

**Model Technical Specifications**

**For**

# **Auxiliary Transformer**

**Rev – 00**

**May 2026**

## SECTION – Auxiliary Transformer

### 1. Technical Requirements (Oil Filled) Transformers

Sr. No.	Parameter	Value
i.	VA Rating & Quantity	As per system requirement
ii.	Voltage Ratio	As per system requirement
iii.	Duty, Application	Continuous application, Outdoor duty
iv.	Winding	Two
v.	Frequency	50 Hz
vi.	Nos. of Phase	Three
vii.	Vector Group & Neutral earthing	As per system requirement
viii.	Cooling	ONAN
ix.	Tap Changer	As per system requirement
x.	Impedance at 75°C	
	a) Principal Tap	As per system requirement
	b) Other Taps	
xi.	Permissible Temperature rise over an ambient of 50 deg C irrespective of tap	
	a) Top Oil	35 deg .C
	b) Each Individual Winding	40 deg.c
xii.	SC withstand time (thermal)	2 sec.
xiii.	Fault Level & Bushing CT	As per system requirement
xiv.	Termination	AS per systemrequirement / Cable
xv.	Bushing rating, Insulation class (Winding & bushing)	As per relevant IS/IEC Creepage distance: 31 mm/kV
xvi.	Noise level	AS PER NEMA TR-I
xvii.	Loading Capability	Continuous operation at rated MVA on any tap with voltage variation of +/-10%, also transformer shall be capable of being loaded in accordance with IS: 6600
xviii.	Flux Density	Not to exceed 1.7 Wb/sq.m. at any tap position with +/- 10% voltage variation from voltage corresponding to the tap. Transformer shall also withstand following over fluxing conditions due to combined voltage and frequency fluctuations: a) 110% for continuous rating. b) 125% for at least one minute. c) 140% for at least five seconds. Bidder shall furnish over fluxing char. up to 150%
xix.	Air Clearance	As per CBIP

Note (common for Oil filled and dry type transformer):

- a) Auxiliary transformers shall be suitable for 3 phase, 4 wire system with additional LVN bushing for equipment earthing.
- b) Auxiliary Transformer can be either Oil Natural/Synthetic Ester oil) filled or Dry Type (refer relevant specification).
- c) In case Ester Oil filled Transformers are offered, then 50% quantity shall be Natural ester filled and balance 50% quantity shall be of Synthetic Ester oil filled.
- d) The adverse effect on life of transformer due to loading cycle, harmonics, grid disturbance etc. must be compensated through suitable design (as applicable) as per system requirement and BESS/PCS manufacturer recommendation.
- e) Applicable in case Auxiliary Transformers HV side fed directly from PCS (AC output side) or from Inverter/PCS Transformer LV side:
  - 1) Auxiliary Transformer shall have copper/Aluminum Shield winding between LV and HV windings. Each HV winding must be capable of handling non-sinusoidal voltage with voltage gradient as per relevant applicable standards and PCS manufacturer recommendation. Also each shield winding shall be taken out to tank with two separate connection from shield to bushing with proper support with 2 nos. 3.6 kV shield bushings and same shall be brought down along with support insulator from tank and copper flat up to the bottom of the tank for independent grounding.
  - 2) Harmonic Factor as per PCS manufacturer recommendation must be taken into account while designing the transformer. The extra no load loss due to voltage harmonics and load and stray load loss due to current harmonics (as applicable) and must be taken into consideration in transformer design. In addition, the dc bias component of 0.5% of rated Inverter output current is to be accounted for its effect on the transformer design.
  - 3) Auxiliary Transformer HV side winding and bushing insulation class shall be of at least 3.6 kV.

### 1.1. Codes and Standard

Transformers	IS:2026, IS: 6600
Bushings	IS:2099, IS: 3347
Insulating oil	IS 16659 / IS16081
Bushings CTs	IS:2705
Indian Electricity Act 2003, BEE Guideline & CEA notifications	

### 1.2. General construction

Transformer shall be constructed in accordance to IS: 2026 and IS: 3639 or equivalent to any other international standard. Transformer shall be complete & functional in all respect and shall be in scope of supplier.

The other important construction particulars shall be as below.

- a. The Transformer tank and cover shall be fabricated from high grade low carbon plate steel of tested quality. The tank and the cover shall be of welded construction and there should be provision for lifting by crane.
- b. A double float type Buchholz relay conforming to IS: 3637 shall be provided.
- c. Suitable Inspection hole(s) with welded flange(s) and bolted cover(s) shall be provided on the tank cover. The inspection hole(s) shall be of sufficient size to afford easy access to the lower ends of the bushings, terminals etc.

- d. All bolted connections to the tank shall be fitted with suitable oil-tight gaskets which shall give satisfactory service under the operating conditions for complete life of the transformer if not opened for maintenance at site
- e. The transformer shall be provided with conventional single compartment conservator. The top of the conservator shall be connected to the atmosphere through indicating type cobalt free silica gel breather (in transparent enclosure). Silica gel shall be isolated from atmosphere by an oil seal.
- f. Transformer shall have adequate capacity Conservator tank to accommodate oil preservation system and volumetric expansion of total transformer oil.
- g. Transformer shall have Oil Temperature Indicator and Winding temperature Indicator (WTI applicable for transformer above 50 KVA) with accuracy class of +/- 2 deg.
- h. For Transformers above 100KVA, radiators shall be detachable type, mounted on the tank with shut off valve at each point of connection to the tank, lifts, along with drain plug/valve at the bottom and air release plug at the top.
- i. M. Box shall be of sheet steel, dust and vermin proof provided with proper lighting and thermostatically controlled space heaters. The degree of protection shall be IP 55. Marshalling Box of all transformers shall be preferably Tank Mounted. One dummy terminal block in between each trip wire terminal shall be provided. At least 20% spare terminals shall be provided on each panel. The gasket used shall be of neoprene rubber. Also Marshalling Box, shall be at least 450 mm above ground level (for transformer above 100 KVA). For transformer above 100 KVA, wiring scheme (TB details) shall be engraved in a stainless steel plate with viewable font size and the same shall be fixed inside the Marshalling Box door.
- j. In case Natural Ester oil (IS 16659) filled transformer, the Transformer should be hermetically sealed and corrugated tank design. It should fitted with monitoring equipment like DGPT etc. for accessing the healthiness of Natural ester oil. As transformer becomes hermetically sealed, fitting, valves and accessories shall be decided during detail engineering but all other part of tender specification related to design of transformer active part and testing requirement shall remain same. HV/LV Bushing shall be fitted vertically on tank cover and all necessary measures to be taken to make the transformer leakage proof. Suitable nitrogen capping system shall be provided for preserving Natural ester oil for O&M.

### **1.3. Windings**

- a) The Bidder shall ensure that windings of all transformers are made in dust proof & conditioned atmosphere.
- b) The conductors shall be of electrolytic grade copper free from scales & burrs.
- c) All windings of the transformers shall have uniform insulation.
- d) Tapping shall be so arranged as to preserve the magnetic balance of the transformer at all voltage ratio.

### **1.4. Core**

- a) The core shall be constructed from non-ageing, cold rolled, super grain-oriented silicon steel laminations equivalent to M4 grade steels or better.
- b) Core isolation level shall be 2 kV (rms.) for 1 minute in air.
- c) Adequate lifting lugs will be provided to enable the core & windings to be lifted.

## 1.5. Insulating Mineral Oil

No inhibitors shall be used in the transformer oil. The oil supplied with transformers shall be new and previously unused and must conform to following while tested at supplier's premises and shall have following parameters.

Sr. No.	Property	Permissible Values
a)	Kinematic Viscosity, mm <sup>2</sup> /s	≤ 12 at 40 ° C ≤ 1800.0 at (-)30 ° C
b)	Flash Point, ° C	≥ 140° C
c)	Pour point, ° C	≤ (-)40 ° C
d)	Appearance	Clear, free from sediment and suspended matter
e)	Density kg/m <sup>3</sup> at 20 ° C	≤ 0.895
f)	Interfacial Tension N/m at 25° C	≥ 0.04
g)	Neutralisation value, mgKOH/g	≤ 0.01
h)	Corrosive sulphur	Non Corrosive
i)	Water content mg/kg	≤ 30 in bulk supply ≤ 40 in drum supply
j)	Anti-oxidants additives	Not detectable
k)	Oxidation Stability -Neutralization value, mgKOH/g -Sludge, % by mass	≤ 1.2 ≤ 0.8
l)	Breakdown voltage As delivered, kV After treatment, Kv	≥ 30 ≥ 70
m)	Dissipation factor, at 90° C And 40 Hz to 60 Hz	≤ 0.005
n)	PCA content	≤1%
o)	Impulse withstand Level, kVp	≥ 145
p)	Gassing tendency at 50 Hz after 120 min, mm <sup>3</sup> /min	≤ 5

Subsequently oil samples shall be drawn at:

Sr. No.	Parameters	Before filling in main tank & tested for	Prior to energization for Applicability following properties & acceptance norms:	Applicability
i.	BDV	60 kV (min)	60 kV (min)	Applicable for all Transformers.
ii.	Moisture	10 ppm (max.)	10 ppm (max.)	

For ester filled oil, relevant IS/IEC shall be followed for relevant oil parameters for type/routine test.

## 1.6. Bushings

- a) Bushing below 52 kV shall be oil communicating type with porcelain insulator.
- b) No arcing horns to be provided on the bushings.

## 1.7. Bushings CTs

- a) Shall be of adequate rating for protection as required, WTI (WTI CT applicable for transformer above 50 KVA) etc. All CTs (except WTI) shall be mounted in the turret of bushings, mounting inside the tank is not permitted.
- b) All CT terminals shall be provided as fixed type terminals on the M. Box to avoid any hazard due to loose connection leading to CT opening. In no circumstances Plug In type connectors shall be used for CT.

## 1.8. Valves

- a) All valves up to and including 50 mm shall be of gun metal or of cast steel. Larger valves may be of gun metal or may have cast iron bodies.
- b) Sampling & drain valves should have zero leakage rate.

## 1.9. Gaskets

- a) Gasket shall be fitted with weather proof, hot oil resistant, nitrile rubber based gasket.
- b) If gasket is compressible, metallic stops shall be provided to prevent over compression.
- c) The gaskets shall not deteriorate during the life of transformer if not opened for maintenance at site. All joints flanged or welded associated with oil shall be such that no oil leakage or sweating occurs during the life of transformer. The quality of these joints is considered established, only if the joints do not exhibit any oil leakage or sweating for a continuous period of at least 3 months during the guarantee period. In case any sweating / leakage is observed, contractor shall rectify the same & establish for a further period of 3 months of the same. If it is not established during the guaranteed period, the guaranteed period shall be extended until the performance is established.

## 1.10. Painting

Parts Name	Type of Paint	No. of Coats	Total DFT
Inside of tank and accessories (except M Box)	Oil & heat resistant fully glossy white	One coat	30 micron
External surface of transformer and accessories including M Box (except radiators)	Chemical resistant epoxy zinc phosphate primer, MIO (Micaceous iron oxide) as intermediate paint followed by polyurethane finish paint (RAL 5012 Blue) or (RAL6018 yellow green for ester filled)	One coat each	Atleast 100 micron

External surface	Radiator	Anticorrosive primary paint followed by high quality full glossy outer finish paint (RAL 5012 Blue) or (RAL6018 yellow green for ester filled)	Two coats each	Atleast 100 micron
Internal surface	Radiator	Hot oil proof, low viscosity varnish and subsequent flushing with transformer oil	---	---
Internal surface of M Box		Chemical resistant epoxy zinc phosphate primer followed by chemical and heat resistant epoxy enamel white paint	Two coats each	Not less than 100 micron

### 1.11. Neutral Earthing Arrangement

- a) Neutral earthing shall be done as per system requirement. In case of solidly earthed neutral of Transformers, it shall be brought through insulated support from tank to the ground level at a convenient point with 2 nos. copper flat, for connection to ground network (as applicable).
- b) Neutral of Transformer if not used should be taken out through bushing and covered by insulating cap.

### 1.12. Cable boxes & disconnecting chamber (Disconnecting chamber applicable 3.3 kV and above)

- a) HV Cable boxes shall be of phase segregated air insulated type & shall be of sufficient size to accommodate Employer's cable & termination. Phase segregation shall be achieved by insulating barriers (for 3.3 kV and above side)
- b) Cable boxes shall have bus bars / suitable terminal connectors of adequate size & bolt holes to receive cable lugs. The degree of protection of cable boxes shall be IP 55.
- c) A suitable removable gland plate of non-magnetic material drilled as per the Employer's instruction shall also be provided in the cable box
- d) The support from base for the cable box (for 3.3 kV and above side) shall be of galvanized iron
- e) The contractor shall provide earthing terminals on the cable box, to suit Employer's GI flat.
- f) The minimum length provided for terminating 33 kV, 11KV & 3.3 KV XLPE cable shall be 1000 mm (for 33 kV) 650 mm (for 3.3 kV and 11 kV) from cable gland plate to the cable lug) for the cable boxes, for 433V side suitable length shall be provided (shall be discussed during detail engineering). The final cable size, number & length of terminating XLPE cable shall be furnished during detailed engineering.
- g) Cable boxes shall be designed such that it shall be possible to move away the transformer without disturbing the cable terminations, leaving the cable box on external supports (as applicable).
- h) Cable boxes shall have removable top cover (for transformer above 100 KVA) & ample clearance shall be provided to enable either transformer or each cable to be subjected separately to high voltage test.

### 1.13. Fittings

Following fittings shall be provided with Transformers covered under this sub section.

a)	-Conservator for main tank (transformer above 100 KVA shall be provided with MOG with low oil level alarm contact), drain valve & indicating type free Cobalt free breather with transparent enclosure (maximum height 1400 mm above ground level) etc.
b)	- Buchholz relay, double float type with alarm and trip contacts, along with suitable gas collecting arrangement (Gas collecting arrangement applicable for transformer above 100 KVA).
c)	- For Auxiliary transformers below 2 MVA, diaphragm type explosion vent shall be provided.
d)	OTI & WTI shall be 150 mm dial type with alarm (WTI only for transformer above 50 kVA) and trip contacts with max. reading pointer & resetting device (maximum height 1500 mm above ground level).
e)	For transformer above 100 KVA: Top & bottom filter valves with threaded male adapters, bottom sampling valve, and drain valve/sludge removal valve at the bottom most point of the tank. For Transformer upto 100 KVA: common drain cum sampling cum bottom filter cum sludge removal valve and top filter valve can be provided.
f)	Air release plug, bushing with metal parts & gaskets, terminal connectors on bushings (as applicable).
g)	Prismatic/toughened glass oil gauge for transformers.
h)	Bi-directional wheel/skids, M.Box, OCTC, Bushing CTs (as applicable), Insulating Oil, Cooling equipment.
i)	Cover lifting eyes, transformer lifting lugs, jacking pads(jacking pad applicable for transformer above 100 KVA), towing holes and core and winding lifting lugs, inspection cover, Bilingual R&D Plate, Terminal marking plates, two nos. earthing terminals etc.
j)	Bolts & nuts (exposed to atmosphere) shall be galvanized steel/SS.
k)	Rain hoods to be provided on Buchholz, MOG & PRD. Entry points of wires shall be suitably sealed.
The fittings listed above are only indicative and other fittings, which generally are required for satisfactory operation of the transformers are deemed to be included.	

## 2. Dry Type Transformers

### 2.1. Parameters

Sr. No.	Parameters	Value
1.	Type	Epoxy cast resin/resin encapsulated
2.	Duty, Service & Application	Continuous application and duty Indoor
3.	MVA & Voltage ratio	As per system requirement
4.	Vector group	
5.	Termination & Bushing CT	
6.	Fault Level & Earthing	
7.	Tap changer type & range	As per system requirement.
8.	Number of Phases	Three (3)
9.	Impedance	As per system requirement
10.	Type of cooling	<b>AN</b>

		Transformer shall be provided with suitable ventilation system to ensure the temperature rise limits under most severe condition while in service however all tests and performance guarantee shall correspond to air natural (AN) cooling.
11.	Bushing rating, Insulation class (Winding & bushing)	As per relevant IS/IEC (However Inverter Transformer LV side winding & bushing insulation class shall be of at least 3.6 kV)
12.	Maximum Temperature rise of winding over 50 deg. C ambient. (by resistance method) with Air Natural (AN) cooling.	90 deg.C. (class F) or better
13.	SC withstand time (thermal)	2 sec
14.	Noise Level	Not to exceed values specified in NEMA TR-1
15.	PD Level (max. Allowable)	10 pc
16.	Loading Capability	Continuous operation at rated KVA on any tap with voltage variation of +/-10% corresponding to the voltage of the tap as well as in accordance with IEC 60076-12/IS: 6600.

## 2.2. Codes & Standard

Dry type transformers	IS: 11171, IEC 60076-11
Indian Electricity Act 2003 and Indian Electricity Rules, BEE notification & CEA guidelines	

## 2.3. Design & Constructional Features

- a) The transformers shall be housed in a metal protective housing, having a degree of protection of IP-23. The enclosure shall be provided with suitable hardware (as required).
- b) The conductors shall be of electrolytic grade copper free from scales & burrs.
- c) Dry Type Transformer windings shall be of class F insulation or better. Cooling shall be AN.
- d) The core shall be constructed from non-ageing, cold rolled, grain oriented silicon steel laminations (M4 or better).
- e) The fittings/accessories including protection/monitoring device (temperature scanner) generally required for satisfactory operation of the transformer, are to be provided.
- f) The adverse effect on life of transformer due to loading cycle, harmonics, grid disturbance etc. must be compensated through suitable design (as applicable) as per system requirement and BESS/PCS manufacturer recommendation.
- g) Applicable in case of Auxiliary Transformers HV side fed directly from PCS (AC output side) or from Inverter/PCS Transformer LV side:
  - 1) Auxiliary Transformer shall have copper/Aluminum Shield winding between LV and HV windings. Each HV winding must be capable of handling non-sinusoidal

voltage with voltage gradient as per relevant applicable standards and PCS manufacturer recommendation. Also each shield winding shall be taken out to tank with two separate connection from shield to bushing with proper support with 2 nos. 3.6 kV shield bushings and same shall be brought down along with support insulator from tank and copper flat up to the bottom of the tank for independent grounding.

- 2) Harmonic Factor as per PCS manufacturer recommendation must be taken into account while designing the transformer. The extra no load loss due to voltage harmonics and load and stray load loss due to current harmonics (as applicable) and must be taken into consideration in transformer design. In addition, the dc bias component of 0.5% of rated Inverter output current is to be accounted for its effect on the transformer design.
- 3) Auxiliary Transformer HV side winding and bushing insulation class shall be of at least 3.6 kV.

### 3. Testing & Inspection

In case the bidder/contractor has conducted type test within last ten years (Dynamic short circuit report shall be valid till the design is changed and transformer supplier shall give affidavit stating that there is no change in the design), he may submit the type test reports to the owner for waiver of conductance of such type test(s). These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.

In case the Bidder is not able to submit report of the type test conducted within above specified period from the date LOA by POWERGRID, or in case the type test report are not found to be meeting the specification requirements, the Bidder shall conduct all such tests under this contract at no additional cost to the Employer and submit the reports for approval.

S. No.	Routine Tests	
1.	All routine test shall be carried out in accordance with IEC 60076.	√
2.	Measurement of Voltage Ratio & phase displacement (as per IEC 60076-1)	√
3.	Measurement of winding resistance on all the taps (as per IEC 60076-1)	√
4.	Vector group and Polarity Check (as per IEC 60076-1)	√
5.	Magnetic Balance and Magnetising Current Test	√
6.	Measurement of no load current with 415 V, 50 Hz AC supply	√
7.	Measurement of no load losses and current at 90%, 100% & 110% of rated voltage (as per IEC 60076-1)	√
8.	Load Loss & Short Circuit Impedance Measurement on principal & Extreme Taps	√
9.	IR measurement (As per IEC 60076-1)	√
10.	Separate Source Voltage Withstand Test /Applied voltage test (as per IEC 60076-3)	√
11.	Induced overvoltage test/Induced voltage withstand(IVW) test as per IEC60076 part 3	√
12.	Repeat no load current/loss & IR after completion of all electrical test	√
13.	Oil leakage test on completely assembled transformer along with radiators (as per relevant clause of this sub section)	√

14.	Marshalling Box/Cable box: It shall not be possible to insert a thin sheet of paper under gaskets and through enclosure joints.	√
15.	IR measurement on wiring of Marshalling Box.	√

S. No.	Type Test	
1.	Temperature Rise test at a tap corresponding to maximum losses as per IS 2026.	√
2.	Short circuit test (special test) as per IEC 60076-5 (if	√

### 3.1. Leakage test on assembled Oil filled Transformer (Routine Test)

All tank & oil filled compartment shall be tested for oil tightness by being completely filled with oil of viscosity not greater than that of specified oil at the ambient temperature & applying pressure equal to the normal pressure plus 35 KN/sq. m measured at the base of the tank. The pressure shall be maintained for a period of not less than 6 hours during which time no sweating shall occur. Bidder can perform this test at site depending upon urgency subject to NTPC REL approval.

### 3.2. Routine / Type Tests (Dry Type Transformers)

Transformer shall be short circuit tested after conducting the routine tests. Rest of the type tests shall be conducted after successful short circuit testing. All routine tests in accordance with IS: 11171 / IEC 60076-11 shall be carried out on each transformer and all type tests should be done as per Employer's approved procedure.

Sr. No.	Test Name	Type of Test
1.	Measurement of winding Resistance for each tap position.	Routine
2.	Measurement of voltage ratio at each taps position.	Routine
3.	Vector group and polarity check	Routine
4.	Measurement of impedance voltage/short circuit impedance & load loss at principal tap and extreme taps	Routine
5.	Measurement of no load losses and magnetising current at rated frequency and 90%, 100% and 110% rated voltage.	Routine
6.	Measurement of insulation resistance	Routine
7.	Measurement of capacitance and tan delta	Routine
8.	Dielectric Tests 1) PF/Separate source AC withstand voltage test. 2) Induced over voltage withstand test	Routine Routine
9.	Partial discharge measurement	Routine
10.	Measurement of iron loss & IR (repeat after induced voltage test)	Routine
11.	Short Circuit test as per IEC (if applicable)	Type
12.	Noise Level Measurement	Type

13.	Temperature rise test as per IEC (HV & LV winding)	Type
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