness of packaging).

- c. Unique numbering inside of each sample of PRIME CRGO coil and verification of records to be maintained in the register for consumption of CRGO coil.
 - d. ISI logo sticker on packed mother coil and ISI logo in Material TC.
4. During inspection of PRIME CRGO, surveillance testing of sample shall be carried out for Stacking Factor, Permeability, Specific watt loss at 1.5 Tesla and/or 1.7 Tesla depending on the grade of PRIME CRGO and aging test etc. applicable as per relevant IS/ IEC standard, Tech. Spec., MQP and Transformer manufacturer plant standard.

Inspection Clearance Report would be issued after this inspection

5. Inspection of PRIME CRGO laminations:

Transformer manufacturer will maintain records for traceability of laminations to prime CRGO coils and burr/bow on laminations shall be measured. Department can review these records on surveillance basis.

6. Inspection at the time of core building:

Visual Inspection of PRIME CRGO laminations. In case of suspected mix-up/ rusting/discoloration, samples may be taken for testing on surveillance basis for tests mentioned in 4 above.

Above tests shall be witnessed by departmental representative. In case testing facilities are not available at Manufacturer's work, the sample(s) shall be sealed by inspector/departmental representative to be sent to approved labs for testing.

Inspection Clearance Report would be issued after this inspection

II) In case PRIME CRGO cutting is at Sub-vendor of Transformer Manufacturer:

1. Review of documents:

Purchase Order (un-priced) to PRIME CRGO supplier/ Authorized Agency

Purchase Order (un-priced) to Core Cutter

Manufacturer test certificate

Invoice of the Supplier

Packing List

Bill of Lading

Bill of Entry Certificate by Customs Deptt.

Reconciliation Statement as per format below

Certificate of origin

BIS Certification

2. Format for Traceability records as below:-

Packing List No./date /Quantity of PRIME CRGO received

Name of Manufacturer

Manufacturer test certificate No./date

Serial No.	Name of Customer	Details of Package	Drawing Reference	Quantity Invoiced	Cumulative Quantity Consumed	Balance Stock	Dispatch details

3. Inspection of PRIME CRGO Coils:

- a. PRIME CRGO-Manufacturer’s Identification Slip on PRIME CRGO Coils
 - b. Visual Inspection of PRIME CRGO Coils offered as per packing list (for verification of coil details as per Test certificate & healthiness of packaging).
 - c. Unique numbering inside of each sample of PRIME CRGO coil and verification of records to be maintained in the register for consumption of CRGO coil.
 - d. ISI logo sticker on packed mother coil and ISI logo in Material TC.
4. During inspection of PRIME CRGO, surveillance testing of sample shall be carried out for Stacking Factor, Permeability, Specific watt loss at 1.5 Tesla and/or 1.7 Tesla, thickness depending on the grade of PRIME CRGO and aging test etc. applicable as per relevant IS/ IEC standard, Tech. Spec., MQP and Transformer manufacturer plant standard.

Inspection Clearance Report would be issued after this inspection

5. Inspection of PRIME CRGO laminations:

Transformer manufacturer representative will inspect laminations and issue their internal Inspection Clearance Report. Inspection will comprise of review of traceability to prime CRGO coils, visual Inspection of PRIME CRGO laminations and record of burr/bow. After clearance given by transformer manufacturer, departmental inspector will issue an Inspection Clearance Report after record review. The department reserves the right to depute the departmental representative during this inspection carried out by transformer manufacturer representative.

Inspection Clearance Report would be issued after this inspection

6. Inspection at the time of core building:

Visual Inspection of PRIME CRGO laminations. In case of suspected mix-up/rusting/discoloration, samples may be taken for testing on surveillance basis for tests mentioned in S.No.4 above.

Inspection Clearance Report would be issued after this inspection

NOTE:-

- a) Transformer Manufacturer to ensure that PRIME CRGO is procured from POWERGRID approved vendors and CRGO manufacturer should have valid BIS Certificate for respective offered Grade.
- b) Transformer Manufacturer should also involve themselves for ensuring the quality of CRGO laminations at their Core Cutter's works. They should visit the works of their Core cutter and carry out necessary checks.

III) General

If a surveillance sample is drawn and sent to TPL (if testing facility not available with the manufacturer), the Transformer manufacturer can continue manufacturing at their own risk and cost pending TPL test report on PRIME CRGO sample drawn. Decision for acceptance of PRIME CRGO shall be based upon report of the sample drawn.

These checks shall be read in-conjunction with approved Quality Plan, specification as a whole and conditions of contract.

Sampling Plan (PRIME CRGO)

33 / 11 kV	1 st transformer and subsequently at random 10% of Transformers (min. 1) offered for inspection.
DTs and other ratings	1 st transformer and subsequently at random 2% of Transformers (min. 1) offered for inspection.

NOTE: -

One sample for each lot of CRGO shall be drawn on surveillance basis.

CRGO has to be procured only from POWERGRID (PGCIL) approved vendors. List of such vendors is available at PGCIL website. Since the list is dynamic in nature, the site may be checked from time to time to see the list of approved vendors.

**GUARANTEED TECHNICAL PARTICULARS FOR 10MVA, 33/11kV, POWER
TRANSFORMER WITH ON LOAD TAP CHANGER AGAINST NIT NO: -----
(To be filled in by the tenderer /bidder)**

S. No	Particulars	Tenderer's response
1.	Name and address of the manufacturer	
2.	Country of origin	
3.	Applicable standard	
4.	Maximum continuous rating (in MVA)	
5.	No load voltage ratio at Principal (Nominal) tap (in KV/KV)	
6.	Rated frequency (in Hz)	
7.	Number of phases	
8.	Type of Cooling	
9.	Connections	
	(i) H.V. Winding	
	(ii) L.V. Winding	
10.	Vector Symbol	
11.	Tappings	
	(a) Range	
	(b) Number of steps	
	(c) Variation of voltage in each step (in kV)	
	(d) No load voltage ratio in each tap (in kV/kV) for 10 MVA 33/11kV TR.	
	Tap Number	Voltage ratio in kV/kV
	1	
	2	
	3	
	4	
	5	
	6	
	7	
	8	
	9	
	10	
	11	

	12		
	13		
	14		
	15		
	16		
	17		
12	(i) Temperature rise under normal operating condition above ambient temperature		
	(a) Top oil (in Degree C)		
	(b) Windings (in Degree C)		
	(ii) Maximum hot spot temperature of Copper windings (in Degree C)		
13	Magnetizing current referred to H.V. at rated frequency		
	(a) at 90% rated voltage : (in Amps)		
	(b) at 100% rated voltage : (in Amps)		
	(c) at 110% rated voltage (in Amps)		
14	Power factor of magnetizing current at 100% rated voltage & frequency		
15	No load current at rated voltage and Rated frequency (in Arms)		
16	No load loss in kW at rated frequency and voltage		
	(a) at Lowest tap		
	(b) at principal tap		
	(c) at highest tap		
17	Load loss in kW at 75 Deg. C. at Rated output and frequency		
	(a) at Lowest tap		
	(b) at principal tap		
	(c) at highest tap		
18	Percentage Regulation at full load at 75 Deg.C		
	(a) at unity power factor		
	(b) at 0.8 power factor lagging		
19	Efficiencies at 75 Deg.C (in percentage)		
	a) at full load (i) at unity power factor		
	(ii) at 0.8 power factor lagging		
	(b) at $\frac{3}{4}$ full load (i) at unity power factor		

	(ii) at 0.8 power factor lagging	
	(c) at 1/2 full load (i) at unity power factor	
	(ii) at 0.8 power factor lagging	
20	Impedance voltage on rated MVA base at rated current and frequency for the Principal tapping 75 Deg.C. (in percentage)	
21	a) Reactance voltage at rated current and frequency for the principal tapping at 75 Deg.C. (in percentage) b) Resistance voltage at rated current and frequency for the principal tapping at 75	
22	Resistance at H.V. base at 75 Deg.C.	
	(a) at Lowest tap	
	(b) at principal tap	
	(c) at highest tap	
23	Reactance at H.V. base at 75 Deg.C.	
	(a) at Lowest tap	
	(b) at principal tap	
	(c) at highest tap	
24	Withstand time for three phase dead short circuit at terminal (in seconds)	
25	Short time current rating for short circuit with duration	
	a) H.V. winding (in K. Amps)	
	b) L.V. winding (in K Amps)	
	c) Duration (in seconds)	
26	Permissible overloading with time	
27	Core :	
	i) Type	
	ii) Flux density of Core and yoke at principal tap	
	a) at 100% rated voltage at 50 Hz (in lines/sq.cm	
	b) at 110% rated voltage at 50 Hz (in lines/sq.cm.)	
	iii) Thickness of Stamping (in mm)	
	iv) Type of insulation between core laminations	
	v) Core bolt withstand Insulation (in KV rms for 1 min)	

	vi) Approximate area of Cross Section of Core and yoke (in sq.mm.)			
	vii) Material of Core clamping plate			
	viii) Thickness of Core clamping plate (in mm)			
	ix) Insulation of Core clamping plate			
	x) Describe location/Method of Core grounding			
28	Terminal Arrangement			
	i) High Voltage			
	ii) Low Voltage			
29	Positive Sequence Impedance between HV & L.V. winding on rated MVA base at rated Current and frequency at 75 Deg.C. winding temperature			
	i) At principal tapping (in percent)			
	ii) At lowest tapping (in percent)			
	iii) At highest tapping (in percent)			
30	Zero Sequence Impedance at reference temperature of 75 Deg.C at principal tap (in percent)			
31	Details of windings			
	i) Type of Winding			
	(a) High Voltage			
	(b) Low Voltage			
32	Winding conductor			
i	Material of the winding conductor			
	(a) High Voltage			
	(b) Low Voltage			
ii	Conductor Area :			
	(a) High Voltage (in sq.cm)			
	(b) Low Voltage (in sq.cm)			
iii	Current density of windings at rated MVA	At principal tapping	At lowest tapping	At highest tapping
a	High voltage (Amp.per sq.cm)			
b	Low voltage (Amp.per sq.cm)			
iv	Insulating material used for			

	(a) High voltage winding			
	(b) Low voltage winding			
v	Insulating material used between			
	(a) High voltage and low voltage winding			
	(b) Low voltage winding and core			
vi	Whether adjustable coil clamps are provided for H.V. & L.V. winding (if yes, details may be given)			
vii	Type of Axial Coil Supports			
	(a) H.V. winding			
	(b) L.V. winding			
viii	Type of Radial Coil Supports			
	(a) H.V. winding			
	(b) L.V. winding			
32	Insulation withstand Test voltages	HV	LV	
	Lightning Impulse withstand test voltage 9kv Peak)			
	(ii) Power frequency withstand test voltage (in KV rms for 1 min)			
	(iii) Induced over voltage withstand test voltage (in KV rms)			
33	Current in the winding at rated MVA	At principal tapping	At lowest tapping	AT highest tapping
	(i) Low voltage (in Amps)			
	(ii) High voltage (in Amps)			
34	Voltage per turn (KV per turn)			
	Ampere turn			
36	Number of turns	At principal tapping	At lowest tapping	AT highest tapping
	(i) Low Voltage			
	(ii) High Voltage			
37	Details of Tap changer			
	i) Number of steps			
	ii) Number of Plus taps			
	iii) Number of minus taps			
	iv) Position of taps on HV			

	v) Type of tap changing arrangement				
38.	Bushing :	High voltage		Low voltage	
	i) Make				
	ii) Type				
	iii) Applicable standard				
	iv) Insulation withstand test Voltage				
	a) Lightning Impulse withstand test voltage (1.2 x 50 micro seconds in KV peak)				
	b) Power frequency withstand test voltage (in KV rms for 1 min)				
	1) Dry				
	2) Wet				
	v) Creepage distance				
	a) Total (in mm)				
	b) Protected (in mm)				
	vi) Minimum height of the bushing				
39.	Minimum clearance (in mm)	In Oil		In Air	
		Between Phases	Phase to Ground	Between Phases	Phase to Ground
	i) H.V.				
	ii) L.V.				
40.	Particulars of Bushing & Neutral C.T.				
	i) Type				
	ii) Ratio				
	iii) Accuracy Class				
	iv) Knee Point Voltage				
	v) RCT at 75 Deg. C				
	vi) Magnetizing Current at Knee Point Voltage				
	vii) Additional winding particulars of testing on the C.T.				
	viii) Short Time Rating				
	ix) Reference Standard				
41	Approximate weight of Transformer (in Kgs)				
	i) Core with clamping				

	ii) Coil with insulation		
	iii) Core and winding		
42.	Tank and fitting with accessories		
	v) Un-tanking weight		
	vi) Oil required for first filling		
	vii) Total weight with Core, Winding, Oil Fittings		
43.	Details of Tank		
i)	Type of tank		
ii)	Approximate thickness of Sheet (in mm)		
	a) Sides		
	b) Bottom		
	c) Cover		
	d) Radiators		
iii)	Vacuum recommended for hot		
iv)	Vacuum to which the tank can be subjected without distortion (in Torr.)		
v)	Under carriage dimensions		
	a) No. of bidirectional wheels provided		
	b) Track gauge required for the wheels	Transverse	Longitudinal
	Dimension of base channel (in mm x mm)		
	vi) Type of Pressure relief device / Explosion Vent and pressure at which it operates		
44.	Conservator		
	i) Total volume (in Litres)		
	ii) Volume between the highest and Lowest visible oil level (in litres)		
45.	Oil Quality		
	i) Applicable standard		
	ii) Total quantity of oil (in Litres)		
46.	Radiator		
	i) Number of Radiator Bank		
	ii) Number of tubes/fins in each radiator Bank		

	iii) Thickness of tubes/fins (in mm)		
	iv) Overall dimensions (in mm)		
	a) Length		
	v) Type of mounting		
	viii) Vacuum withstand capability		
47	Gas And Oil Actuated Relay		
	i) Make		
	ii) Type		
	iii) Number of float contacts		
	Temperature Indicators		
i)	Make		
ii)	Type		
48	Permissible setting ranges for alarm and trip	Oil Temperature Indicator	Winding Temp. Indicator
iv)	Number of contacts		
v)	Current rating of each contact		
	Approximate overall Dimensions (in mm)		
	a) Length		
	b) Breadth		
	c) Height		
	d) Minimum height of bottom portion of bushing from bottom of base channel		
50.	Minimum clearance height for lifting tank cover (in mm)		
51.	Make of OLTC		
52.	Whether OLTC is Type tested		
53.	Whether OLTC is in line with the specification		
54.	Make of RTCC		
	whether RTCC is in line with the specification		
55.	Whether all particulars as specified		
56	Whether the transformer is type tested and whether agreeable to repeat type tests, in line with specification at vendors cost.		

(Note:- Repeat same for 6.3MVA)

Signature of the Bidder: _____

Name: _____

Designation: _____