2.	Appearance	–	Clear, free from sediment and suspended matter
3.	Neutralization Value (Total Acidity)	IEC 62021-1 or IEC 62021-2	0.01 mg KOH/g (Max.)
4.	Interfacial tension at 27°C	IEC 62961 or ASTM D971	0.043 N/m (Min.)
5.	Total sulphur content	ISO 14596 or ISO 8754	0.05 % (Max.) (before oxidation test)
6.	Corrosive sulphur	DIN 51353	Not Corrosive
7.	Potentially corrosive sulphur	IEC 62535	Not Corrosive
8.	Presence of oxidation inhibitor	IS 13631 or IEC 60666	0.08% (Min.) to 0.4% (Max.)
9.	DBDS	IEC 62697-1	Not detectable (<5 mg/kg)
10.	Metal passivator additives	IEC 60666	Not detectable (<5 mg/kg)
11.	2-Furfural and related compound content	IS 15668 or IEC 61198	Not detectable (<0.05 mg/kg) for each individual compound
12.	Stray gassing under thermo-oxidative stress	Procedure in Clause A.4 of IEC 60296-2020 (oil saturated with air) in the presence of copper	Non stray gassing: < 50 µl/l of hydrogen (H_2) and < 50 µl/l methane (CH_4) and < 50 µl/l ethane (C_2H_6)
C	**Performance**		
1.	Oxidation stability	IEC 61125 (method c) Test duration: 500 hours	
	-Total acidity*	4.8.4 of IEC 61125:2018	0.3 mg KOH/g (Max.)
	-Sludge*	4.8.1 of IEC 61125:2018	0.05 % (Max.)
	-Dielectric Dissipation Factor* (tan delta) at 90 °C	4.8.5 of IEC 61125:2018	0.05 (Max.)
	*values at the end of oxidation stability test		
D	**Health, safety and environment (HSE)**		

1.	Flash point	IS 1448 Part 21 or ISO 2719	135 °C(Min.)
2.	Poly Cyclic Aromatic (PCA) content	IP 346	<3%
3.	Poly Chlorinated Biphenyl (PCB) content	IS 16082 or IEC 61619	Not detectable (< 2 mg/kg)

Note: Supplier shall declare the chemical family and function of all additives and the concentrations in the cases of inhibitors, antioxidants and passivators.

II. Oil used for first filling, testing and impregnation of active parts at manufacturer's works shall meet parameters as mentioned below

1	Break Down voltage (BDV)	-	70kV (Min.)
2	Moisture content	-	5 ppm (Max.)
3	Tan-delta at 90°C	-	0.005 (Max.)
4	Interfacial tension	-	0.04 N/m (Min.)

III. Each lot of the oil shall be tested prior to filling in main tank at site for the following:

1	Break Down voltage (BDV)	-	70 kV (Min.)
2	Moisture content	-	5 ppm (Max.)
3	Tan-delta at 90°C	-	0.0025 (Max.)
4	Interfacial tension	-	0.04 N/m (Min.)

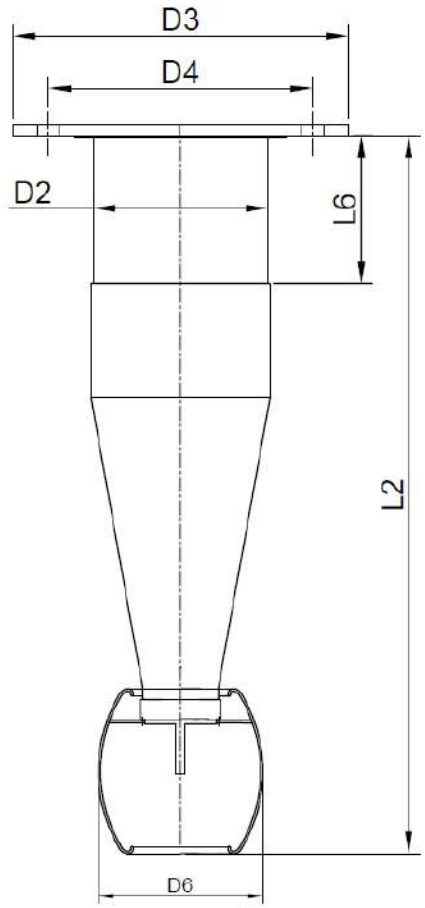
IV. After filtration & settling and prior to energization at site oil shall be tested for following:

1	Break Down voltage (BDV)	-	70 kV (Min.)
2	Moisture content at hot condition	-	5 ppm (Max.)
3	Tan-delta at 90°C	-	0.005 (Max.)
4	Interfacial tension	-	0.04 N/m (Min.)
5	*Oxidation Stability	-	
	a) Acidity		0.3 (mg KOH /g) (Max.)-For Inhibited Oil 1.2 mg KOH/g (Max.)-For Uninhibited Oil
	b) Sludge	-	0.05 % (Max.) - For Inhibited Oil 0.8 % (Max.) - For Uninhibited Oil

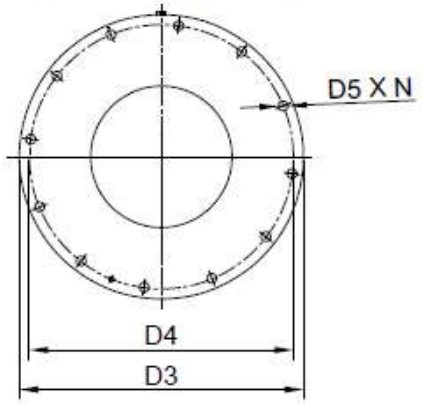
	c) Tan delta at 90 °C	-	0.05 (Max.) - For Inhibited Oil 0.5 (Max.) - For Uninhibited Oil
6	Total PCB content*		Not detectable (< 2 mg/kg)
	* Separate oil sample shall be taken and test results shall be submitted within 45 days after commissioning for approval of the utility		

STANDARD DIMENSIONS FOR CONDENSER BUSHINGS

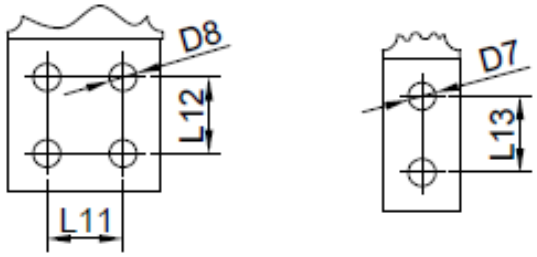
(For 420 kV and below voltage class Bushings)



Bushing Mounting Flange Details



Bottom Connection Details



Symbol	Description
L2	Length between bottom seat of flange and bottom of the oil end shield/ stress relieving electrode/ oil end terminal whichever is the longest
L6	Length for accommodating Bushing Current Transformer (BCT)
D2	Maximum diameter of oil immersed end
D3	Outside diameter of fixing flange
D4	Pitch Circle Diameter of fixing holes of flange
D5	Diameter of fixing hole
N	Number of fixing holes
D6	Maximum diameter of oil end shield/stress relieving electrode
L11	Horizontal Distance between holes for bushing bottom connection for 4 hole connection
L12	Vertical Distance between holes for bushing bottom connection for 4 hole connection
L13	Vertical Distance between holes for bushing bottom connection for 2 hole connection
D7	Diameter of hole for bushing bottom connection for 2 hole connection
D8	Diameter of hole for bushing bottom connection for 4 hole connection

Voltage Rating (kV)	**420**	**245**		**145**		**72.5**		**52**
BIL kVp	1425	1050		650		325		250
Creepage Distance (mm)	13020	7595		4495		2248		1612
Current Rating (A)	**1250**	**1250**	**2000**	**1250**	**2000**	**800**	**2000**	**1250**
Type of lead	Solid Stem (SS)	SS	SS	SS	SS	SS		SS
L2 ±5	1640	1130	1230	800	1030	695		450
L6 (min.)	400	300		300	300	300		100
D2 (max.)	350	270		165	180	115	165	115
D3±2	720	450		335	335	225	335	225
D4±1 (PCD)	660	400		290	290	185	290	185
D5xN	24x12	20x12		15x12	15 x12	15x6	15x12	15x6
D6 (max.)	350	270		180		115		115
L11	-	-	45	-	45	-	55	-
L12	-	-	40	-	40	-	40	-
L13	40	40	-	40	-	40	-	40
D7	Φ14	Φ14		Φ14	Φ14	Φ14	Φ14	Φ14
D8	-	-	Φ 14	-	-	-	-	-
Length & Diameter of Air End Terminal	125 & Φ60	125 & Φ60	125 & Φ60	125 & Φ60	125 & Φ60	125 & Φ60	125 & Φ60	125 & Φ60

Notes:

1. All dimensions are in mm.
2. No positive tolerance where maximum dimension specified and no negative tolerance where minimum dimension is specified.
3. For other details of oil end terminal for 2000 A (145 kV/245 kV) solid stem type bushing, refer Fig 4 of IS 12676.
4. For other details of oil end terminal for 2000 A, 72.5 kV solid stem type bushing, refer Fig 3B of IS 12676.
5. For other details of oil end terminal for 800 A and 1250 A (52kV/72.5 kV/145 kV/245 kV/420 kV) solid stem type bushing, refer Fig 3A of IS 12676.

Annexure-N

PHYSICAL INTERCHANGEABILITY OF TRANSFORMERS OF DIFFERENT MAKE

1.0 One of the objectives of standardization is to achieve physical interchangeability of transformers of different makes, procured by utility (ies), by standardizing the minimum foundation loading to be considered for civil foundation design of transformers. In case of failure of any transformer, outage time to replace a failed unit by a spare unit/new unit of different make would be minimized as it can be accommodated in the same space without/minor modification in existing foundation.

2.0 In general, the foundation layout & design of transformer depends on weight of the transformer (with oil and all fittings & accessories), design of soak pit (with or without remote oil collecting pit) with trans rack/grating & gravels and free space to be kept below the transformer to accommodate oil and water in case of fire. The number of rails, number & location of jacking pads of transformers are also equally important.

3.0 The foundation design should take into account the following points:

a) The foundations of transformer should be of block type foundation. Minimum reinforcement should be governed by IS: 456.

b) Transformer can be placed on foundation either directly or on roller assembly (with suitable locking arrangement) along with suitable anti Earthquake Clamping Device as specified in Chapter-1.

c) The plinth height of transformer foundation may be kept from 300 mm to 500 mm above finished ground level of the substation/switchyard depending upon the size of the transformer. Pulling blocks should be provided for shifting of transformer for maintenance purposes.

d) The pedestal support should be provided for supporting the cooler bank, firefighting system etc. The RCC Rail-cum-road system integrated with the transformer foundation may be provided to enable installation and the replacement of any failed unit. The transfer track system should be suitable to permit the movement of any failed unit fully assembled (including OLTC, bushings) with oil. This system should enable the removal of any failed unit from its foundation to the nearest road. If trench/drain crossings are required, then suitable

R.C.C. culverts should be provided in accordance with I.R.C. standard/relevant IS.

e) Foundation of each transformer including oil conservator tank and cooler banks etc. should be placed in a self-sufficient pit surrounded by RCC retaining walls (Pit walls). The retaining wall of the pit from the transformer should be such that no part of transformer is outside the periphery of retaining wall.

f) An oil soak pit of adequate capacity should be provided below each oil filled transformer to accommodate at least 150% of full quantity of oil contained in the transformer and minimum 300 mm thick layer of gravels/pebbles of approximately 40 mm size (spread over a steel iron grating/trans rack) providing free space below the grating. Alternatively, an oil soak pit should be provided below each transformer to accommodate 1/3rd of total quantity of oil contained in the transformer and minimum 300 mm thick layer of gravels/pebbles of approximately 40 mm size (spread over a steel iron grating/trans rack) providing free space below the grating provided a common remote oil collecting pit of capacity at least equal to oil quantity in the largest size transformer is provided for a group of transformers. Bottom of the soak pit below the transformer should be connected to the common oil collecting pit with drain pipe (two or more Hume/concrete pipes) of minimum 150 mm diameter with a slope not less than 1/96 for fast draining of oil and water through gravity from soak pit to the burnt oil collecting pit, which is generally located away from transformers.

g) Every soak pit below a transformer should be suitably designed to contain oil dropping from any part of the transformer.

h) The common remote oil collecting pit and soak pit (when remote oil collecting pit is not provided) should be provided with suitable automatic pumping facility, to always keep the pit empty and available for an emergency.

i) The disposal of transformer oil should be carried out in an environmental friendly manner.

j) The minimum height of the retaining walls of pit should be 150mm to 200mm above the finished ground level to avoid outside water pouring inside the pit. The bottom of the pit is generally made of PCC M15 grade and should have a uniform slope towards the sump pit. While designing the oil collection pit, the movement of the transformer must be taken into account.

k) The grating shall be made of MS flat of size 30 mm x 5 mm at spacing of 30 mm and MS bar of 6 mm dia at spacing of 150 mm at right angle to each other. Maximum length & width of grating should be 2000 mm & 500 mm respectively. The gratings, supported on ISMB 150 mm, should be placed at the formation level and will be covered with 300 mm thick layer of stone aggregate having size 40 mm (approximate). All steel work used for grating and supports should be painted with epoxy based zinc phosphate primer (two packs) confirming to IS: 13238-1991, thereafter with two or more coat of bituminous paint of approved quality should be applied.

l) In case of transformers with separately mounted cooler / radiator bank, the position of the cooler / radiator bank has been recommended on the left side of the transformer when viewing from HV side. However, transformer shall be designed in such a way that cooler / radiator bank can be positioned on either side of the main tank. Similarly the conservator shall be on the left side of the tank while viewing from HV side.

m) The separation wall(s) or fire barrier wall(s) as per Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulations shall be provided.

n) Other requirement related to civil construction of foundation may be specified by the utility in line with relevant BIS standards and best practices.

4.0 It is a fact that maximum weight of transformer (with oil and all fittings & accessories) and outline dimension do not vary much from manufacturer to manufacturer for same rating. Hence a common foundation layout plan with soak pit (with oil and all fittings & accessories) with loading details would facilitate the interchangeability of transformers of different make of similar/same ratings. The utilities shall strive to standardize the foundation plan for different rating of transformers so that transformers of different makes could be accommodated in the same space with minor modification / without any modification in the existing foundation resulting in reduction in the outage time of replacement of old transformer.

5.0 The rail track gauge shall be 1676 mm. All voltage class transformers shall have two (2) rails.

6.0 The manufacturers have different arrangement of jacking and different spacing between jacking pads. Hence, it is difficult to standardize the civil foundation drawing based on jacking pad locations / arrangement. Design of block foundation based on weight of transformer for a particular MVA

rating along with no. of rails as mentioned above and provision of suitable size of portable metal plate for jacking [(400 mm x 400 mm x 32 mm thick) / (300 mm x 300 mm x 30 mm thick)] would facilitate the physical interchangeability of transformers of different make on same foundation block. One set of metal plates for jacking of Transformer shall be provided by OEM / contractor. Minimum size of metal plates for jacking and minimum weight of transformer to be considered for design of foundation block shall be as follows:

Rating of Transformer (MVA, Voltage ratio, no. of Phases)	Weight of transformer (in metric Tons)	Minimum size of removable metal plates for Jacking of transformer
315MVA, 400/33-33 kV, 3-Phase Transformer	450	400 mm x 400 mm x 32 mm thick
250MVA, 400/33-33 kV, 3-Phase Transformer	400	400 mm x 400 mm x 32 mm thick
160MVA, 400/33-33 kV, 3-Phase Transformer	275	400 mm x 400 mm x 32 mm thick
125MVA, 400/33 kV, 3-Phase Transformer	240	400 mm x 400 mm x 32 mm thick
160MVA, 220 (or 230)/33-33 kV, 3-Phase Power Transformer	230	400 mm x 400 mm x 32 mm thick
125MVA, 220 (or 230)/33 kV, 3-Phase Power Transformer	230	400 mm x 400 mm x 32 mm thick
100MVA, 220 (or 230)/33 kV, 3-Phase Power Transformer	200	400 mm x 400 mm x 32 mm thick
100MVA, 132 (or 110)/33 kV, 3-Phase Power Transformer	165	400 mm x 400 mm x 32 mm thick
80MVA, 132 (or 110)/33 kV, 3-Phase Power Transformer	130	400 mm x 400 mm x 32 mm thick
50MVA, 132(or 110)/33 kV, 3-Phase Power Transformer	110	300 mm x 300 mm x 30 mm thick
31.5MVA, 132(or 110)/33 kV, 3-Phase Power Transformer	85	300 mm x 300 mm x 30 mm thick

Annexure - O

1100 V GRADE POWER & CONTROL CABLES

1.1 Separate cables shall be used for AC & DC.

1.2 Separate cables shall be used for DC1 & DC2.

1.3 At least one (1) core shall be kept as spare in each copper control cable of 4C, 5C or 7C size whereas minimum no. of spare cores shall be two (2) for control cables of 10 core or higher size.

1.4 The Aluminium/Copper conductors used for manufacturing the cables shall be true circular in shape before stranding; shall be of good quality, free from defects and shall conform to IS 8130.

1.5 The fillers and inner sheath shall be of non-hygroscopic, fire retardant material, shall be softer than insulation and outer sheath shall be suitable for the operating temperature of the cable.

1.6 Progressive sequential marking of the length of cable in metres at every one metre shall be provided on the outer sheath of all cables.

1.7 Strip wire armouring method (a) mentioned in Table 5, Page-6 of IS: 1554 (Part 1) – 1988 shall not be accepted for any of the cables. For control cables only round wire armouring shall be used.

1.8 The cables shall have outer sheath of a material with an oxygen index of not less than 29 and a temperature index of not less than 250°C.

1.9 All the cables shall conform to fire resistance test as per IS: 1554 (Part - I).

1.10 The normal current rating of all PVC insulated cables shall be as per IS: 3961.

1.11 Repaired cables shall not be accepted.

1.12 Allowable tolerance on the overall diameter of the cables shall be ± 2 mm.

1.13 **PVC Power Cables**

1.13.1 The PVC insulated 1100V grade power cables shall be of Fire Retardant Low Smoke Halogen (FRLSH) type, C2 category, conforming to IS: 1554

(Part-I) and its amendments read along with this specification and shall be suitable for a steady conductor temperature of 85°C. The conductor shall be stranded aluminium of H2 grade conforming to IS 8130. The insulation shall be extruded PVC of type-C of IS: 5831. A distinct inner sheath shall be provided in all multi core cables. For multi core armoured cables, the inner sheath shall be of extruded PVC. The outer sheath shall be extruded PVC of Type ST-2 of IS: 5831 for all cables. The copper cable of required size can also be used.

1.14 **PVC Control Cables**

1.14.1 The 1100V grade control cables shall be of FRLSH type, C2 category conforming to IS: 1554 (Part-1) and its amendments, read along with this specification. The conductor shall be stranded copper. The insulation shall be extruded PVC of type A of IS: 5831. A distinct inner sheath shall be provided in all cables whether armoured or not. The outer sheath shall be extruded PVC of type ST-1 of IS: 5831 and shall be grey in colour except where specifically advised by the purchaser to be black.

1.14.2 Cores shall be identified as per IS: 1554 (Part-1) for the cables up to five (5) cores and for cables with more than five (5) cores the identification of cores shall be done by printing legible Hindu Arabic Numerals on all cores as per clause 10.3 of IS : 1554 (Part - 1).

ANNEXURE – P

LIST OF CODES/STANDARDS/REGULATIONS/PUBLICATIONS

A list of Codes/Standards/Regulations/Publications which shall be used for design review, manufacturing, testing, erection, transportation etc. has been given below. In case of revision/amendment of these, revised/amended versions shall be followed.

IS 2026: Part 1 : 2011 (Reaffirmed Year : 2016)	-	Power transformers: Part 1 General
IS 2026: Part 2 : 2010 (Reaffirmed Year : 2020)	-	Power transformers Part 2 Temperature-rise
IS 2026: Part 3 : 2018	-	Power Transformers Part 3 Insulation Levels, Dielectric Tests and External Clearances in Air (Fourth Revision)
IS 2026: Part 4 : 1977 (Reaffirmed Year : 2016)	-	Power transformers: Part 4 Terminal marking, tappings and connections
IS 2026 : Part 5 : 2011 (Reaffirmed Year : 2016)	-	Power Transformers Part 5 Ability to Withstand Short Circuit
IS 2026 : Part 6 : 2017	-	Power Transformers Part 6 Reactors
IS 2026 : PART 7 : 2009 (Reaffirmed Year : 2019)	-	Power Transformers Part 7 Loading Guide for Oil-Immersed Power Transformers
IS 2026 : Part 8 : 2009 (Reaffirmed Year : 2019)	-	Power Transformers : Part 8 Applications guide
IS 2026 : Part 10 : 2009 (Reaffirmed Year : 2019)	-	Power Transformers : Part 10 Determination of sound levels
IS 2026 : Part 10 : Sec 1 : 2018	-	Power Transformers part 10 Determination of Sound Levels Section 1 Application guide
IS 2026 : Part 14 : 2018	-	Power Transformers Part 14 Liquid-Immersed Power Transformers Using High-Temperature Insulation Materials
IS 2026 : Part 18 : 2018	-	Power Transformers Part 18 Measurement of Frequency Response

IS 3024 : 2015	-	Grain Oriented Electrical Steel Sheet and Strip (Third Revision)
IEC / IEEE 60214-2:2019		Tap-changers - Part 2: Application guidelines
IS 649 : 1997 (Reaffirmed Year : 2018)	-	Methods for testing steel sheets for magnetic circuits of power electrical apparatus
IS-10028 (Part 1, 2 & 3)	-	Code of practice for selection, installation & maintenance of transformer
IS 3639 : 1966 (Reaffirmed Year : 2016)	-	Fittings and Accessories for Power Transformers
IS 3637 : 1966 (Reaffirmed Year : 2016)	-	Gas Operated Relays
IS 335 : 2018	-	New Insulating Oils — Specification (Fifth Revision)
IEC 60296-2020	-	Fluids for electrotechnical applications – Mineral insulating oils for electrical equipment
IEC 60422 : 2013	-	Mineral insulating oils in electrical equipment - Supervision and maintenance guidance
IS 6792 : 2017	-	Insulating Liquids - Determination of the Breakdown Voltage at Power Frequency - Test Method (Second Revision)
IS 8468 : Part 1 : 2018 IEC 60214-1 : 2014	-	Tap - Changers Part 1 Performance Requirements and Test Methods (First Revision)
IS 8478 : 1977 (Reaffirmed Year : 2016)	-	Application guide for on-load tap changers
IS/IEC 60137 : 2017	-	Bushings for alternating voltages above 1000 Volts
IS 12676 : 1989 (Reaffirmed Year : 2016)	-	Oil Impregnated Paper Insulated Condenser Bushings - Dimensions and Requirements

IS 4257 : Part 1 : 1981 (Reaffirmed Year : 2019)	-	Dimensions for Clamping Arrangements for Porcelain Transformer Bushings - Part I : For 12 kV to 36 kV Bushings
IS 4257 : Part 2 : 1986 (Reaffirmed Year : 2019)	-	Dimensions for clamping arrangements for porcelain transformer bushings: Part 2 For 72.5 kV and 123 kV bushings
IS 8603 : 2008 (Reaffirmed Year : 2019)	-	Dimensions for porcelain transformers bushings for use in heavily polluted atmospheres 12/17.5kV, 24kV and 36kV
IS 8603 : Part 4 : 2003 (Reaffirmed Year : 2019)	-	Dimensions for Porcelain Transformer Bushings for Use in Heavily Polluted Atmospheres - Part 4 : 52 kV Bushings
ANSI-C57.12.80	-	General requirements for Distribution, Power and Regulating Transformers
ANSI-C57.12.90	-	Test Code for Distribution, Power and Regulation Transformers
NEMA-TR-1	-	Transformers, Step Voltage Regulators and Reactors
IS 1747 : 1972 (Reaffirmed Year : 2016)	-	Nitrogen
IS-5: 2007	-	Colours for Ready Mixed Paints and Enamels
IS 3043 : 2018	-	Code of Practice for Earthing
IS 8263 : 2018	-	Radio Interference Test on High -Voltage Insulators (First Revision)
IS 8269 : 1976 (Reaffirmed Year : 2014)	-	Methods for switching impulse tests on high voltage insulators
IS 2071 : Part 1 : 2016	-	High-voltage Test Techniques Part 1 General Definitions and Test Requirements (Third Revision)
IS 16803 : 2018	-	High Voltage Test Techniques - Measurement of Partial Discharges by Electromagnetic and Acoustic Methods

IS/IEC 60270 : 2000 (Reaffirmed Year : 2016)	-	High — Voltage Test Techniques — Partial Discharge Measurements
IS 13235 : Part 1 : 2019	-	Short-Circuit Currents — Calculation of Effects Part 1 Definitions and Calculation Methods (First Revision)
IS 13235 : Part 2 : 2019	-	Short-Circuit Currents — Calculation of Effects Part 2 Examples of Calculation (First Revision)
IS 16227 : Part 1 : 2016 IEC 61869-2 : 2007	-	Instrument Transformers: Part 1 General requirements
IS 16227 : Part 2 : 2016 IEC 61869-2 : 2012	-	Instrument Transformers Part 2 Additional Requirements for Current Transformers
IS 16227 : Part 100 : 2018	-	Instrument Transformers Part 100 Guidance for Application of Current Transformers in Power System Protection
IS/IEC 60529 : 2001 (Reaffirmed Year : 2019)	-	Degrees of protection provided by enclosures (IP CODE)
IS/IEC-60947	-	Low voltage switchgear and control gear
IS 2062 : 2011 (Reaffirmed Year : 2016)	-	Hot Rolled Medium and High Tensile Structural Steel
IS 9595 : 1996 (Reaffirmed Year : 2019)	-	Metal arc welding of carbon and carbon manganese steels - Recommendations
IS 10801 : 1984 (Reaffirmed Year : 2016)	-	Recommended procedure for heat treatment of welded fabrications
IS 4253 : Part 1 & 2 : 2008 (Reaffirmed Year : 2019)	-	Cork Composition Sheets
IS 11149 : 1984	-	Rubber Gaskets

(Reaffirmed Year : 2019)		
IS 12444 : 1988 (Reaffirmed Year : 2015)	-	Continuously cast and rolled electrolytic copper wire rods for electrical conductors
IS 513 : 2016	-	Cold Reduced Carbon Steel Sheet and Strip
IS 12615 : 2018	-	Line Operated Three Phase A.C. Motors (IE CODE) "Efficiency Classes and Performance Specification" (Third Revision)
IS/IEC 60034 : PART 5 : 2000 (Reaffirmed Year : 2018)	-	Rotating electrical machines : Part 5 Degrees of protection provided by the integral design of rotating electrical machines (IP CODE) - Classification
IS 5561 : 2018	-	Electric Power Connectors- Specification
IS 2932 : Part 1 : 2013 (Reaffirmed Year : 2018)	-	Enamel, Synthetic, Exterior : (a) Undercoating (b) Finishing - Specification : Part 1 for Domestic and Decorative Applications
IS 2074 : Part 1 : 2015	-	Ready Mixed Paint, Air Drying, Red Oxide - Zinc Chrome, Priming - Specification
IS 3400	-	Methods of Test for Vulcanized Rubber
IS 456 : 2000 (Reaffirmed Year : 2016)	-	Plain and Reinforced Concrete - Code of Practice (Including Amendment 1, 2, 3,& 4)
IS 13238 : 1991 (Reaffirmed Year : 2017)	-	Epoxy Based Zinc Phosphate Primer (two Pack)
IS 2848 : 1986 (Reaffirmed Year : 2016)	-	Industrial Platinum Resistance Thermometer Sensors
IS/IEC 61850	-	Communication Networks and Systems for Power Utility Automation
IS 16683 : Part 1, 2 & 3 : 2018	-	Selection and Dimensioning of High Voltage Insulators Intended for Use in Polluted Conditions
IEEE 1538-2000		Guide for determination of maximum winding temperature rise in liquid filled

		transformers
IEEE Standard C57.156-2016		Guide for tank rupture mitigation of oil immersed transformers
IEEE Standard C57.150-2012		Guide for Transformer Transportation
IEEE Standard C57.149-2012		Guide for the application and interpretation of Frequency Response Analysis of oil immersed transformers
IEEE Standard C57.104-2019		Guide for the Interpretation of Gases Generated in Mineral Oil-Immersed Transformers
IEC 60599-2015		Mineral oil-filled electrical equipment in service - Guidance on the interpretation of dissolved and free gases analysis
IEEE Std. C57.12.10 - 2017		Standard requirements for liquid immersed power transformers
IEEE Std. 57.104-2019		Guide for the Interpretation of Gases Generated in Mineral Oil-Immersed Transformers
IEC 60599		Mineral oil-filled electrical equipment in service – Guidance on the interpretation of dissolved and free gases analysis
IEEE Std. 62-1995		Guide for Diagnostic Field Testing of Electric Power Apparatus - Part 1: Oil Filled Power Transformers, Regulators, and Reactors
CIGRE Technical Brochure No. 529 -2013		Guide lines for conducting design reviews for Power Transformers
CIGRE Technical Brochure No. 673-2016		Guide on Transformer Transportation
CIGRE Technical Brochure No. 530-2013		Guide for conducting factory capability assessment for Power Transformers
CIGRE TB 209		Short Circuit Performance of Power Transformers
CIGRE TB 436		Experiences in service with new insulating liquids
Central Electricity Authority (Measures Relating to Safety and Electric Supply) Regulations		

Central Electricity Authority (Technical Standard for Construction of Electrical Plants and Electric Lines) Regulations
Central Electricity Authority (Installation and Operation of Meters) Regulations
CBIP Manual on Transformers (Publication No. 317)
ISO 9001: Quality System – Model for Quality Assurance in Design/Development.
ISO-14001 (Environmental Management System)
OHSAS 18001 (Occupational Health and Safety Management System)

APPENDIX:

CEA order for constitution of the Committee for preparation of Technical specifications of power transformers for solar park pooling stations

भारत सरकार
Government of India
विद्युत मंत्रालय
Ministry of Power
केन्द्रीय विद्युत प्राधिकरण
Central Electricity Authority
विद्युत प्रणाली अभियांत्रिकी एवं प्रौद्योगिकी विकास प्रभाग
Power System Engineering & Technology Development Division
3rd Floor, Sewa Bhawan, R.K. Puram
New Delhi – 66, Telephone: 011-26732358
(bhanwar.cea@gov.in)

To,
As per attached list

विषय / Subject: Constitution of Committee for preparation of Standard Technical Specification of Power Transformers for Solar Power Park pooling Station.

महोदय/ Sir,

Large scale integration of generation from Renewable Energy (RE) sources is the trend of future. India has total exploitable potential of 1100 GW (750 GW from solar energy and 300 GW from wind energy) generation from renewable resources. By 2030, the generation from renewable resources is likely to increase by five times (around 450 GW), contributing about 54% of total installed generation capacity and major contribution would be from solar.

1. Generally, electrical energy generated form the solar block is pooled at 33 kV level and stepped up to 400 kV / 220 kV /132kV level at the pooling station of solar power park developers and then connected to the Inter-State/Intra-State Transmission System. The requirement of these transformers is likely to increase in future considering the contribution from solar generation.

2. There are different practices among the solar park developers across the country regarding ratings, no. of LV windings, losses, % impedance etc. of power transformers (400/33 kV, 220/33 kV & 132/33 kV) at the pooling stations. Hence, there is need for preparation of standard specification of

transformer for solar park pooling station as they are most expensive & vital asset and play crucial role in reliable evacuation of power. The standardisation will help the utilities/ developers and manufacturers across the country to get products of similar quality & reliability, the delivery will be faster and would establish uniform practices across all the utilities and facilitate interchangeability of transformers of different make.

3. In view of above, a technical Committee is constituted under the Chairmanship of Chief Engineer (PSE&TD), CEA with the following composition for preparation of standard specification of transformer for solar park pooling stations:

1.	Chief Engineer (PSE&TD), CEA		Chairman
2.	Chief Engineer (RT&I), CEA	-	Member
3.	A representative from SECI	-	Member
4.	A representative from NTPC Ltd.	-	Member
5.	A representative from PGCIL	-	Member
6.	A representative from CPRI	-	Member
7.	Representatives from Power Utilities • RRVPNL (Rajasthan) • KPTCL (Karnataka) • GETCO (Gujarat) • MPPTCL (Madhya Pradesh) • APTRANSCO (Andhra Pradesh)	-	Members
8.	Two (2) Solar Power Park developers representing Solar Power Developer Association	-	Members
9.	Two(2) manufacturers of power transformers representing IEEMA	-	Members
10.	BHEL	-	Member
11.	Director (PSE&TD), CEA	-	Convener

The Terms of Reference of the Committee are as under:

(a) To standardize ratings and technical specification of transformer including losses, Basic Insulation Level of winding and bushing, percentage impedance, tap range and location of tap, cooling system,

other performance parameters; constructional features and fittings & accessories

(b) To standardize Manufacturing Quality Plan, testing and any other issue as decided by the committee.

The committee will submit the standard specification of transformer for solar park pooling stations within three (3) months from the first meeting of the committee. The committee may co-opt any other member, as deemed fit.

This issues with approval of Chairperson, CEA

(भंवर सिंह मीना / Bhanwar Singh Meena)

उप निदेशक / Deputy Director

To:

1.	Chief Engineer (PSE&TD), CEA skrmohapatra@nic.in
2.	Chief Engineer (RT&I), CEA akrajput@nic.in
3.	SA to Member (PS), CEA sa-memberps@gov.in
Following Organisations are Requested to nominate suitable officer (s) to the Committee	
4.	Chairman & Managing Director, RRVPNL, Corporate office, Vidyut Bhawan Jyoti Nagar, Janpath, Jaipur-302005 cmd.rvpn@gmail.com
5.	Chairman, GETCO, Sardar Patel Vidyut Bhavan, Corporate Office Race Course, Vadodara-390007 md.getco@gebmail.com
6.	Managing Director, APTRANSCO, Vidhyut Soudha, Gunadala, Eluru road, Vijayawada-520004 mdtantransco@tnebgov.org
7.	Managing Director, MPPTCL, Block No.2, Shakti Bhawan, Rampur,P.O Vidhyut Nagar Jabalpur-482008 md@mptransco.nic.in
8.	Chairman & Managing Director, KPTCL, 1st floor, Kaveri Bhawan, KG Road, Bangalore-560009 md@kptcl.com
9.	Chairman & Managing Director, SECI, 1st Floor, D-3, A Wing, Prius Platinum Building District Centre, Saket, New Delhi – 110017 md@seci.co.in
10.	Director General, Central Power Research Institute, P B No.8066, Sadashivnagar PO, Prof. Sir C V Raman Road, Bangalore - 560 080 dgcpri@cpri.in

11.	Chairman & Managing Director, NTPC Ltd. NTPC Bhawan, Core 7, Scope Complex 7, Institutional Area Lodhi Road, New Delhi-110003 cmd@ntpc.co.in
12.	Chairman & Managing Director, POWERGRID, Saudamini, Plot No.2, Sector 29, Near IFFCO Chowk, Gurgaon (Haryana) - 122001, INDIA cmd@powergridindia.com
13.	Director General, Solar Power Developers Association(SPDA), 910, 9th floor Surya Kiran Building, 19, KG Marg, New Delhi-110001 dg@solarpda.com
14.	Chairman & Managing Director Bharat Heavy Electricals Limited Industry Sector, Integrated Office Complex, Lodhi Road, New Delhi – 110003 cmd@bhel.in
15.	Director General, IEEMA Rishyamook Building, First Floor 85 A, Panchkuian Road New Delhi – 110001 sunil.misra@ieema.org

Contributing Members

Chairman of the Committee Shri S. K. Ray Mohapatra Chief Engineer (PSE&TD), CEA		
Contributors & Participants		
1.	Shri Ashok Rajput	CEA
2.	Shri Y. K. Swarnkar	CEA
3.	Shri Bhanwar Singh Meena	CEA
4.	Shri Akshay Dubey	CEA
5.	Shri Karan Sareen	CEA
6.	Shri Apoorv Goyal	CEA
7.	Shri A. Balan	SRPC
8.	Shri S.K. Gupta	BHEL
9.	Shri Sanjeev Singh	SECI
10.	Shri Piyush Gupta	SECI
11.	Shri M. Chandra Sekhar	CPRI
12.	Shri P.S.S. Anjaneya Prasad	APTRANSCO
13.	Shri Chavasreenivasa Rao	APTRANSCO
14.	Shri Surya Chandram Podium	APTRANSCO
15.	Shri Loveleen Singh	DTL
16.	Shri B.P. Soni	GETCO
17.	Shri S. Shivamallu	KPTCL
18.	Shri Rajesh Shrivastava	MPPTCL
19.	Shri P.K. Gargava	MPPTCL
20.	Shri Sahil Kumar Singla	PSTCL
21.	Shri Shiv Shankar Mishra	NTPC
22.	Shri Animesh Manna	NTPC
23.	Shri U.K. Pati	OPTCL
24.	Shri S. J. Lahiri	PGCIL
25.	Shri Gunjan Agrawal	PGCIL
26.	Shri Richik Manas Das	PGCIL
27.	Shri R. C. Mahawar	RVPN
28.	Shri V. Velappan	NLCIL
29.	Shri Swetang S. Shah	Torrent Power
30.	Smt. Taruna Saxena	Hitachi-ABB
31.	Shri Tarun K. Garg	Hitachi-ABB
32.	Shri Dinesh Goud	Hitachi-ABB
33.	Shri Himanshu Shah	Hitachi-ABB
34.	Shri Suchint Thareja	CG Power

35.	Shri Sujit Kannaujia	CG Power
36.	Shri M.Vijayakumaran	PRIMEMEIDEN
37.	Shri C. Jayasenan	SIEMENS
38.	Shri Manish Yadav	Toshiba
39.	Shri R Gopala Krishna	Toshiba
40.	Shri Krishna Pavan	Toshiba
41.	Shri P. Ramchandra	EX-ABB
42.	Shri Subbu Pulipaka	NSEFI
43.	Shri Ravi Verma	Solar Power Developer Association
44.	Shri Nagarjuna Babu	Shirdi Sai Electricals
45.	Shri Sai Krishna	Shirdi Sai Electricals
46.	Shri Shekhar Agarwal	Adani Green Energy
47.	Shri Deepak Saxena	Avaada Energy
48.	Shri Vivek Jain	Avaada Energy
49.	Shri Manish Ahuja	ACME
50.	Shri Vinay Vyas	ACME
51.	Shri Manoj Kumar Goyal	Azure Power India
52.	Shri Yogesh Sanklecha	Azure Power India
53.	Shri V. Raveendra	Greenko Group
54.	Shri P. Manohar	Greenko Group
55.	Shri P Laxman	Greenko Group
56.	Shri SVB Singh	Greenko Group
57.	Shri Kailash Pandey	ReNew Power
58.	Shri Mukesh Mandal	ReNew Power
59.	Shri S Gururaj Rao	GRT Jewellers India
60.	Shri Amey Kulkarni	Savita Oil Technologies
61.	Shri Ajay Nilakantan	MR