ITMA CONFERENCE

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

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INDIAN STANDARDS ON DISTRIBUTION TRANSFORMERS

- IS 1180(Part 1): 1989: Outdoor type three phase distribution transformers up to and including 100kVA 11 kV Part 1: Non sealed type.
- IS 1180(Part 2): 1989: Outdoor type three phase distribution transformers up to and including 100kVA 11 kV Part 2: Sealed type.
- The Scope of these IS was to address distribution Transformers primarily of REC (Rural Electrification Corporation Ltd) range, up to 100 kVA, 11 kV.
- For other range of distribution transformers, reference was made to IS 2026 'Power transformers

REVISED VERSION OF IS 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.

Revision of IS 1180:2014

- Revision of these standards has been undertaken to take into account many technological developments taken place on transformer and also to take into account the developments at international level.
- Maximum losses at 50 and 100 percent loading have been incorporated and the scope is extended up to 2 500 kVA.
- Single phase high voltage (11 to 33 kV) distribution transformers up to 25 kVA rating, have also been included.

Losses In 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.

Drawal of Samples and Conformity of Product

- 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

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

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Special Tests

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ROUTINE TESTS
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.

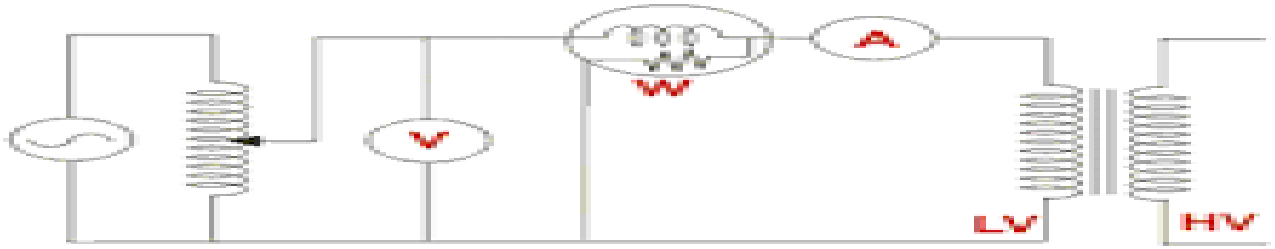
ROUTINE TESTS-Measurement of voltage ratio & check of phase displacement

- This test measures the voltage ratio as per the customer's requirement.
- The voltage ratio shall be measured on each tapping.
- The polarity of single-phase transformers and the connection symbol of three-phase transformers shall be checked.

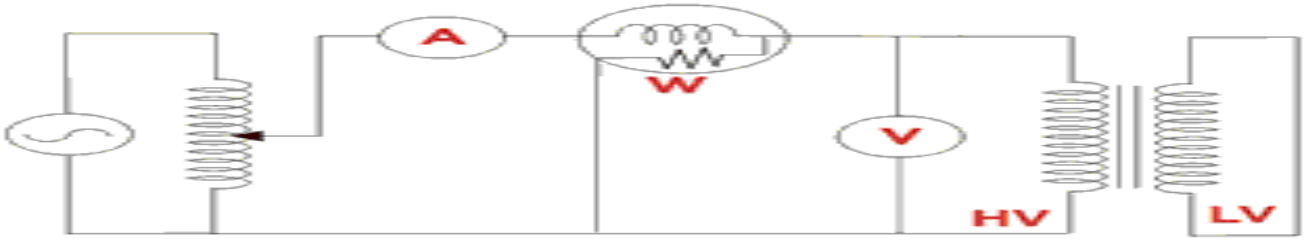
ROUTINE TESTS - Measurement of short-circuit impedance & load loss

- The short-circuit impedance and load loss for a pair of windings shall be measured at rated frequency with voltage applied to the terminals of one winding, with the terminals of the other winding short-circuited.
- The supplied current should be equal to the relevant rated current (tapping current) but shall not be less than 50 percent thereof.
- The measurements shall be performed quickly so that temperature rises do not cause significant errors.

ROUTINE TESTS (cont.)



Open Circuit Test on Transformer



Short Circuit Test on Transformer

ROUTINE TESTS
Measurement of no load loss and current

- Measurement of no load loss and current test of transformer is performed to locate defects in the magnetic core structure, failure in turn to turn insulation or problem in tap changers.
- These conditions change the effective reluctance of the magnetic circuit, thus affecting the current required to establish flux in the core.

ROUTINE TESTS
Measurement of insulation resistance

- Measures the insulation resistance of HV & LV windings with respect to earth (body) and between LV & HV winding.
- This test is carried out to ensure the healthiness of over all insulation system of an electrical power transformer.

ROUTINE TESTS
Induced Over voltage Withstand test (DVDF)

- The induced voltage test of transformer is intended to check the inter turn and line end insulation as well as main insulation to earth and between windings.
- For a 11kV/433V transformer,866 V are applied at the 433V winding and frequency 100 Hz with the help of a Generator for 1 minute.

ROUTINE TESTS
Separate source voltage withstand test (HV)

- This test checks the insulation property between Primary to earth, Secondary to earth and between Primary & Secondary.
- A single phase power frequency voltage of prescribed level, is applied on transformer winding under test for 60 seconds while the other windings and tank are connected to the earth and it is observed that whether any failure of insulation occurs or not during the test.

ROUTINE TESTS
Pressure Test (routine test)

- The transformer with bolted cover shall be tested at an air pressure above atmosphere pressure maintained inside the tank for 10 min.
- Pressure for different tank design
  - Non-sealed type transformers (plain tanks) -35 kPa
  - Corrugated tanks -15 kPa.
  - Sealed type transformers- 80 kPa.(Only up to 200kVA)
- There should be no leakage at any point.

ROUTINE TESTS
Oil Leakage Test

- Assembled transformer (plain tanks)) shall be tested at a pressure equivalent to twice the normal head measured at the base of the tank for 6 hour (Single Phase) & 8 hour (Three Phase)
- Tank with corrugations shall be tested for oil leakage test a pressure of 15 kPa
- There should not be no leakage at any point.

ROUTINE TESTS (cont.)

9.Oil Leakage Test.

- Assembled transformer shall be tested at a pressure equivalent to twice the normal head measured at the base of the tank for 8 hr.
- There should not be no leakage at any point.

TYPE TESTS OF TRANSFORMER

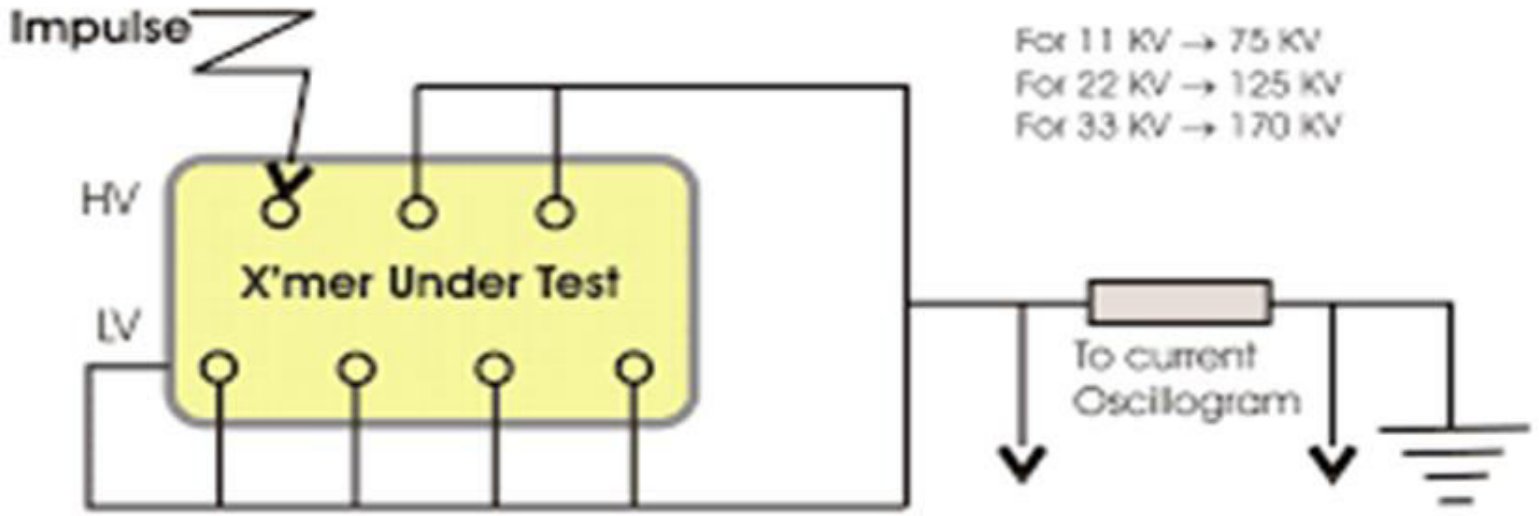
1) Lightning Impulse Test [IS 2026 Part 3]
2) Short circuit withstand Test [IS 2026 Part 5]
3) Temperature rise Test [IS 2026 Part 3]
4) Pressure Test [IS 1180 cl 21.5]

- To be conducted on one unit

TYPE TEST
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
LIGHTNING IMPULSE TEST



TYPE TEST
LIGHTENING IMPULSE TEST

TYPE TEST
LIGHTENING IMPULSE TEST

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

TYPE TEST
LIGHTENING IMPULSE TEST

TYPE TEST & Special Test
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 IS2026.

TYPE TEST & Special Test
Short circuit withstand ability test

- 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

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Short circuit withstand ability test

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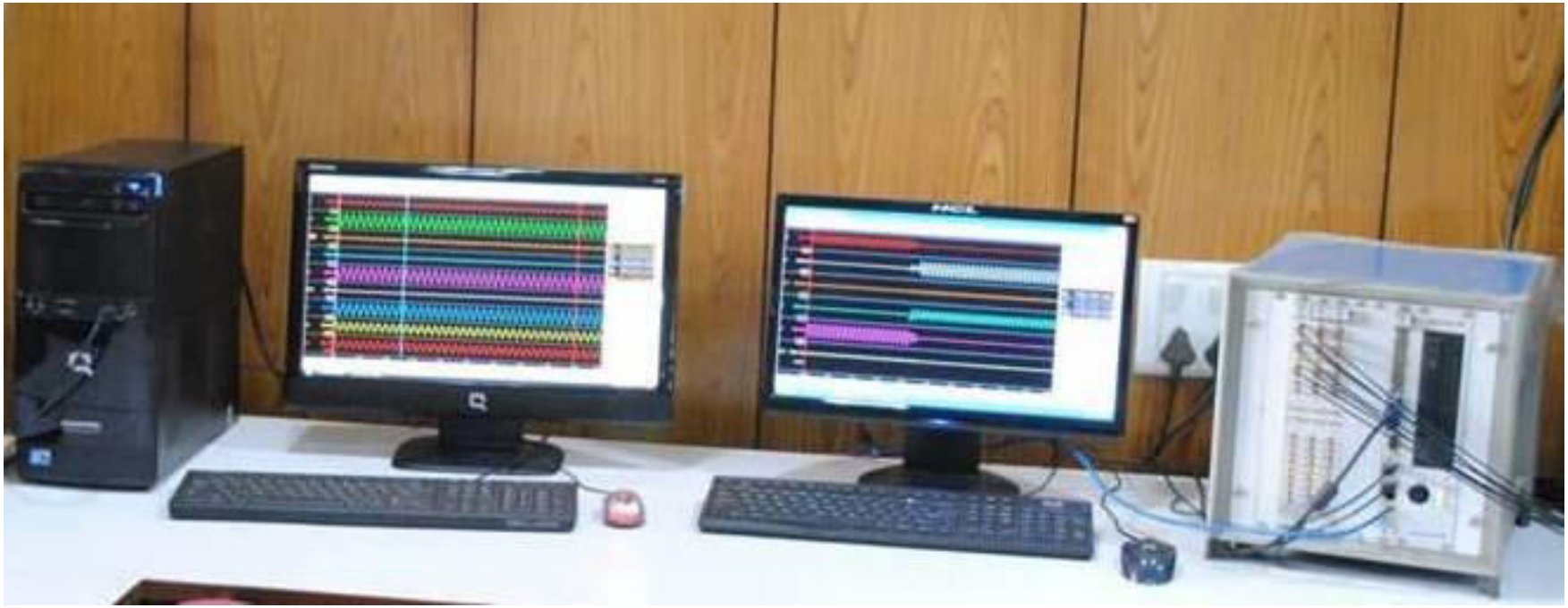


Transformer Untanking

PHOTOGRAGH SHOWING
TRANSFORMER AFTER S.C. TEST

Type Test
Temperature Rise Test

- In this test we check whether the temperature rise 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 transformer.

Type Test
Temperature Rise Test

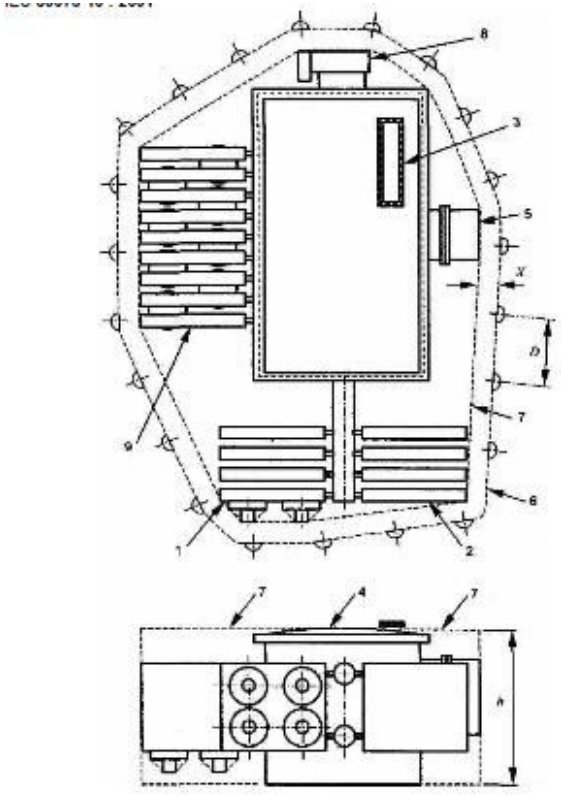
Type Test
Pressure test

- 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
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
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
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 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.
- Increase of 12.5 percent of rated 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
Paint adhesion tests

- For external surfaces of transformers one coat of thermo setting powder paint or one coat of epoxy primer followed by two coats of polyurethane base paint shall be used.
- This test is done for assessing the adhesion of Paint to metallic substrates by applying and removing pressure-sensitive tape over cuts made in the Paint.
- A lattice pattern with either six or eleven cuts in each direction is made in the film to the substrate, pressure-sensitive tape is applied over the lattice and then removed, and adhesion is evaluated by comparison with descriptions and illustrations.

Special Test
BDV and moisture content of oil in the transformer

- This testis conducted on oil sample taken from transformer under test.
- Breakdown voltage of transformer is determined.
- Moisture content of oil is determined.

THANK YOU