Chapter - 1

Technical Specification & Parameters

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CHAPTER - 1

TECHNICAL SPECIFICATION & PARAMETERS

INTRODUCTION:

1. Ratings, Voltage Ratio, Tapping range, Impedance and other technical parameters may be selected as per CBIP Publication No. 295, Manual on Transformers, 2012.

2. This Manual gives the recommended losses for the standardised ratings of power transformers (Annexure - 1.1). Two ranges of losses are given - High Losses (for maximum specific loadings of current density 3A/mm^2 and flux density 1.7 T at rated tap) and Low Losses (for maximum specific loadings of 2.3 A/mm^2 and flux density of 1.6 T at rated tap). Current Density refers to all taps and flux density refers to at rated tap and voltage. Low losses may be adopted where the capitalization rates are high (say ₹ 2 lakhs per no-load loss kW and ₹ 1 lakh per load loss kW) and high losses where low capitalization rates are applicable (say ₹ 1 lakh per no-load loss kW and ₹ 0.5 lakh per load loss kW). When fixed maximum losses are specified, transformer buyers need not capitalize the losses for bid comparison. With fixed losses and using standardised GTP, buyers can compare various bids effectively and expeditiously. They can compare quoted weights of active materials with standardised losses. Indicated stray losses and type of conductors (rectangular conductor Vs continuously transposed cable – CTC) can be compared. Hardness of conductor and epoxy coated CTC gives an indication of short circuit withstand strength of winding.

3. Where the buyer wants losses different from the above standardised losses, he may get losses from reliable vendors after indicating the loss capitalization rates or maximum specific loadings. After evaluating the market losses, fixed losses for the special duty transformers may be decided and bids may be invited for the fixed losses.

4. The GTPs are prepared in two parts. One is to be specified by buyer and other by vendor. The tick mark ' √ ' is shown in the column indicate by whom the data is to be filled in.

5. Ratings are also standardised covering 132 kV and above and up to 765 kV class transformers and accordingly considered in this manual (Annexure - 1.2).

6. List of applicable standards for transformer is enclosed for ready reference (Annexure - 1.3).

Guaranteed Technical Particulars for Power Transformers

A. GENERAL

Item	Description	Unit	Specified (by Buyer)	Offered (by Vendor)
1	**General Information** i) Supplier ii) Manufacturer iii) Place of Manufacture iv) Type of Transformer (Core/Shell)			√
2	**Applications** i) Indoor/Outdoor ii) 2Wdg/3Wdg/Auto iii) GT/Step down/ICT/Station Start up/Auxiliary/Rail Trackside Supply		√	
3	**Corrosion Level at Site** i) Light ii) Medium iii) Heavy iv) Very Heavy		√	

Item	Description	Unit	Specified (by Buyer)	Offered (by Vendor)
4	**Applicable Standards** i) IEC: 60076 ii) IS : 2026 iii) ANSI C57.12.00		√	
5	**Type** i) Liquid Immersed ii) Dry		√	
6	**Full Load Rating** (HV/IV/LV)	MVA	√	
7	**3 Phase/Bank of Three Phase/Single Phase (A,B,C)**		√	
8	**Rated No Load Voltages** (HV/IV/LV) **Currents** (HV/IV/LV)	kV Amp	√	
9	**Rated Frequency**	Hz	√	
10	**Connections and phase displacement symbols** (Vector Group)		√	
11	**Weight Schedules** (Maximum) / (Minimum with no negative tolerance)			
	i) Active part	kg		√
	ii) Oil	kg		√
	iii) Tank and Fittings	kg		√
	iv) Total Weight	kg		√
	v) Overall dimensions L x B x H	mm		√
	vi) Size of heaviest package L x B x H	mm		√
	vii) Weight of heaviest package	kg		√
11.a	**Transport Limitation**			√
12	**LV Winding**			
	i) Stabilizing tertiary (Yes/No)		√	
	ii) Loaded (Yes/No)		√	
13	**Tappings**			
	i) OLTC/OCTC		√	
	ii) Tappings on		√	
	iii) Variation on		√	
	iv) Range of variation	%	√	
	v) No of Steps		√	
	vi) Parallel Operation Requirements		√	
14	**Impedance and Losses**			
	i) Calculated I^2R Loss at rated tap and 75 ^{0}C	kW		√
	ii) Eddy current and stray loss at rated tap and 75 ^{0}C (indicative)	kW		√
	iii) Calculated Load Loss(I^2R+Eddy and Stray)at rated tap and 75 ^{0}C	kW		√
	iv) Guaranteed Load loss at rated tap and 75 ^{0}C (Max)	kW	√	

Item	Description	Unit	Specified (by Buyer)			Offered (by Vendor)
			HV-IV	HV-LV	IV-LV	
	v) Guaranteed Impedance (Base MVA at Principal tap)	%	√	√	√	
	Tolerance	%	√	√	√	
	vi) Impedance at extreme tappings					
	a) Max. Voltage tap	%				√
	b) Min. Voltage tap	%				√
	Tolerance	%				√
	vii) Regulation at full load 0.8 pf at 75 ^{0}C winding temperature	%				√
	viii) Guaranteed No Load Loss (Max)	kW		√		
	ix) Calculated Fan Loss	kW				√
	x) Calculated Pump Loss	kW				√
	xi) Guaranteed Auxiliary Loss (Max)	kW		√		
	xii) Guaranteed maximum Magnetizing Current at rated Voltage	%				√
	xiii) Efficiency at rated load, unity PF	%				√
	xiv) Load for Maximum efficiency	%				√
15	**Any limitations in the performance of the required test?** If Yes, State limitations					√
16	**Deviations from specifications** (if any)					√

B. MAGNETIC SYSTEM

Item	Description	Unit	Specified (by Buyer)	Offered (by Vendor)
1	**Core Type**			√
	i) 3 Phase 3 Limb (3 wound Limbs)			
	ii) 3 Phase 5 Limb (3 wound Limbs)			
	iii) 1 Phase 2 Limb (2 wound Limbs)			
	iv) 1 Phase 3 Limb (1 wound Limb)			
	v) 1 Phase 4 Limb (2 wound Limbs)			
	vi) 1 Phase 5 Limb (3 wound Limbs)			
2	**Type of Core Joint**			√
	i) Mitred			
	ii) Step Lap			
3	**CRGO** a) Thickness b) Max. Specific loss at 1.7 T, 50Hz.	 mm W/kg		 √ √
4	**Core bolts in Limb/Yoke**	Yes/No	√	
5	**Minimum Gross Area** of Core/Limb/Yoke/Unwound Limb (May be verified during manufacturing stage)	cm^2		√
6	**Stacking Factor**	%		√

Item	Description	Unit	Specified (by Buyer)	Offered (by Vendor)
7	**Voltage per Turn**	V		√
8	**Apparent Core Density** for Weight Calculation			√
9	**Minimum Net Weight of Silicon Steel Lamination CRGO** (may be verified during manufacturing stage by calculation using input from item -5)	kg		√
10	**Max Flux density at Rated Voltage and Frequency** (may be verified during manufacturing stage by calculation)	T		√
12	**W/kg at working flux density**	w		√
13	**Building Factor considered**			√
14	**Calculated No Load Loss** at rated voltage and Frequency (Net Weight x W/kg x Building factor)	kW		√
15	**Maximum Sound Level**	dB		√
17	**Core Isolation test**	kV		√

C. CONDUCTING SYSTEM

Item	Description	Unit	Offered (by Vendor)			
			HV	IV	LV	Reg
1	**Type of Winding** Helical/Disc/Layer/interwound		√	√	√	√
2	**Type of Conductor** PICC/CTC/CTCE/CTCEN/BPICC		√	√	√	√
3	**Minimum Yield Strength of Conductor** (*0.2% elongation*)	N/mm^2	√	√	√	√
4	**Maximum Current density at any tap**	A/mm^2	√	√	√	√
5	**Bare Weight of copper without paper insulation and lead** (*Minimum*)	kg	√	√	√	√
6	**Per Phase Maximum resistance of winding at rated tap @ 75°C**	Ohm	√	√	√	√
7	**Number of Turns/Phase**		√	√	√	√
9	**Dielectric Shielding used**		√	√	√	√
	i) Interleaved winding ii) Wound in Shield iii) Others					
10	**Magnetic Shielding Used**		√	√	√	√
	i) Yoke Shunt on core clamp					
	ii) Magnetic shunt on tank					
	iii) Electromagnetic (Copper/Aluminum) shield on tank					
	iv) Others					

D. COOLING SYSTEM

Item	Description	Unit	Specified (by Buyer)	Offered (by vendor)
1	**Type of Cooling** i) ONAN ii) ONAN/ONAF iii) ONAN/ONAF/OFAF iv) ONAN/ONAF1/ONAF2 v) ONAN/ONAF/ODAF vi) OFAF vii) ODAF viii) OFWF ix) ODWF		√	
2	**Percentage Rating Corresponding to Cooling Stages** (HV/IV/LV)		√	
3	**Guaranteed Maximum Temperature rise at 1000m altitude**			
	i) Top Oil by Thermometer	^{0}C	√	
	ii) Average Winding by resistance	^{0}C	√	
	iii) Winding Hot Spot	^{0}C	√	
4	**Type of Cooler**			
	i) Radiator Bank			√
	ii) Oil to Air Heat Exchanger			
	iii) Oil to Water Cooler (Single Tube)			
	iv) Oil to Water Cooler (Double Tube)			
	v) Tank Mounted			
	vi) Header Mounted			
	vii) Separately Mounted			
5	**Cooling Fans**			
	i) Type			√
	ii) Size	mm		
	iii) Rating (kW)	kW		
	iv) Supply Voltage	V		
	v) Quantity (Running + Standby)	No.		
6	**Oil Pumps**			
	i) Type			√
	ii) Size			
	iii) Rating (lpm and kW)	lpm kW		
	iv) Supply voltage	V		
	v) Quantity (Running + Standby)	No.		
7	**Coolers (Oil to Air)**			
	i) Quantity (Running + Standby)	No.		√
	ii) Type			√
	iii) Rating			√

8	**Coolers (Oil to Water)**			
	i) Quantity (Running + Standby)			√
	ii) Type and Rating			
	iii) Oil flow rate	lpm		
	iv) Water flow rate	lpm		
	v) Nominal Cooling rate	kW		
	vi) Material of tube			
9	**Radiators:**			
	Width of elements	mm		√
	Thickness	mm		
	Length	mm		
	Numbers	No.		

E. DIELECTRIC SYSTEM

Item	Description	Unit	Specified (by Buyer)	Offered (by Vendor)
1	**Geometric Arrangement of winding with respect to core** *e.g.: Core-LV-IV-HV-Reg Coarse-Reg Fine*			√
2	**Regulating Winding**			
	i) Body Tap			√
	ii) Separate			√
3	**HV Line Exit point in winding**			
	i) Top			√
	ii) Center			√
4	**Varistors used across Windings**	Yes/No		√
	If yes, give details			√

			Offered (by Vendor)				
5	**Insulation Levels**		HV	IV	LV	HVN	IVN
	i) 1.2/50 µs Impulse	kVp	√	√	√	√	√
	ii) Chopped Impulse	kVp					
	iii) Switching Impulse	kVp					
	iv) AC (Short duration / Long duration)	kVrms					
	v) Max PD level at 1.5 PU	PC					

F. ACCESSORIES

Item	Description	Unit	Specified (by Buyer)	Offered (by Vendor)
1	**Tap Changers**			
	i) Control a-Manual b-Automatic c-Remote d-Local		√	
	ii) Voltage Class and Current Rating of Tap Changers			√
	iii) Make and Model			√
	iv) Make and Type of AVR			√
	v) Power Supply for control motor (*No of Phase/Voltage/Frequency*)			√
	vi) Rated Voltage for control circuit (*No of Phase/Voltage/Frequency*)			√
2	**Tank**			
	i) Tank Cover : Conventional/Bell/Bottom Plate Tank cover : Bolted /Welded			√
	ii) Plate thickness : side, bottom, cover	mm		√
	iii) Rail Gauge AXB	mm	√	
	iv) Minimum Clearance height from rail for lifting Active Part	mm		√
	v) Wheels : Numbers/Plane/Flanged/Uni-Directional/ Bi-Directional/Locking Details			√
	vi) Vacuum withstand Capability	mm of Hg		√
	vii) Tank/Radiators/Conservator/Accessories			√
	viii) Radiator fins / conservator plate thickness	mm		√

			Offered (by Vendor)			
3	**Bushings**		HV	IV	LV	HVN/IVN
	i) Termination Type a - Outdoor b - Cable Box (oil/Air/SF_6) c - Plug in Type					
	ii) Type of Bushing : Porcelain/OIP/RIP					
	iii) Bushing housing - Porcelain / polymer					
	iv) Rated Voltage Class	kV				
	v) Rated Current	A				
	vi) Rated 1.2/50 us Impulse Withstand	kVp	√	√	√	√
	vii) Rated One minute AC withstand, Dry	kVrms				
	viii) Minimum Creepage Distance	mm				
	ix) Make and Model					
	x) Terminal Pad details					
	xi) BCT Requirements					

Item	Description	Unit	Offered (by Vendor)
4	**Indicative**		
	i) Winding temperature thermometer		
	ii) Oil temperature thermometer		
	iii) Temperature sensors by Fibre optic		
	iv) Oil actuated/gas operated relay		
	v) Pressure Relief Device		
	vi) Dehydrating Breathers		
	vii) Conservator Bag(air cell)		
	viii) Oil level Indicators		√
	Main Conservator		
	OLTC Conservator		
	ix) Oil Sight Window		
	Main Tank		
	Main Conservator		
	OLTC Conservator		
	x) Tap Changer protective device		
	xi) Bushing CTs		
5	**Transformer Oil**		
	i) Grade as per IEEMA spec (**see Chapter 6 of this Manual**) / IEC60296 Inhibited / Uninhibited		√
	ii) Spare oil as percentage of first filling		
	iii) Manufacturer		
6	**Press Board** i) Make ii) Type		√
7	**Conductor Insulating Paper** (*Kraft paper, thermally upgraded Kraft paper, Nomex*)		√

ANNEXURE 1.1

Legend: NLL - No Load Loss in kW; FLL - Full Load Loss in kW; AL - Auxiliary Loss in kW

STANDARDISED LOSSES FOR POWER TRANSFORMERS				
145kV CLASS TRANSFORMER				
Sl.No	MVA	IMPEDANCE %	HIGH LOSS NLL/FLL/AL	LOW LOSS NLL/FLL/AL
1	7.5	8.35	8.5/45/-	7/35/-
2	10	10	12/80/-	8.5/70/-
3	12.5	10	14/100/-	10/80/-
4	16	10	15/110/-	11/100/-
5	20	10	17/130/-	12/110/-
6	25	10	18/140/-	14/115/-
7	31.5	12.5	20/150/-	18/125/-
8	40	12.5	25/185/-	20/140/-
9	50	12.5	30/200/-	25/160/-
10	63	12.5	32/240/5	27/190/4
11	80	12.5	40/275/6	32/230/5
245kV CLASS TRANSFORMERS				
Sl.No	MVA	IMPEDANCE %	HIGH LOSS NLL/FLL/AL	LOW LOSS NLL/FLL/AL
1	50	12.5	33/215/-	26/160/-
2	80	12.5	44/280/6	35/235/5
3	100	12.5	55/320/8	45/270/7
4	125	15	60/370/9	55/300/8
5	160	15	74/445/11	64/365/10
245kV CLASS TRANSFORMERS(GT)				
Sl.No	MVA	IMPEDANCE %	HIGH LOSS NLL/FLL/AL	LOW LOSS NLL/FLL/AL
1	140	12.5	80/400/10	65/340/10
2	250	14	130/600/13	110/500/12
3	315	14	140/750/16	130/650/15
4	600(3*200)	14	100/450/14	80/380/12
245kV CLASS TRANSFORMERS (AUTO)				
Sl.No	MVA	IMPEDANCE %	HIGH LOSS NLL/FLL/AL	LOW LOSS NLL/FLL/AL
1	100	12.5	30/240/6	25/210/6
2	160	12.5	38/350/8	35/300/8
3	200	15	45/430/12	40/330/12

400kV CLASS AUTO - TRANSFORMERS				
Sl.No	MVA	IMPEDANCE %	HIGH LOSS NLL/FLL/AL	LOW LOSS NLL/FLL/AL
1	100(400/132/33)	12.5	60/300/8	50/250/8
2	200(400/132/33)	12.5	80/400/10	65/325/10
3	315(400/220/33)	12.5	95/565/15	75/520/15
4	500(400/220/33)	12.5	150/700/18	120/650/16
5	3*105	12.5	50/175/7	40/165/8
6	3*166.67	12.5	60/250/12	50/210/12
7	3*200	12.5	65/300/13	60/260/13
8	3*250	12.5	78/360/15	70/310/15
9	100	12.5	45/300/8	40/270/8
10	200	12.5	76/400/10	65/350/10
11	315	12.5	95/550/13	78/440/13
12	500	12.5	140/600/16	115/600/16
13	3*105	12.5	37/195/6	33/185/6
14	3*166.7	12.5	48/270/11	42/250/11
15	3*200	12.5	60/350/12	55/320/12
16	3*250	12.5	70/420/15	60/380/15
420kV CLASS TRANSFORMERS (GT)				
Sl.No	MVA	IMPEDANCE %	HIGH LOSS NLL/FLL/AL	LOW LOSS NLL/FLL/AL
1	250	14.5	150/600/14	140/550/12
2	315	14.5	175/650/16	160/600/14
3	3*200	14	120/410/12	110/380/12
4	3*260	14.5	135/500/14	125/460/14
5	3*333	15	157/615/6	140/580/16
800kV CLASS TRANSFORMERS (AUTO)				
Sl.No	MVA	IMPEDANCE %	HIGH LOSS NLL/FLL/AL	LOW LOSS NLL/FLL/AL
1	3*333	14	74/510/15	55/400/8
2	3*500	14	83/660/16	62/510/10
800kV CLASS TRANSFORMERS(GT)				
Sl.No	MVA	IMPEDANCE %	HIGH LOSS NLL/FLL/AL	LOW LOSS NLL/FLL/AL
1	3*200	15	75/464/35	70/280/10
2	3*260	15	92/565/40	92/340/12
3	3*333	15	125/650/40	115/495/12

ANNEXURE 1.2

LIST OF TRANSFORMER RATINGS CONSIDERED IN STANDARDISATION MANUAL				
Type	132KV	220KV	400KV	765KV
Two Winding Transformers	132/33 kV, 40/50 MVA	220/66 kV, 100 MVA	-	-
Auto Transformers	132/66 kV, 40/50 MVA 132/33 kV, 25/31.5 MVA	220/132 kV, 100 MVA, 3Ø 220/132 kV, 160 MVA, 3Ø	400/220/33 kV, 315 MVA, 3Ø & 500 MVA, 3Ø 400/220/33 kV 167 MVA, 1 Ø	765/√3 // 400/√3 333 MVA, 1 Ø 500 MVA, 1 Ø
Generating Transformers	-	15.75/235 kV, 3Ø 315 MVA	15.75/420 kV, 315 MVA, 3Ø 21/420 kV, 200 MVA, 1Ø 21/420 kV, 260 MVA, 1Ø 21/420 kV, 333 MVA, 1Ø	21/765 kV, 260 MVA, 1Ø 21/765 kV, 333 MVA, 1Ø

ANNEXURE 1.3

List of applicable Standards for Transformers

1. APPLICATION GUIDES

Particulars	IEC	ANSI/IEEE
Transformers	60076-8 ed1.0	-
Converter Transformers	61378-3	-
Tap Changers	60214-2	-
Transformers using High Temp. Insulation Materials	60076-14 ed1.0-2013	IEEE 1276-1997
Transformers connected to Generators	-	C57.116-1989
Transformers for non-sinusoidal currents (loads with Harmonics)	-	C57.110-2008
Loss Evaluation Guide	-	C57.120-1991
Phase shifting transformer (Application, Specification, Testing Guide)	62032 ed2.0	C57.135-2012
Terminal Marking & Connections	TR 60616-1978	C57.105-1978 (Connections) C57.12.70-2000 (Terminal markings)
Apparatus Bushings	-	C57.19.100-1995
Standard Terminology	60050-421	C57.12.80-2010
Through fault current duration- (Equipment damage curves) Dry Oil filled	-	 C57.12.59-2001 C57.12.109-1993
Insulation co-ordination	60071-1,2,3 60664-1 (Low voltage)	1313.1-1993 (Definition & principles) 1313.2-1999 (Application guide)
Preferred Voltage Ratings	60038-2009	1312-1993
Transformers for Nuclear Generating station	-	638-1992
Bar coding of Distribution transformers	-	C57.12.35-2007
Selection of insulators for polluted environments	TS 60815-2008	-
Permissible temperature rise for terminal	60943-1998	-
Bushings - Seismic Qualification	TS 61463-2000	-
Seismic Guide for Transformers & Reactors	-	C57.114-1990 (withdrawn in 1996)
Recommended Practice for Seismic design of substations	-	693-2005
Direct connection details between transformers & GIS	61639-1996	-

Particulars	IEC	ANSI/IEEE
Determination of sound level Guide for sound abatement	60076-10-1 (2005)ed1.0	C57.136-2000 C57.12.58-1991
Cleaning of Insulators	-	957-2005
Occurrence and Mitigation of Switching transients induced by transformers	-	C 57.142/ 2010
Standard Terminology	60050-421-1990	C57.12.80-2010
Metric conversion of transformer standards	-	C57.144-2004
Transient Voltage Analysis of Dry type transformer Coil	-	C57.12.58-1991
Determination of maximum winding temperature rise in liquid filled transformers	-	IEEE Std 1538-2000
Electrical Power System Device Function Numbers, Acronyms, Contact designations	61850-7-4	C37.2-2008
Recommended electrical clearances in air insulated electrical power substations	-	IEEE Std 1427-2006
Guide for protecting Transformers Guide for protection of network Transformers Guide for Protection of Shunt Reactors Application of CTs used for Protective Relays	-	C37.91-2008 C37.108-2002 C37.109-2006 C37.110-2007
Safety of Transformers - EMC requirements	62041 ed2.0-2010	-

2. Specifications

Particulars	IEC	ANSI/IEEE
-Oil filled	60076-1 ed3.0-2011	C57.12.00-2006
-Dry	60076-11 ed1.0	C57.12.01-2005
-Self protected liquid filled transformer	60076-13 ed1.0	-
-SF-6 filled	60076-15	-
-Converter transformer	61378-1 ed 2.0 (2011-07)	C57.18.10-1998
-HVDC transformer	61378-2	C57.129- 2007
-Traction transformer	60310-2004	
-Phase shifting transformer	62032-2005	C57.135-2005
Transformers < 230 kV, 1~10 MVA single phase, 0.8~100 MVA 3 Phase	-	C57.12.10-1997
Overhead distribution transformers < 500 kVA, 34.5/13.8 kV	-	C57.12.20-2005

Particulars	IEC	ANSI/IEEE
Pad mounted 3 Phase DT < 2.5MVA 34.5/0.48kV	-	C57.12.22-1993
Pad mounted single Phase DT < 167 kVA 34.5/0.48kV With separable HV Connector	-	C57.12.25-1990
Pad mounted 3 Phase DT - with insulated HV connectors < 2.5MVA 34.5/____kV with separable HV connector	-	C57.12.26-1992
Pad Mounted Compartmental type Single Phase Distribution Transformers (HV 34.5 kV / LV 240-120 V ≤167 kVA)	-	C57.12.21-1992
Pad mounted 3 Phase DT < 5 MVA 34.5/0.48kV	-	C57.12.34-2004
Enclosure Integrity-Pad mounted	-	C57.12.28-2005
Enclosure Integrity-Pad mounted for coastal environments	-	C57.12.29-2005
Enclosure Integrity-Pole mounted	-	C57.12.31-2002
Enclosure Integrity-Submersible equipment	-	C57.12.32-2002
Electronics Power Transformers	-	IEEE Std 295-1969
Liquid immersed distribution substation transformers	-	C57.12.36-2007
Secondary network transformers – subway and vault type	-	C57.12.40-2006
Secondary network protectors	-	C57.12.44-2005
Ventilated, Dry type power transformers 1~500 kVA single phase 15~500 kVA 3 phase	-	C57.12.51-1981
Sealed, dry power transformers > 0.5 MVA 3 phase 34.5 kV	-	C57.12.52-1981
Dry type transformers used in unit substations	-	C57-12.55-1987
Transformers for Wind Turbine applications	60076-16 ed1.0(2011-06)	-
Step Voltage Regulators_standard requirements ,terminology and test code	60076-21 ed1.0 (2011-12)	-
Design, testing and application of liquid immersed transformers using high temperature insulation	60076-4 ed1.0 (2013)	PC57.154/D9.1-2012-06

3. Testing

Particulars	IEC	ANSI
Testing -General, Dry transformer -General, oil filled -HVDC transformer	60076-1 ed2.1	C57.12.91-2001 C57.12.90-2010 C57.129-2007
Dielectric tests	60076-3 ed3.0-2013	C57.12.90-2006
Temperature rise test -Oil filled -Dry transformer -Determination of hot spot temperature of dry type transformer	60076-2 ed3.0 -2011	C57.12.90-2006, IEEE 1538-2000 C57.134-2000
Impulse/ switching surge test Recommended practice for impulse test of distribution transformer	60076-4 ed1.0	C57.98-1993 C57.138-1998
Short circuit withstand requirements & testing	60076-5 ed3.0	C57.12.90-2006
Loss measurement	-	C57.123-2010
Temperature rise test for Overload	-	C57.119-2001
PD testing -Oil filled -Acoustic -Dry Transformer	60270-2000 / 60076-3-2000	C57.113-1991 C57.127-2007 C57.124-1991
Test for thermal evaluation of dry type transformers (Cast resin & Resin encapsulated)	-	C57.12.60-1998
Test for thermal evaluation of dry type transformers (Ventilated dry type)	-	C57.12.56-1986
Test for thermal evaluation of dry type transformers (Dry type specialty and general purpose)	-	IEEE 259-2004
Guide for determination of maximum winding temperature rise in liquid filled transformers	-	IEEE 1538-2000
Test procedure for thermal evaluation of insulation systems for liquid immersed transformers	-	C57.100-2011
Measurement of frequency response	60076-18 ed1.0(2012-07)	C57.149 -2012
Determination of uncertainties in loss measurement	60076-19 ed1.0(2013)	-

4. Transformer Oil

Particulars	IEC	ANSI / IEEE / ASTM
Mineral Oil Specifications	60296-2012	ASTM D3487-08
Mineral Oil- Recycled Oil	62701 ed1.0-2013	-
Silicone Oil Specifications	60836-2005	ASTM D4652-1987
Natural Ester Oils	62770 ed1.0- 2013	-
Organic Ester Oil Specifications	61099-1992	-
Synthetic Aromatic oil specifications	60867-1993	-
Mineral oil Maintenance	60422-2005	C57.106-2013
Natural Ester oil maintenance	-	C57.147-2008
Silicon oil maintenance	60944-1988	C57.111-1989
Synthetic Organic Ester Maintenance	61203-1992	-
Hydrocarbon fluid maintenance	-	C57.121-1998
Sampling	60475-1974 60567-2005	ASTM D923-97 ASTM D3613-98
BDV	60156-1995	ASTM D1816-97 ASTM D 877-00
Oxidation stability	61125	ASTM D2440 ASTM D2112-01
Water content	60814	ASTM D1533-05
DGA - Interpretation of results	60599-1999	C57.104-2008
DGA - Bushings	TS 61464-1998	-
DGA – OLTC	-	C57.139-2012
DGA –During factory test	61181-2007	PC57.130/D17-2006
DGA – Sampling	60567-2005	-
DGA – Test method	-	ASTM D 3612-01
DGA – Silicone oil filled transformers	-	C57.146-2005
Reclamation of Oil	-	IEEE 637-1985 (R2007)
DGA –Ester Fluids	-	PC57.155D4

5. Accessories

Particulars	IEC	ANSI
Tap changers	60214-1	C57.131-2012
Bushing -General -HVDC Bushings -Dimensions -Terminals Bushing Application Guide Bushings - Seismic Qualification	 60137-2008 - - 60518-1975 - -	 C57.19.00-2000 C57.19.03-1996 C57.19.01-2000 - C57.19.100-1995 TS 61463-2000
Reactors -Specifications -Testing -Dry type series	60076-6	C57.21-2008 (Shunt) C57.16-1996
-Smoothing reactors for HVDC	-	IEEE 1277-2000
Induction voltage regulator		C57.15-1999
Control Cabinet		C 57.148-2011

6. Raw Materials

Particulars	IEC	ANSI
Winding Wires: Paper tape covered Rectangular Wire	60317 ed4.0- 2013	-
Magnetic Materials - Part 8-7-Specifications for individual materials (Cold-rolled grain-oriented electrical steel strip and sheet delivered in the fully processed state).	61061-3-1	-
Non-impregnated densified ,laminated wood for electrical purposes : Part 1 Definitions Part 2-Methods of Test Part 3-1 Specifications for Sheets Part 3-2 Specifications for rings	60404-8-7 ed3.0—2008	-
Electrical Papers - Part 1 Definitions Part 2 Methods Of Test Part 3-1General Purpose Paper Part 3-2Capacitor Paper Part 3-3 Crepe Paper Part 3-4 Electrolytic capacitor paper Part 3-5 Special Papers Non cellulosic Electrical Paper Part3-3 Unfilled aramide(aromatic polyamide)	 60554-1 60554-2 60554-3-1 60554-3-2 60554-3-3 60554-3-4 60554-3-5 60819-3-3 ed3.0-2011	-

Particulars	IEC	ANSI
Pressboard and press paper for electrical purposes Part 1 Specifications Part 2 Methods of Test Part 3 -1 Press Board Part 3-2 Press Paper **Laminated Press Board** Part 1Definitions Part 2 Methods of Test Part 3-1 Laminated pre compressed Press Board	 60641-1 60641-2 60641-3-1ed2.0-2008 60641-3-2 60763-1 ed2.0-2010 61628-2 ed1.1-2007 60763-3-1 ed2.0-2010	-

7. Installation, Operation & Maintenance

Particulars	IEC	ANSI/ IEEE
Guide for Transportation of Transformers &Reactors		57.150-2012
Installation & maintenance -Oil filled Transformer -Dry type Transformer	 - -	 C57.93-2007 C57.94-1982
Loading guide - Oil filled Transformer - Dry type transformer	 60076-7 ed1.0(2005-12) 60076-12 ed1.0(2008-11)	 C57.91-2011 C57.96-1999
Failure investigation	-	C57.125-1991
Reporting failure data	-	C57.117-1986
Evaluation and Reconditioning of oil filled transformers	-	C57.140-2006
Diagnostic field testing	-	C57.152-2013
Monitoring of transformers & accessories	-	C57.143-2012
Substation-Fire protection Containment &control of oil spills in substations	-	979-1994(R2004) 980-1994(R2001)
Guide for the design, construction and operation of Electric Power substations for community acceptance and environmental compatibility	-	1127-1998

8. Operation & Maintenance:

Item	CIGRE Brochures	IEEE Standard	IEC Standard
Operational Problems	170-2000 Static Electrification 228-2002 Ageing Process 323-2007 Ageing of Cellulose 349-2008 Moisture Equilibrium and migration in insulation system 378-2009 Copper sulfide in insulation 393-2009 Thermal performance of Transformers 445-2012 Maintenance	C57.91-2011 Loading Guide for Oil Immersed Transformers C57.96-1999 Loading Guide for Dry Type Transformers	60076-7:2005 Loading Guide for Oil Immersed Transformers 60905-1987 Loading Guide for Dry type Transformers
Life Assessment	227-2003 Life Management Techniques 248-2004 Economics of Management 298-2006 Life time Data Management 413-2010 Oil regeneration and Dehalogenation	C57.93-2007 Installation & Maintenance of Transformers C57.106-2002 Maintenance of Oil C57.140-2006 Evaluation & Reconditioning 637-1985(R2007) Reclamation of Oil	60422-2005 Maintenance of Oil
Diagnostics	254-2002 Dielectric Response 296-2006 Recent developments in the interpretation of DGA 342-2008 SFRA 343-2008 Recommendations for Condition Monitoring and condition assessment facilities for transformer 414-2010 Dielectric response methods for transformer windings 420-2010 Life Time Condition Assessment 436-2010 Experiences in service with new Insulating Liquids 443-2010 DGA on non-mineral oil and OLTC oil. 444-2010 Guide lines on unconventional PD measurements 494-2012 Furanic Compounds for Diagnosis	62-1995 (R2005) Diagnostic Field Testing of Transformers & Reactors C57.104-2008 DGA of Oil C57.117-1986 Guide for reporting failure data of transformers C57.125-1991 Guide for Site failure investigation of Transformers C57.146-2005 DGA of Silicon Oil filled Transformers C57.200-2000 PD detection by Accoustics PC 57.139 D12-2009 DGA of OLTC Oil PC 57.143 D21-2010 Transformer Monitoring	60076-18-2012 SFRA 60567-2011 Sampling of gases for DGA 60599-1999 DGA interpretation

9. **CIGRE Brochures for Asset Management of T&D equipment:**

Standing Committee/ Product	A2 Transformer	A3 HV Equipments	B1 Cables	B2 Lines	B3 Substations	C1 Asset Management	D1 Material	Other SC's
Condition Assessment & Monitoring	393 436	083 259 WG A3.06	-	-	300 380 381 400	-	226	SC A1: 437, 386
End of Life Issues	227	165 368	358	353	252	422	296 409 414	-
Risk Management and AM Decision Making	248	-	-	-	300 472	309 327 422	420	SC C3 : 340,383
Grid Development	-	335 336	-	385	-	176	-	-
Maintenance Processes & Decision Making	445	259 319	279	230	380	-	-	-
Collection of Asset Data and Information	298	-	-	-	-	-	-	SC B5: 329 SC D2: 341