Technical Specification

For

400/630/1000 KVA,11/0.433 KV

Oil Filled Distribution Transformer

(With Reduced Dimension)

Specification No – SP-TRDU-02-02

PREPARED BY	REVIEWED BY	APPROVED BY	REV	DATE
SUPRIYA	MEENAKSHI BANERJI	KIRAN KUMAR ALLA	00	27.07.2015
SEEMA SHEKHAWAT	AMIT TOMAR	VIJAY PANPALIA	01	19.05.2017
VANI SOOD	AMIT TOMAR	K SHESHADARI	02	12.12.2019
Vani sood 12/12/19.	12/12/19	16/12/19.	PAGE	01 OF 51

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Record of Revision

Sl No.	Revision No	Item/Clause No.	Nature of change	Approved by
1	R1	3.23	1000kVA Transformer rating revised to 1000kV	MDB/KKA
2	R1	3.24.1	400 & 630kVA percentage impedance changed to 4.5%	MDB/KKA
3	R1	3.41 & 4.2.11.1	Tapping range revised	MDB/KKA
4	R1	4.2.5.5	Flux density at over fluxing changed	MDB/KKA
5	R1	4.2.7.1	Transformer oil type testing from CPRI/ERDA	SS/VP
6	R1	7.2	Testing shall be BSES Standard QAP	SS/VP
7	R1	10.1.5	Oil testing as per BSES QAP and Specification	SS/VP
8	R1	10.2	IR values shall not be less than 2000Mohn	SS/VP
9	R1	3.2.5 & 3.2.6	Losses revised	SS/VP
10	R2	4.2.6.5	Type of LV and HV winding added	AT/KS
11	R2	4.2.8.1	Type of HV bushing revised	AT/KS
12	R2	4.11	WTI/OTI added	AT/KS
13	R2	5.1.5	Rating plate revised	AT/KS
14	R2	10.1.2	Core testing added	AT/KS
15	R2	Annexure –C	Properties of transformer oil revised	AT/KS
16	R2	4.2.7.1 &Annexure -- D	Separate containers for extra oil added	AT/KS
17	R2	Annexure-H	CRGO & Testing Points added	AT/KS

1.0 Scope of supply

For scope of supply, refer annexure – A

2.0 Codes & standards

a)Materials, equipment and methods used in the manufacture of Power Transformer shall conform to the latest edition of below mentioned standards. b) Vendor shall possess valid BIS Certification.

IEC Standards

IEC 60034	Rotating Electrical Machines. (e.g. For Cooler Fan Motors.)
IEC 60071	Co-ordination of Insulation.
IEC 60076	Power transformers.
IEC 60156	Method for Determination of the Electric Strength for Insulating Oils.
IEC 60044	Current Transformers.
IEC 60214	On Load Tap Changers
IEC 60296	Specification for Unused Mineral Insulating Oils for Transformers and Switchgear.
IEC 60354	Loading Guide for Oil-Immersed Power Transformers.
IEC 60445	Basic& Safety principles for man-machine interface, marking and identification, Identification of Equipment Terminals and conductor terminals
IEC 60529	Degrees of Protection Provided by Enclosures (IP Code).
IEC 60551	Determination of Transformer and Reactor Sound Levels.
IEC 60606	Application Guide for Power Transformers.
IEC 60616	Terminal and Tapping Markings for Power Transformers.
IEC 60947	Low-Voltage Switchgear and Control gear.
IEC 60947	Bushing for alternating voltage above 1000V

British Standard

BS 148	Determination of Transformer and Reactor Sound Levels.
BS 148	Application Guide for Power Transformers.
BS 148	Terminal and Tapping Markings for Power Transformers.

Indian Standards

IS:335	Insulating oil

IS:1271	Thermal evaluation and classification of electrical insulation
IS:2099	Bushing for Alternating voltage above 1000V
IS:2705	Current Transformers
IS:3347	Dimensions for Porcelain Transformer bushing
IS:3637	Gas operated relays
IS:3639	Fitting & Accessories for power transformers
IS:4201	Application guide for CT's
IS:6600	Guide for loading of oil immersed transformers
IS:8478	Application guide for On-load tap changer
IS:8468	On-load tap changer
IS:10028	Code of practice for selection, installation & maintenance of transformers
IS:13947	LV switchgear and Controlgear-Part1
IS 2026	Power Transformers
IS 1180	Outdoor type oil immersed distribution transformer upto and including 2.5MVA,33kV
IS 5561	Electrical Power Connectors
IS 5	Colors for ready mix paints
IS 6272	Industrial cooling fans
IS 325	Three phase induction motors
	Indian Electricity Rules
	Indian Electricity Act
	CBIP manual

In the event of direct conflict between various order documents, the precedence of authority of documents shall be as follows -

i. Guaranteed Technical Particulars (GTP)

ii. This Specification

iii Indian Standards / IEC standards

iv Approved Vendor Drawings

iv. Other documents

3.0 Major Design Criteria & Parameters of the Transformer

Sr No	Description	Data by purchaser
3.1	Voltage variation on supply side	+ / - 10 %
3.2	Frequency variation on supply side	+/ - 5 %
3.3	Transient condition	- 20 % or + 10 % combined variation of voltage and frequency

3.4	Service Condition	Refer Annexure B
3.5	Insulation level	Class A
3.6	Location of equipment	Generally Outdoor but may be located indoor also with poor ventilation
3.7	Reference design ambient temperature	50 deg C
3.8	Type	Oil immersed, core type, step down
3.9	Type of cooling	ONAN
3.10	Reference standard	IS: 2026/IS 1180
3.11	No. of phases	3
3.12	No. of windings per phase	2
3.13	Rated frequency (Hz)	50 Hz
3.14	Highest system voltage HV side	12 kv
3.15	Highest system voltage LV side	460 volt
3.16	Lightning Impulse withstand voltage , kV peak	
3.16.1	For nominal system voltage of 11 kV	75
3.17	Power Frequency Withstand Voltage kV rms	
3.17.1	For nominal system voltage of 11 kV	28
3.17.2	For nominal system voltage of 415 V	3
3.18	Clearances Phase to Phase , mm	
3.18.1	For nominal system voltage of 11 kV	280
3.18.2	For nominal system voltage of 415 V	75
3.19	Clearances Phase to Earth , mm	
3.19.1	For nominal system voltage of 11 kV	140
3.19.2	For nominal system voltage of 415 V	40
3.20	System Fault Level , HV side	350 MVA
3.21	System Fault Level , LV side	35 MVA
3.22	System earthing	
3.22.1	HV	Solidly earthed
3.22.2	LV	Solidly earthed
3.23	Ratings	400/630/1000 kVA**[R1]**
3.24	Percentage Impedance at 75 deg.V	5.0 % with IS tolerance

3.25	Max Total losses(No Load+ Load Losses at 75ºC) at 50% of the rated load , kW	
3.25.2	400 kVA	1.225**[R1]**
3.25.3	630 kVA	1.860**[R1]**
3.25.4	1000 kVA	2.79**[R1]**
3.26	Max Total losses(No Load+ Load Losses at 75ºC) at 100% of the rated load , kW	
3.26.1	400 kVA	3.45**[R1]**
3.26.2	630 kVA	5.30**[R1]**
3.26.3	1000 kVA	7.70**[R1]**
3.27	Phase CT Ratio , Amp	
3.27.1	400 kVA	600/5
3.27.2	630 kVA	1000/5
3.27.3	1000 kVA	1600/5
3.28	HV cable size for all sizes / Conductor size	11 kV (E) grade , A2XCEWY 3C x 150 sqmm
3.29	Tinned Copper Busbar size on HV side for cable termination, mm x mm	Not Required
3.30	LV cable size, 650 /1100 V grade , A2XY cable single core 630 sqmm unarmoured (approx cable dia 40 mm)	Cable
3.30.1	400 kVA	2 runs per phase + 2 runs in Neutral
3.30.2	630 kVA	3 runs per phase + 2 runs in Neutral
3.30.3	1000 kVA	3 runs per phase + 2 runs in Neutral
3.31	Tinned Copper Busbar size on LV side for cable termination, mm x mm	
3.31.1	Phase	Not Required
3.31.2	Neutral	Not Required
3.32	Maximum Overall Dimension Acceptable (length x width x height), mm x mm x mm **(Mandatory)**	
3.32.1	400 kVA	1700 x 1500 x 1700
3.32.2	630 kVA	1800 x 1800 x 1900
3.32.3	1000 kVA	**1850 x 1800 x 2350**

3.33	Short Circuit withstand Capacity of the transformer	
3.34	Three phase dead short circuit at secondary terminal with rated voltage maintained on the other side	For 3 secs.
3.35	Single phase short circuit at secondary terminal with rated voltage maintained on other side	For 3 secs.
3.36	Overload Capability	As per IS 6600/IEC 60905
3.37	Noise Level	400/630/1000 KVA-56/57/58 db respectively.
3.38	Radio Influence Voltage	Maximum 250 microvolt
3.39	Harmonic suppression	Transformer to be designed for suppression of 3rd, 5th, 7th harmonic voltages and high frequency disturbances.
3.40	Partial Discharge	Transformer to be free from partial discharge upto 120 % of rated voltage as the voltage is reduced from 150 % of rated voltage i.e. there shall be no significant rise above background level
3.41	Tappings	Off Circuit taps on HV winding , + 5 to -10 % in steps of 2.5 % , change of taps by externally operated switch **[R1]**
3.41.1	Rotary tap switch operating voltage	11 kV
3.41.2	Rotary tap switch current rating, Amp.	
3.41.2.1	400 kVA	60 Amp
3.41.2.2	630 / 1000 kVA	100 Amp
3.42	Loss capitalization formulae	As per CBIP manual (see note 1)
3.43	No load Loss capitalization figure	Rs 4,09,979 per kw
3.44	Load loss capitalization figure	Rs 2,26,718 per kw

Note : The bidder shall guaranteed No load losses & load loss individually without any positive tolerance , the bidder shall also guarantee losses at 50% and 100% load (at rated voltage & frequency & 75 deg. C) and no positive tolerance shall be allowed on max. Total losses declared by bidder for 50 % & 100 % loading values. In the event of measured loss figures during testing exceeding the guaranteed loss figures of the successful bidder, penalty shall be applied at the rate of 1.25 times the figures mentioned above. The corresponding capitalization figures for load and load losses shall be as Cl. 3.43 and 3.44 above.

4.0 Construction & Design

4.1	Type	Double Copper wound, three phase, oil immersed, with ONAN cooling, with off circuit tap changer
4.2	**Major Parts**	
4.2.1	**Tank**	
4.2.1.1	Type	Non sealed type with conservator as per manufacturer's standard.
4.2.1.2	Material of Construction	Robust mild steel plate without pitting and low carbon content
4.2.1.3	Plate Thickness	Adequate for meeting the requirements of pressure and vacuum type tests as per IS
4.2.1.4	Welding features	i) All seams and joints shall be double welded ii) All welding shall be stress relieved for sheet thickness greater than 35 mm iii) All pipes, radiators, stiffeners, welded to the tank shall be welded externally

4.2.1.5	Tank features	i) Adequate space at bottom for collection of sediments ii) Stiffeners provided for rigidity and designed to prevent accumulation of water iii) No internal pockets in which gas/air can accumulate iv) No external pocket in which water can lodge v) Tank bottom with welded skid base vi) Tank cover sloped to prevent retention of rain water vii) Minimum disconnection of pipe work and accessories for cover lifting viii) Tanks shall be of a strength to prevent permanent deformation during lifting , jacking, transportation with oil filled. ix) Tank to be designed for oil filling under vacuum x) Tank cover fitted with lifting lug xi) Tank cover bent at all the ends xii) Bushings to be mounted on top Cover
4.2.1.5	Flanged type adequately sized inspection cover rectangular in shape required for	i) HV line bushing ii) LV line bushing iii) LV neutral bushing iv) Core / Winding
4.2.1.6	Fittings and accessories on main tank	See under fittings and accessories.
4.2.2	**Conservator for the main tank**	
4.2.2.1	Capacity	Adequate between highest and lowest visible levels to meet the requirement of expansion of oil volume in the transformer and cooling equipment from minimum ambient temperature to Maximum operating temperature.
4.2.2.2	Conservator oil preservation system	Conventional
4.2.2.3	Conservator features	i) Conservator shall be bolted into position so that it can be removed for

		cleaning / other maintenance purposes ii) Main pipe from tank shall project about 20 mm above conservator bottom for creating a sump for collection of impurities iii) Conservator minimum oil level corresponding to minimum temperature shall be well above the sump level. iv) Conservator to main tank piping shall be supported at minimum two points.
4.2.2.4	Fittings and accessories on main tank conservator	i) Prismatic oil gauge with MINIMUM , NORMAL and MAXIMUM marking ii) End Cover iii) Oil Filling Hole with cap iv) Silica Gel Dehydrating Breather with oil seal and dust filter with clear acrylic single piece clearly transparent cover resistant to UV rays**(1kg).** Silica gel shall be of round ball type of 2.5mm dia. vi) Drain Plug vii) Air release plug as required viii) Pressure/ Vacuum gauge ix) Magnetic Oil Gauge with LOW LEVEL ALARM x) Silica gel shall be of round ball type of 2.5mm dia.
4.2.3	**Radiators**	Detachable type
4.2.3.1	Thickness	1.2 mm min.
4.2.4.2	Features	With lifting lugs, air release plug, drain plug
4.2.5	**Core**	
4.2.5.1	Material	High grade , non ageing, low loss, high permeability, grain oriented, cold rolled silicon steel lamination.

4.2.5.2	Grade	Premium Grade minimum M3 or better
4.2.5.3	Lamination thickness	0.23mm Max
4.2.5.4	Design Flux Density at rated conditions at principal tap	As per Manufacturer design.
4.2.5.5	Maximum Flux Density at 12.5 % over excitation / over fluxing**[R1]**	1.9 T
4.2.5.6	Core Design Features	i) Magnetic circuit designed to avoid short circuit paths within core or to the earthed clamping structures ii) Magnetic circuit shall not produce flux components at right angles to the plane of lamination to avoid local heating iii) Least possible air gap and rigid clamping for minimum core loss and noise generation iv) Adequately braced to withstand bolted faults on secondary terminals without mechanical damage and damage/ displacement during transportation and positioning. v) Percentage harmonic potential with the maximum flux density under any condition limited to avoid capacitor overloading in the system vi) All steel sections used for supporting the core shall be thoroughly sand blasted after cutting , drilling, welding vii) Provision of lifting lugs for core coil assembly viii) Supporting framework designed not to obstruct complete drainage of oil from transformer
4.2.6	**Winding**	
4.2.6.1	Material	Electrolytic Copper
4.2.6.2	Maximum Current Density allowed	3 Amp per sq mm at all taps.
4.2.6.3	Winding Insulating material	Class A , non catalytic, inert to transformer oil, free from compounds liable to ooze

		out, shrink or collapse.
4.2.6.4	Winding Insulation	Uniform
4.2.6.5	Design features	i) Type of winding **[R2]:** LV: Spiral/Helical HV: Crossover/Disc **Note: No foil winding shall be acceptable** ii) Stacks of winding to receive adequate shrinkage treatment ii) Connections braced to withstand shock during transport, switching, short circuit, or other transients. iii) Minimum out of balance force in the transformer winding at all voltage ratios. iv) Conductor width on edge exceeding six times its thickness v) Transposed at sufficient intervals. vi) Coil assembly shall be suitably supported between adjacent sections by insulating spacers + barriers vii) Winding leads rigidly supported , using guide tubes if practicable viii) Winding structure and major insulation not to obstruct free flow of oil through ducts ix) Provision of taps as per clause 3.41
4.2.7	**Transformer Oil**	
4.2.7.1	Type	Should be in accordance with specification as per Annex C1 of this document One sample of oil drawn from every lot of transformer offered for inspection should be tested from CPRI/ERDAfor tests as listed in BSES Standard QAP. The cost of this testing should be included within the cost of transformer. The results shall be confirming to BSES specification Annex C 10% extra oil to be furnished in separate non-returnable drum with each transformer **[R2]**
4.2.8	**Bushings and Terminations**	

4.2.8.1	Type of HV side bushing	Outdoor, porcelain, rated voltage and creepage as per 31mm/kV with voltage class of 12kV respectively Bushing to be considered on top cover for optimization of size**.[R2]**
4.2.8.2	Type of LV side & Neutral bushing	Outdoor, Porcelain , 1.1kV rated voltage andcreepage 31mm/kV.
4.2.8.2.1	Extra Neutral Bushing	Outdoor, Porcelain. Extra Neutral Bushing shall be provided. Extra Neutral Bushing shall be short internally with LV Neutral Bushing.
4.2.8.3	Arching Horns	Not required
4.2.8.4	Support of HV and LV Cable	By HDPE cleat fixed on the on MS bracket of size 50x 10 supported from the tank wall.
4.2.8.5	Termination on HV side bushing	Cable connection for cable size of 11kV(E) grade,A2XFY 3Cx150 sq mm
4.2.8.6	Termination of LV side bushing	Cable connection for cable size of 0.65/1.1 kV grade, A2XY,1Cx630 sq mm (approx cable size 40mm)
4.2.8.7	Minimum creepage distance of all bushings and support insulators	31mm/kV
4.2.8.8	Protected creepage distance	At least 50% of total creepage distance.
4.2.8.9	Continuous Current rating	Minimum 20 % higher than the current corresponding to the minimum tap of the transformer
4.2.8.10	Rated thermal short time current	25 times rated current for 2 secs.
4.2.8.11	Atmospheric protection for clamp and fitting of iron and steel	Hot dip galvanizing as per IS 2633
4.2.8.12	Bushing terminal lugs in oil and air	NA
4.2.8.13	Sealing washers /Gasket ring	NA
4.2.8.14	Terminal Clearances	As per Cl No 3.18
4.2.9	**HV & LV Cable Box**	
4.2.9.1	Material of Construction	
4.2.9.2	Cable entry	
4.2.9.3	Cable size for HV	

4.2.9.4	Cable size for LV	Not required
4.2.9.5	Cable size for LV Neutral	
4.2.9.6	Detachable Gland Plate material for HV, LV, LV Neutral box	
4.2.9.7	Gland plate thickness for HV, LV, LV Neutral box	
4.2.9.8	Cable gland for HV, LV, LV Neutral cables	
4.2.9.9	Cable lug for HV, LV, LV Neutral cables	
4.2.9.10	Essential parts	
4.2.9.11	Termination Height required for cable termination.	
4.2.9.12	Terminal Clearances	
4.2.10	**Current Transformers**	
4.2.10.1	Provision	On all three phases on LV side
4.2.10.2	Mounting	On LV side bushings on all three phases with the help of fibre glass mounting plate affixed to main tank by nut bolt arrangement
4.2.10.3	Maintenance requirements	Replacement should be possible by removing fixing nut of mounting plate after removal of LT cable without disturbing LT bushing
4.2.10.4	Accuracy Class	0.5
4.2.10.5	Burden	10VA
4.2.10.6	Type	Resin Cast Ring type suitable for outdoor use (Mounted on transformer top)
4.2.10.7	CT ratio	
	400kVA	600/5
	630kVA	1000/5
	1000kVA	1500/5
4.2.10.8	**CT terminal Box**	
4.2.10.8.1	Size	650 mm height x 450 mm width x 275 mm depth.
4.2.10.8.2	Fixing of instrument / meters within box	On slotted channel 40 x 12 mm size, channel fixed on vertical slotted angle 40 x 40 mm size at two ends

4.2.10.8.3	No of horizontal channels to be provided	Four
4.2.10.8.4	Fixing of terminals within the box	On horizontal slotted channel with the help of C channel available with the terminals
4.2.10.8.5	Location	On tank wall
4.2.10.8.6	Box door design	Openable from outside with antitheft hinge, padlock facility, door fixed by stainless steel allen screw M6 size , door shall have canopy for rain protection
4.2.10.8.7	Terminal strip	Nylon 66 material, minimum 4 sq mm, screw type for control wiring and potential circuit.
4.2.10.8.8	Cables and wires	PVC insulated, extruded PVC inner sheathed, armoured, extruded PVC outer sheathed 1100 V grade control cable as per latest edition of IS 1554 part 1 minimum 2.5 sq mm for signals and 4 sq mm for CT with multi strand copper conductor
4.2.10.8.9	Cable Glands	Nickel plated brass double compression weatherproof cable gland
4.2.10.8.10	Lugs on wires	Tinned copper pre insulated Pin, Ring, Fork type as applicable
4.2.10.8.11	Potential signal in CT box	i)Tapped from main LV busbar ii)Neutral Link and Fuse to be provided by bidder for PT
4.2.10.8.12	Essential provision	Wiring diagram to be fixed on the back of door along with CT spec. on Aluminum engraved plate fixed by rivet.
4.2.11	**Off Circuit tap Switch**	
4.2.11.1	Range /Step	Off circuit taps on HV winding, +/- 5% in steps of 2.5%, change of taps by externally operated switch.
4.2.11.2	Type	Rotary type, 3 pole gang operated, draw out type
4.2.11.3	Operating Voltage	11kV
4.2.11.4	Rated Current for tap Switch	400 kVA - 60 Amps

		630/1000 kVA - 100 Amps
4.2.11.5	Operating Handle	External at suitable height to be operated from ground level.
4.2.11.6	Essential provision	Tap position indicator, direction changing facility, locking arrangement, and caution plate metallic fixed by rivet.
4.2.12	**Pressure Relief Device**	
4.2.12.1	Type	Explosion vent
4.2.12.2	Provision on explosion vent	Double diaphragm & sight glass
4.3	**Hardware**	
4.3.1	External	Stainless Steel
4.3.2	Internal	Cadmium plated except special hardware for frame parts and core assembly as per manufacturer's design
4.4	**Gasket**	
4.4.1	For Transformer , surfaces interfacing with oil like inspection cover etc.	Nitrile cork rubber RC70C grade
4.4.2	For Cable boxes, Marshalling box, etc.	Neoprene rubber based/cork nitrile
4.5	**Valves**	
4.5.1	Material of construction	Brass / gun metal
4.5.2	Type	Both end flanged gate valve / butterfly valve depending on application
4.5.3	Size	As per manufacturer's standard
4.5.4	Essential provision	Position indicator, locking rod, padlocking facility, valve guard, cover plate.
4.6	**Cable routing on Transformer**	Control cables for accessories on transformer tank shall be routed through perforated GI trays
4.6.1	Control cable specification	PVC insulated, extruded PVC inner sheathed, armoured, extruded PVC outer sheathed 1100 V grade control cable as per latest edition of IS 1554 part 1 minimum 2.5 sq mm for signals and 4 sq mm for CT with multi strand copper conductor
4.6.2	Specification of wires to be used inside marshalling box , OLTC drive	PVC insulated multi-strand flexible copper wires of minimum 2.5 sq mm size, 1100 V

	mechanism	grade as per latest edition of relevant IS
4.7	**Terminal Blocks to be used by the vendor**	Nylon 66 material, minimum 4 sq mm, screw type for control wiring and potential circuit.
4.7.1	Essential provision for CT terminals	Sliding link type disconnecting terminal block screwdriver operated stud type with facility for CT terminal shorting material of housing melamine/ Nylon66
4.8	**Cable glands to be used by the vendor**	Nickel plated brass double compression weatherproof cable gland
4.9	**Cable lugs to be used by the vendor**	
4.9.1	For power cables	NA
4.9.2	For Control Cable	Tinned copper pre insulated Pin, Ring, Fork type as applicable
4.10	**Painting of transformer, Radiator, marshalling box for CT, cable boxes etc.**	
4.10.1	Surface preparation	By 7 tank pretreatment process or shot blasting method
4.10.2	Finish on internal surfaces of the transformer	Bright Yellow heat resistant and oil resistant paint two coats. Paint shall neither react nor dissolve in hot transformer insulating oil.
4.10.3	Finish on inner surface of the CT terminal box, HV/LV/LVN cable box	White Polyurethane paint anti condensation type two coats , minimum dry film thickness 80 microns
4.10.4	Finish on outer surface of the transformer, radiator, CT terminal box, HV/LV/LVN cable box	Battle ship Grey shade 632 Polyurethane paint two coats , minimum dry film thickness 80 microns
4.10.5	Frame parts	Battle ship grey shade 632 IS 5, 80 micron minimum insulating oil resistant paint. Paint shall neither react nor dissolve in hot transformer insulating oil.
4.11	**Winding /Oil Temperature scanner for DT [R2]**	Required
4.11.1	No. of RTD inputs	Five (Three for windings, one for enclosure & one shall be spare) RTD for enclosure temperature monitoring shall be

		fixed at enclosure Top from inside to give max. Enclosure temp reading & shall be wired up to temp. Scanner to indicate the reading.
4.11.2	Location of winding RTD	At location of winding where maximum Temperature is expected.
4.11.3	No of potential free trip contacts	Two
4.11.4	No of potential free Alarm contacts	Two
4.11.5	Auxiliary Supply	240 V AC, 1 phase, 50 Hz. Tapped from LV side busbar through a MCB located inside box.
4.11.6	Winding Temperature Scanner terminal Box	Required
4.11.7	Size	As per manufacturers standard
4.11.8	Fixing of instrument within box	On side wall of enclosure
4.11.9	Fixing of terminals within the box	On C channel available with the terminals
4.11.10	Location	Within enclosure frame such that Marshalling Box & WTI on same side & free access to all LV side doors.
4.11.11	Terminal Strip	Nylon 66 material, minimum 4 sq mm, screw type for control wiring and potential circuit.
4.11.12	Cables & Wires	PVC insulated, extruded PVC inner sheathed, armoured, extruded PVC outer sheathed 1100 V grade control cable as per latest edition of IS 1554 part 1 minimum 2.5 sqmm for signals and 4 sqmm for CT with multistrand copper conductor & PVC insulated multistrand flexible copper wires of minimum 2.5 sqmm size, 1100 V grade as per latest edition of relevant IS
4.11.13	Cable Glands	Nickel plated brass double compression weatherproof cable gland
4.11.14	Lugs on wires	Tinned copper preinsulated Pin, Ring, Fork type as applicable
4.11.15	Auxiliary supply in box	Tapped from main LVbusbars, taken via MCB for isolation and protection of scanner, MCB to be fixed on DIN rail with clamps on two sides.
4.11.16	Essential provision	Wiring diagram to be fixed on the back of door along with brief details of scanner, HV side, LV side door limit switches to be wired up-to Terminal Block, Service socket to be provided with switch, fuse and link.

5.1	Rating and Diagram Plate	Required
5.1.1	Material	Anodized aluminum 16SWG
5.1.2	Background	SATIN SILVER
5.1.3	Letters, diagram & border	Black
5.1.4	Process	Etching
5.1.5	Rating and Diagram Plate details	Following details shall be provided on rating and diagram plate as a minimum i) Type/kind of transformer with winding material ii) Standard to which it is manufactured iii) Manufacturer's name; iv) Transformer serial number; v) Month and year of manufacture vi) Rated frequency in Hz vii) Rated voltages in kV viii) Number of phases ix) Rated power in kVA x) Type of cooling (ONAN) xi) Rated currents in A xii) Vector group connection symbol xiii) 1.2/50 s wave impulse voltage withstand level in kV xiv) Power frequency withstand voltage in kV xv) Impedance voltage at rated current and frequency in percentage at principal, minimum and maximum tap xvi) Max. Total losses at 50 % rated load xvii) Max. Total losses at 100 % rated load xviii) Load loss at 50% & 100% rated load xix) No-load loss at rated voltage and frequency xx) Energy efficiency level.

		xxi) Continuous ambient temperature at which ratings apply in deg C xxii) Top oil and winding temperature rise at rated load in deg C; xxiii) Winding connection diagram with taps and table of tapping voltage, current and power xxiv) Transport weight of transformer xxv) Weight of core and windings xxvi) Weight of core**[R2]** xxvii) Weight of winding**[R2]** xxviii) Total weight xxix) Volume of oil xxx) Weight of oil xxxi) Name of the purchaser xxxii) PO no and date xxxiii) Guarantee period
5.2	Terminal marking Plate for Bushing, anodized aluminium black lettering on satin silver background both inside cable boxes near termination and on cable box cover (all fixed by rivet)	Required
5.3	Company Monogram Plate fixed by rivet	Required
5.4	Lifting Lug to lift complete transformer with oil	Required
5.5	Lifting lug for top cover	Required
5.6	Lashing Lug	Required
5.7	Jacking Pad with Haulage hole to raise or lower complete transformer with oil	Required
5.8	Detachable Bidirectional flat roller Assembly	Required
5.8.1	Roller center to center distance	Minimum 900 mm on the side of HV and LV cable box Maximum 800 mm on the other side (perpendicular to HV, LV cable box).
5.8.2	Essential provision	Roller dia 150 mm min., roller to be

		fixed in such a way so that the lowermost part of the skid is above ground by at least 100 mm when the transformer is installed on roller.
5.9	Pockets for ordinary thermometer on tank cover with metallic identification plate fixed by rivet.	Required
5.10	Drain valve (gate valve) for the main tank with cork above ground by 150mm minimum with padlocking and valve guard with metallic identification plate fixed by rivet.	Required
5.11	Filter valve (gate valve) at top with padlocking and valve guard with metallic identification plate fixed by rivet.	Required
5.12	Air Release Plug on tank cover with metallic identification plate fixed by rivet.	Required
5.13	Equalizer pipe connection between conservator and explosion vent	Required
5.14	Earthing pad on tank for transformer earthing complete with non ferrous nut ., bolt, washers, spring washers etc. with metallic identification plate fixed by rivet	Required
5.15	Rainhood for vertical gasketted joints , in cable boxes, Conservator	Required Not required as per Annexure A Scope of supply
5.16	Earthing bridge by copper strip jumpers on all gasketted joints at at least two points for electrical continuity	Required
5.17	Skid base welded type with haulage hole	Required
5.18	Core , Frame to tank Earthing	Required

5.19	Danger plate made of Anodized aluminum with white letters on red background on Transformer, cable boxes (all fixed by rivet)	Required
5.20	Caution plate for Off Circuit tap changer fixed by rivet.	Required
5.21	MOG with auxillary contact wired upto Terminal Box	Required

6.0 Approved make of component

6.1	CT	Pragati / ECS / Kappa
6.2	Bushings Bushings –Porcelain	3M, Raychem, Denson &Nexans CJI
6.3	Tap Changer	Alwaye /Paragon
6.4	MOG	Sukrut/Atvus
6.5	Valves	Newman
6.6	WTI/OTI Scanner **[R7]**	Pecon/Precimeaure

Note – Any other make of component to be approved by purchaser

7.0 Quality assurance

7.1	Quality Assurance program	To be submitted before contract award. Program shall contain following i) The structure of the organisation ii) The duties and responsibilities assigned to staff ensuring quality of work. iii) The bidder should have qualified technical & dedicated QA personnel at various stages of manufacture & testing. iv) Factory inspection of bidder may be carried out to ascertain the quality system and process in place at manufacturing facility. The same is applicable to bidders not approved with BSES. v) The system for purchasing, taking delivery and verification of materials vi) The system for ensuring quality of workmanship vii) The system for control of documentation

		viii) The system for the retention of records ix) The arrangements for the Supplier's internal auditing x) A list of the administration and work procedures required to achieve and verify Contract's quality requirements. These procedures shall be made readily available to the Purchaser for inspection on request
7.2	Quality Plan	To be submitted by the successful bidder for approval. Plan shall contain following as a minimum i) An outline of the proposed work and programme sequence ii) The structure of the Supplier's organisation for the contract iii) The duties and responsibilities assigned to staff ensuring quality of work for the contract iv) Inspection Hold and notification points mutually agreed. v) Submission of engineering documents required by the specification vi) The inspection of materials and Components on receipt vii) Reference to the Supplier's work procedures appropriate to each activity viii) Inspectionduring fabrication/construction ix) Final inspection and testing as per BSES Standard QAP ANNEXURE-G[R1] x) Successful bidder shall include submittal of Mills invoice, Bill of lading, Mill's test certificate for grade, physical tests, dimension, specific watt loss per kG for the core material to the purchaser for verification in the quality plan suitably

8.0 Progress Reporting

8.1	Outline Document	To be submitted for purchaser approval for outline of production, inspection, testing, packing, dispatch,

		documentation programme
8.2	Detailed Progress report	To be submitted to Purchaser once a month containing i) Progress on material procurement ii) Progress on fabrication iii) Progress on assembly iv) Progress on internal stage inspection v) Reason for any delay in total programme vi) Details of test failures if any in manufacturing stages vii) Progress on final box up viii) Constraints ix) Forward path

9.0 Submittals

9.1	Submittals required with bid	i) Completed technical data schedule ii) Descriptive literature giving full technical details of equipment offered; iii) Outline dimension drawing for each major component, general arrangement drawing showing component layout and general schematic diagrams; iv) Type test certificates, where available, and sample routine test reports; v) Detailed reference list of customers already using equipment offered during the last 5 years with particular emphasis on units of similar design and rating; vi) Details of manufacturer's quality assurance programme and ISO 9000 series or equivalent national certification; vii) Deviations from this specification. Only deviations approved in writing before award of contract shall be accepted; viii) Recommended spare parts and consumable items for five years of operation with prices and spare parts catalogue with price list for future requirements

		ix) Transport / Shipping dimension and weights, space required for handling parts for maintenance x) Write up on oil preservation system xi) Write up on OLTC xii) Quality Assurance Program
9.2	Submittals required after award for Approval (A), Reference (R), and subsequent distribution	i) Programme for production and testing (A) ii) Guaranteed Technical Particulars (A) iii) General description of the equipment and all components, including brochures (R) iv) Calculations to substantiate choice of electrical, structural, mechanical component size/ratings (A) v) Detailed loading drawing to enable the Purchaser to design and construct foundations for the transformer (R) vi) Transport / shipping dimensions with weights, wheel base details, untanking height etc (R) vii) Terminal arrangements and cable box details (A) viii) Flow diagram of cooling system showing no of cooling banks (A) ix) Drawings of major components like Bushing , CT etc (A) x) PT fixing arrangement xi) List of makes of all fittings and accessories (A) xii) Statement drawing attention to all exposed points in the equipment at which contact with or in close proximity to other metals and stating clearly what protection is employed to prevent corrosion at each point (A) xiii) Detailed installation and commissioning instructions xiv) Quality Plan.
9.3	Submittals required at the final hold point prior to despatch	i) Inspection and test reports carried out in manufacturer's works (A)

		ii) Test certificates of all bought out items iii) Operation and maintenance Instruction as well as trouble shooting charts/ manual
9.4	Drawing and document sizes	Standard size paper A1, A2, A3, A4
9.5	No of drgs /Documents required at different stages	As per Annexure A Scope of Supply

10.0 Inspection & testing

10.1	Inspection and Testing during manufacture	Only type tested equipment shall be acceptable
10.1.1	Tank and Conservator	i) Check correct dimensions between wheels demonstrate turning of wheels through 90 deg and further dimensional check. ii) Check for physical properties of materials for lifting lugs, jacking pads etc. All load bearing welds, including lifting lug welds shall be subjected to required load tests. iii) Leakage test of the conservator. iv) Certification of all test results. v) Oil leakage test vi) Vacuum and Pressure test on tank as type test as per IS
10.1.2	Core	i) Sample testing of core material for checking specific loss, bend properties, magnetization characteristics and thickness. ii) Check on the quality of varnish if used on the stampings. a) Measurement of thickness and hardness of varnish on stampings. b) Solvent resistance test to check that varnish does not react in hot oil. c) Check over all quality of varnish by sampling to ensure uniform hipping colour, no bare spots. No ever burnt varnish layer and no bubbles on varnished surface. iii) Check on the amount of burns. iv) Bow check on stampings. v) Check for the overlapping of stampings. Corners of the sheet

		are to be apart. vi) Visual and dimensional check during assembly stage. vii) Check on complete core for measurements of iron-loss and check for any hot spot by exciting the core so as to induce the designed value of flux density in the core. viii) Check for inter laminar insulation between core sectors before and after pressing. ix) Visual and dimensional checks for straightness and roundness of core, thickness of limbs and suitability of clamps. x) High voltage test (2 KV for one minute) between core and clamps. xi) Certification of all test results. xii) One sample of CRGO to be sealed for testing at ERDA/CPRI. Tests to be conducted in accordance with annexure H [**R2]** Inspection call need to be given to BRPL prior 10 days in advance and test shall be witnessed by BRPL.
10.1.3	Insulating Materials	i) Sample check for physical properties of materials. ii) Check for dielectric strength. iii) Visual and dimensional checks. iv) Check for the reaction of hot oil on insulating materials. v) Certification of all test results.
10.1.4	Windings	i) Sample check on winding conductor for mechanical properties and electrical conductivity. ii) Visual and dimensional check on conductor for scratches, dept. mark etc. iii) Sample check on insulating paper for PE value, Bursting strength, Electric strength. iv) Check for the reaction of hot oil on insulating paper. v) Check for the bending of the insulating paper on conductor. vi) Check and ensure that physical condition of all materials taken for

		winding is satisfactory and free of dust. vii) Check for absence of short circuit between parallel strands. viii) Check for Brazed joints wherever applicable. ix) Measurement of voltage ratio to be carried out when core/ yoke is

		completely restocked and all connections are ready. x) Certification of all test results.
10.1.4.1	Checks before drying process	i) Check conditions of insulation on the conductor and between the windings. ii) Check insulation distance between high voltage connection distance between high voltage connection cables and earthed and other live parts. iii) Check insulation distance between low voltage connection and earthed and other parts. iv) Insulation test of core earthing. v) Check for proper cleanliness vi) Check tightness of coils i.e. no free movement. vii) Certification of all test results.
10.1.4.2	Checks during drying process	i) Measurement and recording of temperature and drying time during vacuum treatment. ii) Check for completeness of drying. iii) Certification of all test results.
10.1.5	Oil	As per IS 335/BSES Specification
10.1.6	Test on fittings and accessories	As per manufacturer's standard
10.2	Routine tests	The sequence of routine testing shall be as follows i) Visual and dimension check for completely assembled transformer ii) Measurements of voltage ratio iii) Measurements of winding resistance at principal tap and two extreme taps. iv) Vector Group and polarity test v) Measurements of insulation resistance* vi) Separate sources voltage withstand test. vii) Measurement of iron losses and exciting current at rated frequency and 90%, 100% and 110% rated voltage. viii) Induced voltage withstand test. ix) Load losses measurement at 50%&100 % of load x) Impedance measurement of principal tap (HV and LV) of the transformer. x) Routine test of tanks xi) Induced voltage withstand test (to be

		repeated if type tests are conducted). xii) Measurement of Iron loss (to be repeated if type test are conducted). xiii) Measurement of capacitance and Tan Delta for transformer winding and Tan Delta for transformer oil (for all transformers). xiv) Ratio of CT xv) Oil leakage test on completely assembled transformer xvi) Magnetic balance test xvii) Power frequency voltage withstand test on all auxiliary circuits xviii) Certification of all test results. a) *Insulation resistance measurement shall be carried out at 5kV for HV and 1kV for LV. Value of IR should not be less than 2000 Mohms. Polarization Index (PI = IR_{10min}/IR_{1min}) should not be less than 1.5 (If one minute IR value is above 5000 Mohms and it is not be possible to obtain an accurate 10 minutes reading, in such cases polarization index can be disregarded as a measure of winding condition.) b) #Temperature rise test may be necessary to be carried one unit/lot. Purchaser's engineer, will at its discretion, select transformer for temp. rise test from any lot offered for inspection at manufacturer's works and witness the same for comparison with ERDA/CPRI type test results Inspection call need to be given to BRPL prior 10 days in advance and test shall be witnessed by BRPL
10.3	Type Tests	On one transformer of each rating and type (In Govt. recognized independent test laboratory / Internationally accredited test lab or at manufacturer's facility if it is approved by competent authority) i) Impulse withstand test on all three HV limbs of the transformers for chopped wave as per standard ii) Temperature rise test as per IS iii) Dissolved gas analysis before and after Temperature Rise Test iv) Air pressure test for sealed transformers v) Pressure and Vacuum test on tank

		Note – Purchaser may choose to carry out short circuit, impulse & temperature rise test on one unit from a lot offered from inspection at Gov. recognized test house Inspection call need to be given to BRPL prior 10 days in advance and test shall be witnessed by BRPL
10.3.2	Notification to bidders	The product offered must be of type tested quality. In case the product offered is never type tested the same as per above list to be conducted by bidder at his own cost at CPRI/ERDA.The test report shall not be more than 5 years old
10.4	Special Tests	On one transformer of each rating and type i) Dynamic & Thermal (3 sec) Short Circuit Test as per IS 2026 ii) Measure of zero seq. impedance (Cl. 16.10 IS 2026 Part I). iii) Measurement of acoustic noise level (Cl. 16.12 of IS 2026 Part I). iv) Measurement of harmonic level on no load current. v) Paint adhesion test. v) High voltage withstand test shall be performed on the auxiliary equipment and wiring after complete assembly. Cost of such tests, if extra, shall be quoted separately by the Bidder. Inspection call need to be given to BRPL prior 10 days in advance and test shall be witnessed by BRPL
10.4.1	Note for special test	In case the product offered is never tested for dynamic short circuit(dynamic& thermal) same to be conducted by bidder at his own cost at CPRI/ERDA. The test report shall not be more than 5 years old.
10.5	Customer Hold Point	i) GTP & Drawings approval ii) Core Inspection(See Cl No 10.1.2) Sample to be tested at CPRI/ERDA for each lot. iii) Tank Pressure & vacuum Test iv) Core & Coil Stage inspection of each lot to be offered for final testing.

11.0 Packing , Shipping, Handling and Storage

11.1	Packing	
11.1.1	Packing protection	Against corrosion, dampness, heavy rains, breakage and vibration
11.1.2	Packing for accessories and spares	Robust wooden non returnable packing

		case with all the above protection
11.1.3	Packing details	On each packing case details required as follows i) Individual serial number; ii) Purchaser's name; iii) PO number; iv) Destination; v) Supplier's name; vi) Name and address of supplier's agent vii) Description and quantity viii) Manufacturer's name ix) Country of origin x) Case measurements xi) Gross and net weights in kilograms xii) All necessary slinging and stacking instructions.
11.2	Shipping	The bidder shall ascertain at an early date and definitely before the commencement of manufacture, any transport limitations such as weights, dimensions, road culverts, overhead lines, free access etc. from the manufacturing plant to the project site; and furnish to the Purchaser confirmation that the proposed packages can be safely transported, as normal or oversize packages, upto the plant site. Any modifications required in the infrastructure and cost there of in this connection shall be brought to the notice of the Purchaser.
11.3	Handling and Storage	As per manufacturer's instruction

12.0Deviations

Deviations from this Specification shall be stated in writing with the tender by reference to the Specification clause/GTP/Drawing and a description of the alternative offer. In absence of such a statement, requirements of the Specification shall be met without exception.

13.0 Inspection Expenses

Inspection (i.e. routing test, acceptance test, type test, factory visit etc.) shall be done any time by BSES on the basis of PO or may involve 3rd party as per BSES requirement. Inspection expenses like accommodation, fooding, local transport, air fare, train fair, taxi (NCR) etc shall be borne by seller.

Any kind of test (routine/type test/acceptance test if any) at 3rd lab (i.e. CPRI/ERDA/NABL approved lab) shall be carried out by seller at their own cost. BSES may witness the test and the expenses like accommodation, fooding, local transport, air fare, train, taxi etc. shall be borne by seller.

Above expenses shall be applied at each and every inspection and shall stand till closing of PO/WO/Rate contracts etc.

Annexure A Scope of supply

1.0The scope of supply shall include following

1.1Design, manufacture, assembly, testing at stages of manufacture as per Cl. 10 of this specification, final testing at manufacturer works on completely assembled transformer before dispatch, packing, transportation, delivery and submission of all documentation for the Power transformer with all accessories as below

Sr. No	Description	Scope of Supply
1.1.1	Fully assembled transformer with all major parts like conservator, Radiators, CT box, Fittings and accessories as per Clause 5.0 of this specification	YES
1.1.2	Off circuit tap changer as per this specification	YES
1.1.3	HV, LV, cable boxes	NO
1.1.4	Support steel material for support of cable boxes from ground	NO
1.1.5	Foundation Bolts for complete transformer	YES
1.1.6	Support structure to support of cable from the transformer tank	YES
1.1.7	Nickel Plated brass double compression glands for HV and LV, LVN cables (in case of termination by cable)	NO
1.1.8	Long barrel medium duty Aluminium lugs for power cables (in case of termination by cable)	NO
1.1.9	Nickel Plated brass double compression glands and tinned copper lugs for control cable termination in CT box for vendor's cables	YES
1.1.10	Cables and wires for transformer accessories and internal wiring of CT box	YES
1.1.11	Touch up paint, minimum 2 litres	YES
1.1.12	Extra Transformer oil 10 % in non returnable drums	YES
1.1.13	One spare complete set of gaskets	YES
1.1.14	Routine testing as per Cl. 10.2 of this specification	YES

1.1.15	Type testing as per Cl. 10.3 of this specification	YES
1.1.16	Special testing as per Cl. 10.4 of this specification	YES
1.1.17	Submission of Documentation as detailed below	YES
1.1.18	HV Cable Connector	NO
1.1.19	LV Cable Connector	NO

2.0 Submission of documents

Submission of of drawings, calculations, catalogues, manuals, test reports shall be as follows

	Along with offer	For Approval after award of contract	Final after approval	Remarks
Drawings	3 copies (Typical drgs)	4 copies	12 copies + 1 soft copy in CD	See Clause 9 for various drawings required
Calculations	3 copies (Typical)	4 copies	6 copies + 1 soft copy in CD	See Clause 9 for details
Catalogues	1 copy		12 copies + 1 soft copy in CD	
Instruction manual for the transformer	1 copy		12 copies + 1 soft copy in CD	
Test Report	2 copies (Type test ans sample Routine Test)		12 copies + 1 soft copy in CD	Type test and sample routine test reports

3.0 Delivery schedule

3.1 Delivery period start date -

3.2 Delivery period end date -

3.3 Material dispatch clearance - after inspection by purchaser & written dispatch clearances from purchaser

Annexure B Service Conditions

1.0.0	Delhi Atmospheric conditions	
a)	Average grade atmosphere :	Heavily polluted, dry
	Maximum altitude above sea level	1000 M
b)	Ambient Air temperature	Highest 50 deg C, Average 40 deg C
	Design ambient temperature	50 deg C
c)	Relative Humidity	90 % Max
d)	Seismic Zone	4
e)	Rainfall	750 mm concentrated in four months

Annexure – C Technical Particulars of transformer Oil

Transformer oil shall be new and conform to the following requirements:

1.0 Codes & standards

Latest revision of following codes & standards with all amendments –

S.no.	Standard no	Title
1.1	IS 335	New insulating oils
1.2	IS 1783	Drums for oils

2.0 Properties

The insulating material shall have following features**[R2]:**

Sr No	Item description	Specification requirement
2.1	Appearance of oil	Clear, free from sediment and suspended matter
2.2	Viscosity Max.	15 mm^2 /s at 40^0C
		1800 mm^2 /s at 0^0C
2.3	Pour Point, Max	- 10^0C
2.4	Water content, Max	30 mg/Kg
	Breakdown voltage	
	i) New unfiltered oil. Min.	30 kV
2.5	ii) After filtration Min.	70 kV
2.6	Density Max.	0.895 g/ml at 20^0C
2.7	Dielectric dissipation factor Max	0.005 at 90 ^{0}C,
2.8	Particle Content	Value to be provided by the vendor
2.9	Acidity Max	0.01 mg KOH/g
2.10	Interfacial tension at 27^0C Min	40 mN/m
2.11	Total sulphur content	Value to be provided by the vendor
2.12	Corrosive sulfur	Not-corrosive
2.13	Potentially Corrosive sulfur	Not-corrosive
2.14	DBDS	Not detectable (<5 mg/kg)
2.15	Inhibitor	Not detectable (<0.01%)
2.16	Metal Passivator	Not detectable (<5 mg/kg)
2.17	Other addivites	Type and concentration of additives to be providedby the vendor
2.18	2-furfural and related Compounds content	Not detectable (<0.05 mg/kg) for each individual compound
2.19	Oxidation stability	
a)	Total acidity, Max	1.2 mg KOH/g
b)	Sludge Max	0.8%
c)	DDF at 90 ^{0}C, Max	0.5
2.20	Gassing Tendency	Value to be provided by the vendor
2.21	ECT	Value to be provided by the vendor
2.22	Flash point Min.	135^0C,
2.23	PCA content Max	3%
2.24	PCB content	Not detectable (<2 mg/Kg)

Annexure D Guaranteed Technical Particulars (Data by Seller)

Sr.	Particulars	Specified / Required			Offered
1.0	General				
1.1	Make				
1.2	Type	Oil immersed, core type, step down located generally outdoor but may be located indoor also with poor ventilation. Bidder shall confirm full rating available in indoor location also			
2.0	Nominal Continuous Rating, KVA				
2.1	HV winding	400 kva	630 kva	1000 kva	
2.2	LV winding	400 kva	630 kva	1000 kva	
3.0	Rated voltage (kV)				
3.1	HV Winding	11 kv			
3.2	LV Winding	433 volt			
4.0	Rated current (Amps)	400 kva	630 kva	1000 kva	
4.1	HV Winding				
4.2	LV Winding				
5.0	Connections				
5.1	HV Winding	Delta			
5.2	LV Winding	Star with neutral			
5.3	Vector Group reference	Dyn11			
6.0	Impedance at principal tap rated current and frequency, ohm @75 deg C [R1]				
6.1	Impedance	4.5% with IS tolerance	4.5% with IS tolerance	5% with IS tolerance	
6.2	Reactance				
6.3	Resistance				
6.4	Impedance at lowest tap at rated current and frequency				
6.5	Impedance at highest tap at rated				

	current and frequency		
7.0	Resistance of the winding at 75^0 C in ohm		
7.1	a) HV		
7.2	b) LV		
8.0	Zero sequence impedance in ohm		
8.1	a) HV		
8.2	b) LV		
9.0	Guaranteed maximum losses at principal tap full load and 75°C without any positive tolerance, kW		
9.1	No load losses (max.)	as per Spec Cl 3.25	
9.2	Load losses (max.)	as per Spec Cl 3.26	
9.3	Cooler fan losses (max.)	Not applicable	
9.4	Total I^2R losses of windings @ 75 deg C, KW		
9.5	Total stray loses @ 75 deg C, KW		
9.6	Total losses (max.), KW		
9.7	No load loss at maximum permissible voltage and frequency (approx.), kW		
10.0	Temperature rise over reference ambient of $40\ ^0$C		
10.1	Top oil by thermometer ^{0} C	$40\ ^0$C	
10.2	Winding by resistance ^{0} C	$45\ ^0$C	
11.0	Efficiency		
11.1	Efficiency at 75^0C and unity power factor %		
11.1.1	at 110% load		
11.1.2	at 100% load		

11.1.3	at 80% load	Not Less than 99.5%	
11.1.4	at 60% load		
11.1.5	at 40% load		
11.1.6	at 20% load		
11.2	Efficiency at 75^0C and 0.8 power factor lag %		
11.2.1	at 110% load		
11.2.2	at 100% load		
11.2.3	at 80% load		
11.2.4	at 60% load		
11.2.5	at 40% load		
11.2.6	at 20% load		
11.3	Maximum efficiency at 75^0C %		
11.4	Load and power factor at which it occurs		
12.0	Regulation , (%)		
12.1	Regulation at full load at 75^0 C		
12.1.1	at unity power factor		
12.1.2	at 0.8 power factor lagging		
12.2	Regulation at 110% load at 75^0 C		
12.2.1	at unity power factor		
12.2.2	at 0.8 power factor lagging		
13.0	Tappings		
13.1	Type		
13.2	Capacity		
13.3	Range-steps x % variation		
13.4	Taps provided on HV winding (Yes / No)		
13.5	Rated current of rotary switch		
14.0	Cooling system		

14.1	Type of cooling	ONAN	
14.2	No. of cooling unit Groups		
14.3	Capacity of cooling units		
14.4	Mounting of radiators		
14.5	Number of Radiators		
14.8	Total radiating surface , sqmm		
14.9	Thickness of radiator tubes, mm	Minimum 1.2 mm	
15.0	Details of Tank		
15.1	Material	Robust mild steel plate without pitting and low carbon content	
15.2	Thickness of sides mm		
15.3	Thickness of bottom mm		
15.4	Thickness of cover mm		
15.5	Confirmation of Tank designed and tested for Vacuum, Pressure (Ref: CBIP Manual) , (Yes/ No)		
15.5.1	Vacuum mm of Hg. / (kN/m^2)	As per IS	
15.5.2	Pressure mm of Hg.		
15.6	Is the tank lid sloped?	Yes	
15.7	Inspection cover provided (Yes / No)	as per spec	
15.8	Location of inspection cover (Yes / No)		
15.9	Min. dimensions of inspection cover (provide list of all inspection cover with dimension), mm x mm		
16.0	Core		
16.1	Type:	Core	
16.2	Core material grade	Premium grade minimum M3 or better	
16.3	Core lamination thickness in mm		
16.4	Insulation of lamination	With insulation coating on both	

		sides	
16.5	Design flux density at rated condition at principal tap, Tesla		
16.6	Maximum flux density at 10 % overexcitation /overfluxing, Tesla	1.9 Tesla Max allowed	
16.7	Equivalent cross section area mm^2		
16.8	Guaranteed No Load current at 100% rated voltage , Amps		
16.8.1	HV		
16.8.2	LV		
16.9	Guaranteed No Load current At 110% rated voltage, Amps		
16.9.1	HV		
16.9.2	LV		
17.0	Type of Winding**[R2]**		
17.1	HV	Crossover/Disc	
17.2	LV	Spiral/Helical	
17.3	Conductor material	Electrolytic Copper	
17.4	Current density (HV/LV)	Maximum allowed 3.0 A per sq mm.at all taps	
17.5	Gauge/area of cross section of conductor		
17.5.1	a) HV		
17.5.1	b) LV		
17.6	Insulating material		
17.6.1	HV Turn		
17.6.2	LV Turn		
17.6.3	LV Core		
17.6.4	HV - LV		
17.7	Insulating material thickness, mm		
17.7.1	HV Turn		

17.7.2	LV Turn	-	
17.7.3	LV to Core		
17.7.4	HV to LV		
		-	
18.0	Minimum design clearance, mm		
18.1	HV to earth in Air		
18.2	HV to earth in oil		
18.3	LV to earth in Air		
18.4	LV to earth in oil		
18.5	Between HV & LV in Air		
18.6	Between HV & LV in oil		
18.7	Top winding and yoke		
18.8	Bottom winding and yoke		
19.0	**Insulating oil**		
19.1	Quantity of oil Ltrs		
19.1.1	In the Transformer tank		
19.1.2	In each radiator		
19.1.4	Total quantity		
19.2	10% excess oil furnished?	To be furnished in separate nonreturnable drum with each transformer **[R2]**	
19.3	Type of Oil	As per cl 4.2.7	
20.0	**Bushing / Support Insulator**		
20.1	Make	-	
20.2	Type		
20.2.1	HV side	As per Cl. 4.2.8.1 of the spec	
20.2.2	LV side	As per Cl. 4.2.8.2 of the spec	
20.3	Reference Standard		
20.4	Voltage class, kV		
20.4.1	HV side Bushing/ Support Insulator	12 kV	
20.4.2	LV side line and neutral bushing/ Support Insulator	1.1 kV	
20.5	Creepage factor for all bushing / Support Insulator mm/KV	31 mm / kV	
20.6	Rated thermal short time current		

20.6.1	HV bushing	25 times rated current for 2 secs.	
20.6.2	LV line and neutral bushing	25 times rated current for 2 secs.	
20.7	Weight, Kg		
20.7.1	HV bushing		
20.7.2	LV line and neutral bushing		
20.8	Free space required for bushing removal, mm		
20.8.1	HV bushing		
20.8.2	LV line and neutral bushing		
21.0	**Terminal connections**		
21.1	HV	Cable size as per Cl no 3.28	
21.2	LV	Cable size as per Cl no 3.30	
21.3	LV Neutral	Cable size as per Cl no 3.30	
22.0	**HV Terminal Clearances**		
22.1	Suitable for cable type,size	Cable size as per Cl no 3.28	
22.2	H.V Cable termination arrangement	As per Cl No 4.2.8.1	
22.3	Phase to phase	280 mm	
22.4	Phase to earth	140 mm	
22.5	Termination	Top Cover	
23.0	**LV Terminal Clearances**		
23.1	Suitable for cable type , size	Cable size as per Cl no 3.30	
23.2	L.V Cable termination arrangement	As per Cl No 4.2.8.1	
23.3	Phase to phase	75 mm	
23.4	Phase to earth	40 mm	
23.5	Termination	Top Cover	
24.0	L.V neutral Cable termination arrangement	Top Cover	
25.0	Current Transformer on LV phases		

25.1	Type				
25.2	Make				
25.3	Reference Standard				
25.4	CT Ratio				
25.5	Burden, VA				
25.6	Class of Accuracy				
25.7	CT terminal box size				
26.0	WTI/OTI Scanner details **[R2]**	Required	Required	Required	
27.0	Pressure release device				
27.1	Minimum pressure the device is set to rupture				
27.1.1	For Main Tank				
28.0	Fittings Accessories Each Transformer furnished as per Clause No 5. (Bidder shall attach separate sheet giving details, make and bill of materials)				
29.0	Painting: as per clause for the transformer, cable boxes, radiator, Marshalling box (Yes/No)				
30.0	Max over all transformer dimensions	As per Clause 3.32			
30.1	Length, mm				
30.2	Breadth, mm				
30.3	Height, mm				
31.0	Transformer Tank Dimensions				
31.1	Length, mm				
31.2	Breadth, mm				
31.3	Height, mm				
32.0	Weight data				
32.1	Core, kG				

32.2	Frame parts, kG		
32.3	Core and frame, kG		
32.4	Total Winding, kG		
32.5	Core , Frame, Winding, kG		
32.6	Tank, kG		
32.7	Tank lid, kG		
32.8	Empty conservator tank, kG		
32.9	Each radiator empty, kG		
32.10	Total weight of all radiators empty, kG		
32.11	Weight of oil in Tank, kG		
32.12	Weight of oil in Conservator, kG		
32.13	Weight of oil in each Radiators, kG		
32.14	Total weight of oil in Radiators, kG		
32.15	Total Transport weight of the transformer, kG		
33.0	Volume Data		
33.1	Volume of oil in main tank, litres		
33.2	Volume of oil between highest and lowest levels of main conservator, litres		
33.3	Volume of oil in each radiator, litres		
33.4	Total volume of oil in radiators, litres		
33.5	Transformer total oil volume, litres		
34.0	Shipping Data		
34.1	Weight of heaviest package, kG		
34.2	Dimensions of the largest package (L x B x H) mm		
35.0	Tests		
35.1	All in process tests confirmed as		

per Cl. (Yes/ No)

35.2 All Type Tests confirmed as per Cl. (Yes / No)

35.3 All Routine Tests confirmed as per Cl. (Yes/ No)

35.4 All Special Tests confirmed as per Cl. (Yes/ No)

Annexure E Guaranteed Technical Particulars of Transformer Oil

Bidder to submit hard copy duly filled & signed along with techno commercial offer. Bidder to submit separate GTP for each type of insulating oil –

Sr No.	Item description	Specification requirement	Data by vendor
1.1	Appearance of oil	Clear, free from sediment and suspended matter	
1.2	Viscosity Max.	15 mm^2 /s at 40^0C	
		1800 mm^2 /s at 0^0C	
1.3	Pour Point, Max	- 10^0C	
1.4	Water content, Max	30 mg/Kg	
1.5	Breakdown voltage		
	i) New unfiltered oil. Min.	30 kV	
	ii) After filtration Min.	70 kV	
1.6	Density Max.	0.895 g/ml at 20^0C	
1.7	Dielectric dissipation factor Max	0.005 at 90 ^0C,	
1.8	Particle Content	Value to be provided by the vendor	
1.9	Acidity Max	0.01 mg KOH/g	
1.10	Interfacial tension at 27^0C Min	40 mN/m	
1.11	Total sulphur content	Value to be provided by the vendor	
1.12	Corrosive sulfur	Not-corrosive	
1.13	Potentially Corrosive sulfur	Not-corrosive	
1.14	DBDS	Not detectable (<5 mg/kg)	
1.15	Inhibitor	Not detectable (<0.01%)	
1.16	Metal Passivator	Not detectable (<5 mg/kg)	
1.17	Other addivites	Type and concentration of additives to be provided	
1.18	2-furfural and related Compounds content	Not detectable (<0.05 mg/kg) for each individual compound	
1.19	Oxidation stability		
a)	Total acidity, Max	1.2 mg KOH/g	
b)	Sludge Max	0.8%	
c)	DDF at 90 ^0C, Max	0.5	
1.20	Gassing Tendency	Value to be provided by the vendor	
1.21	ECT	Value to be provided by the vendor	
1.22	Flash point Min.	135^0C,	
1.23	PCA content Max	3%	
1.24	PCB content	Not detectable (<2 mg/Kg)	

Annexure – F Recommended Spares (Data by Supplier)

List of recommended spares as following –

Sr No	Description of spare part	Unit	Quantity
1		No	
2		No	
3		No	
4		No	
5		No	
6		No	

Annexure – G BSES Standard Quality Plan (To be following during Testing/Inspection)

Annexure H - CRGO & Testing Points [R2]

In addition to the BSES specification following points to be verified during manufacturing/inspection.	
1	Transformer core shall be low loss, non-ageing, high permeability PRIME GRADE CRGO with M3 Grade or better with max thickness of 0.23mm and with max core loss of 1 W/Kg, perfectly insulated and clamped to minimize noise and vibrations.
2	Following stage inspections will be carried out by purchaser or by third party engineers appointed by BSES :
2.1	Verification & inspection of the mother coil at port & putting stamp & seal may be inspected by BSES.
2.2	Reconciliation of mother coil by checking stamp & seal at factory before slitting. One sample of CRGO to be sealed for testing at ERDA/CPRI. Following Tests shall be conducted on the sample**:** 1) Specific core loss measurement 2) Magnetic polarization 3) Magnetic permeability 4) Specific core loss measurement after accelerated ageing test 5) Surface insulation resistivity 6) Electrical resistivity measurement 7) Stacking factor 8) Ductility(Bend test) 9) Lamination thickness 10) Magnetization characteristics (B-H curve)
2.3	Bidder should have in house core cutting facility for proper monitoring & control on quality. In case it is done outside cutting shall be done in presence of BSES.
2.4	Following documents to be submitted during the stage inspection :
2.4.1	Invoice of supplier
2.4.2	Mills test certificates
2.4.3	Packing list
2.4.4	Bill of lading
2.4.5	Bill of entry certificates by customs
2.4.6	Core material shall be directly procured either from the BSES approved manufacturer or through their authorized service centre/distributor and not through any contractor.
2.5	Bidder should have hydraulic core lifting facility to avoid any jerk at the time of core building.
2.6	BSES may appoint recognized testing authority like CPRI /ERDA with their instruments & engineer's team and measure no load loss, load loss and percentage impedance of the transformer at supplier's works at our own cost. Bidder shall agree and give them full co-operation during their stay & testing at shop floor. The losses & impedance values so obtained will be considered as final.
2.7	Bidder should have in-house NABL accredited testing facility.