ITMA CONFERENCE

Transformer Testing as per IS 1180:2014 Facilities available in CPRI

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REVISED VERSION OF IS-1180,2014 ON DISTRIBUTION TRANSFORMERS

- IS 1180(Part 1): 2014 - Outdoor type, insulated liquid immersed Distribution Transformers up to and including 2500 kVA, 33kV (Part 1: Mineral Oil Immersed)
- During this revision scope of both standards Part 1 and Part 2 have now been clubbed to make one combined standard for distribution transformer.

3 Categories of transformers in revised version of IS 1180:2014

- Three phase distribution transformers up to and including 200KVA
- Three phase distribution transformers higher than 200KVA up to and UPTO 2500KVA
- Single phase distribution transformers up to and including 25KVA

Losses define in revised version of IS 1180:2014

- Three levels of losses
  - Energy Efficiency Level 1,
  - Energy Efficiency Level 2
  - Energy Efficiency Level 3
- In each level maximum losses (No Load Loss + Load Loss) at 50% load & 100% load have been specified for each rating in all categories.

Drawl of Samples define in revised version of IS 1180-2014

- Three phase transformers

Nominal System Voltage in kV	≤200 kVA, 3 Phase	> 200kVA and ≤ 2500 kVA, 3 Phase
3.3	One Sample of Highest rating	One Sample of Highest rating
6.6	One Sample of Highest rating	One Sample of Highest rating
11	One Sample of Highest rating	One Sample of Highest rating
>11 & ≤ 22	One Sample of Highest rating	One Sample of Highest rating
>22 & ≤ 33	One Sample of Highest rating	One Sample of Highest rating

Drawl of Samples for single phase transformer define in revised version IS 1180;2014

- Single phase transformers

Nominal System Voltage in kV	≤200 kVA, 1 Phase
11	One Sample of Highest rating
22	One Sample of Highest rating
33	One Sample of Highest rating

List of tests for BIS Certification
Routine Tests

Routine Test

- (a) Measurement of winding Resistance
- (b) Measurement of voltage Ratio and check phase relationship
- (c) Measurement of short circuit Impedance and load loss at 50% and 100% load
- (d) Measurement of no load loss and current
- (e) Measurement of insulation resistance
- (f) Induced overvoltage withstand test
- (g) Separate source voltage withstand test
- (h)Pressure test
- (j) Oil leakage test

List of tests for BIS Certification
Type Tests

Type Tests

- Lightning Impulse test
- Temperature rise test
- Short circuit withstand test
- Pressure test

List of tests for BIS Certification
Special Tests

Special Tests

- Determination of sound levels
- Short-circuit withstand test (above 200 kVA)
- No load current at 112.5 percent voltage
- Paint adhesion tests.
- BDV and moisture content of oil in the transformer

Test facility available at CPRI(Bhopal & Bangalore)

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SIGNIFICANCE OF ROUTINE TESTS FOLLOWS;
Measurement of winding resistance

- This test measures the resistance of the HV & LV winding.
- The values of resistance should be balance for all three phases and should match the designed values.
- The resistance of each winding, the terminals between which it is measured and the temperature of the windings shall be recorded.
- Direct current shall be used for the measurement.

TYPE TESTS OF TRANSFORMER

1) Lightning Impulse Test [IS 2026 Part 3]
2) Short circuit withstand Test [IS 2026 Part 5]
3) Temperature rise Test [IS 2026 Part 3]
4) Pressure Test [IS 1180 cl 21.5]

- To be conducted on one unit

TYPE TEST DETAILS OF LIGHTENING IMPULSE TEST

- All the dielectric tests check the insulation level of the job. Impulse generator is used to produce the specified voltage impulse wave of 1.2/50 micro seconds wave.
- One impulse of a reduced voltage between 50 to 75% of the full test voltage and subsequent three impulses at full voltage.
- For a three phase transformer, impulse is carried out on all three phases in succession, keeping the other terminals earthed.
- The current and voltage wave shapes are recorded.
- Three basic wave shapes are Full wave, Chopped on tail and Front of wave.
- CPRI has facility to conduct Impulse test with Chopping and without chopping

TYPE TEST set up at Bhopal for LIGHTENING IMPULSE TEST,2500kv,250 kJ

Nominal System Voltage in kV	Rated BIL (kVp)
3.3	40
6.6	60
11	75
22	125
33	170

TYPE TEST details about *Short circuit withstand ability test*

- This test verifies Transformers to sustain without damage the effects of overcurrent's originated by external short circuits.
- HV terminals are connected to the supply bus of the testing plant. The LV is short circuited.
- The testing plant parameters are such adjusted to give the short circuit current. Fault is created for desired interval. The record of voltage & current wave form is recorded.
- There should not be any mechanical distortion, fire to the transformer during this test. Similarly no wave form distortion.
- The transformer should also withstand the routine tests after the short circuit test.
- The % change in %X reactance of the winding measured before and after the S.C. test should not vary beyond the limits stated in the IS 2026.

TYPE TEST
Short circuit withstand ability test(contd.)

- The results of the short circuit tests and the measurements and checks performed during tests do not reveal any condition of faults.
- The out-of-tank inspection does not reveal any defects such as displacements, shift of laminations, deformation of windings, connections or supporting structures, so significant that they might endanger the safe operation of the transformer.
- No traces of internal electrical discharge are found.
- Percentage change in %X should be within
  - 2 percent for transformers with circular coils.
  - 7.5 percent for transformers with non-circular concentric coils

TYPE TEST & Special Test
Calculation of SC current in Transformer

$$I = \frac{U}{\sqrt{3} \times (Z_t + Z_s)} (\text{kA}) \qquad \ldots(1)$$

where

Z_s = short-circuit impedance of the system.

$$Z_s = \frac{U_s^2}{S}, \text{ in ohm } (\Omega) \text{ per phase} \qquad \ldots(2)$$

(equivalent star connection)

where

U_s = rated voltage of the system, in kilovolts (kV);

S = short circuit apparent power of the system, in megavoltamperes (MVA).

Z_t = short circuit impedance of the transformer referred to the winding under consideration; it is calculated as follows:

$$Z_t = \frac{z_t \times U_r^2}{100 \times S_r}, \text{ in ohms } (\Omega) \text{ per phase} \qquad \ldots(3)$$

$$k \times \sqrt{2} = 1 + [e^{-(\phi + \pi/2) R/X} \sin\phi] \times \sqrt{2}$$

where

e = base of natural logarithm; and

ϕ = phase angle which is equal to arctan X/R, in radians.

Table 4 Values for Factor $k \times \sqrt{2}$

X/R	1	1.5	2	3	4	5	6	8	10	14
$k \times \sqrt{2}$	1.51	1.64	1.76	1.95	2.09	2.19	2.27	2.38	2.46	2.55

NOTE — For other values of X/R between 1 and 14, the factor $k \times \sqrt{2}$ may be determined by linear interpolation

When $Z_s < 0.05\ Z_t$, instead of X_t and R_t (in ohms), x_t and r_t may be used for the principal tapping where

x_t = reactive component of z_t, in per cent (percent);

r_t = resistance component, at reference temperature, of z_t, in per cent (percent);

z_t = short circuit impedance of the transformer, at reference temperature, in per cent (percent).

TYPE TEST & Special Test(set up at Bhopal)
Short circuit withstand ability test

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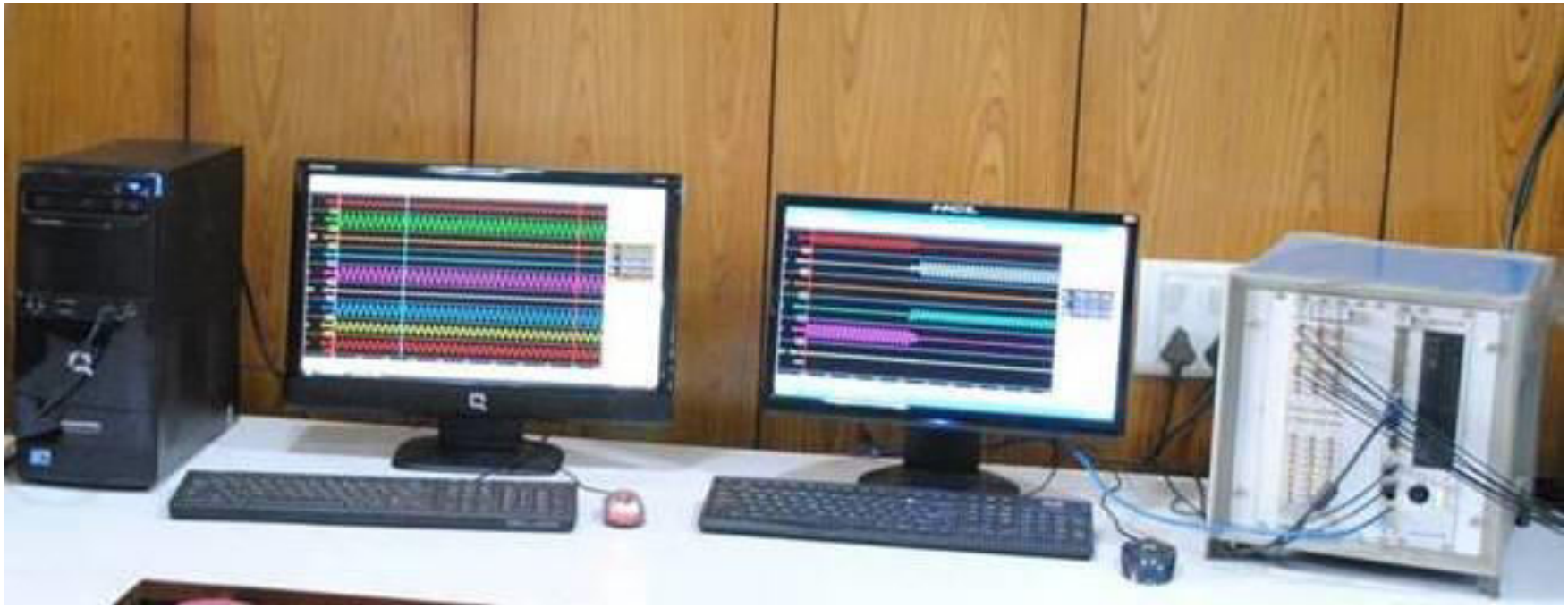
Short circuit withstand ability test



Type Test details about Temperature Rise Test

- In this test we check whether the temperature rising limit of the transformer winding and oil as per specification or not.
- In this type test of transformer, we have to check oil temperature rise as well as winding temperature rise limits of an electrical transformer.

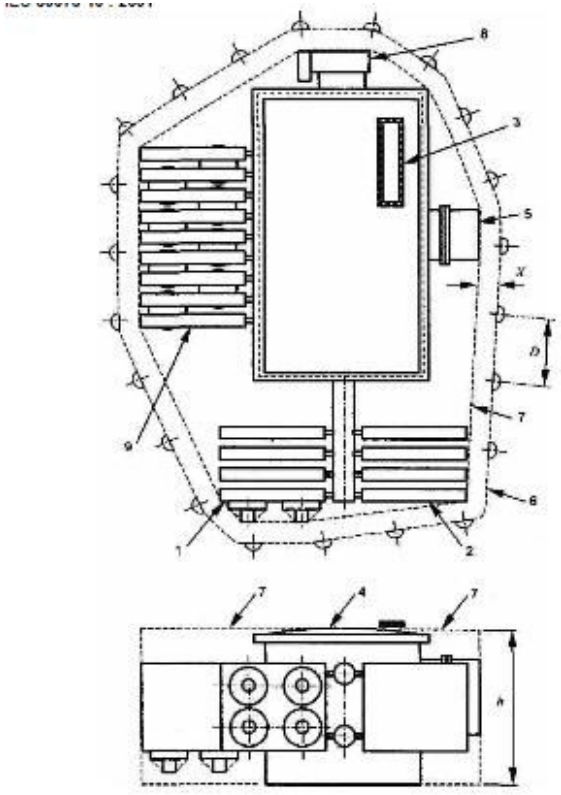
Type Test details about Pressure test

- For 3 Phase non-sealed and sealed type transformers, the transformer tank is subjected to air pressure of 80 kPa for 30 minutes and vacuum of 250 mm (for up to 200 kVA) & 500 mm (for 200 to 2500 kVA) of Mercury for 30 minutes.
- The permanent deflection of flat plates, after pressure /vacuum has been released, shall not exceed the values specified.
- For 1 Phase transformers transformer tank is subjected to air pressure of 100 kPa above atmospheric pressure for 30 min. There should be no leakage at any point and there is no deformation of tank.

Special Test details about Determination of sound levels

- Measurements are taken at the prescribed contour shall be spaced 0,3 m away from the principal radiating surface. For transformers with a tank height of <2.5 m, the prescribed contour shall be on a horizontal plane at half the tank height.
- For transformers with a tank height >2,5 m, two prescribed contours shall be used which are on horizontal planes at one-third and two-thirds of the tank height
- The microphone positions shall be on the prescribed contour(s), approximately equally spaced and not more than 1 m apart

Special Test(set up)
Determination of sound levels



Key

1 Horizontal forced air cooling	5 Cable box	9 Vertical forced air cooling
2 Natural air cooling	6 Prescribed contour	*D* Microphone spacing
3 Turret	7 Principal radiating surface	*h* Height of the tank
A Transformer tank	8 On-load tap-changer	*X* Measurement distance

Figure 2 - Typical microphone positions for sound measurement on transformers having cooling auxiliaries mounted either directly on the tank or on a separate structure spaced <3 m away from the principal radiating surface of the main tank

Special Test details about No load current at 112.5 percent voltage

- This test is similar to no load test except only no load current is measured
- *No Load current at 100 % voltage* shall not exceed 3 % (up to 200 kVA) & 2 % (200 to 2500 kVA) of full load current and will be measured by energizing the transformer at rated voltage and frequency.
- *No Load current at 112.5 % voltage* shall not increase the no load current by 6 %(up to 200 kVA) & 5 % (>200 to 2500 kVA) maximum of full load current.

Special Test(chemical analysis)
BDV and moisture content of oil in the transformer

- Breakdown voltage (BDV)of transformer oil .
- Moisture content in the transformer oil .

THANK YOU

CONCERN OFFICERS

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