

Testing of Distribution Transformer

¹Dr.Sweta Shah, ²Poojan Patel, ³Sachin Patel, ⁴Amit Raghavani, ⁵Nikhil Patel

¹ Assistant Professor Electrical Engineering, ^{2,3,4} B.Tech Student, ⁵Director
^{1,2,3}IITE, Indus University, Rancharda, Ahmedabad-382115

⁵Hetal Engineering works.

Abstract: Testing is performed on any electrical equipment to check whether the equipment is able to comply with customers' requirements or not. In this paper testing of distribution transformer is considered. Thousands of distribution transformers are being tested by manufacturers worldwide each week. The prominent purpose is to make sure the transformer meet manufacturing specifications. Internal quality assurance program of a manufacturer includes testing of equipment. Equipment must fulfill the customer specification in addition to applicable standards and manufacturers own criteria.

Index Terms – Distribution Transformer, Testing, Commissioning.

1. INTRODUCTION

Due to the use of Advanced Technologies and recent development in the power systems we have significantly increased the power plant capacity. This power must be transmitted at higher voltage is then the generated voltage is to curtail the power losses. To step up the generated voltage at much higher voltage for transmission purpose, Power Transformers are extensively used in the industry. The distribution transformer is used to reduce the primary voltage of transmission line to one suitable for residential and commercial load. Distribution transformer is a static device which transfer the AC current electric power by electromagnetic induction from one circuit to another circuit without changing the frequency but with different voltage and current levels.

Following types of test are distinguished by ICC and IEEE standard.

- 1 Routine test
- 2 Type test
- 3 Special test.

Routine Test: This test is performed on all individual transformer in a production lot.

Type Test: This test is conducted on a single transformer which represents all the transformer in a production lot. This test demonstrate that the transformer meet with the customers' specifications and design expectations.

Special Test: This test is carried other than type test and routine test agreed by the customer and manufacturer.

2. Sequence of the Test

The following sequence is followed by most of the manufactures

- 1 Voltage ratio test
- 2 High Voltage test
- 3 Induced over potential test (Generator test)
- 4 Open circuit test
- 5 Short circuit test
- 6 Megger test
- 7 Oil breakdown test

2.1 Voltage ratio test

2.1.1 Purpose

This test is carried out to ensure that the measured turns ratio is equal to the theoretical calculated values. It also certifies that there are no short circuited turns in the winding of the transformer. To ensure whether the vector connection comply with specified vector connections or not.

2.1.2. Method

Ratio meter is used for measurement of the turns ratio. It is a direct indicating instrument. The under test high voltage winding of the transformer and the ratio meter's high voltage terminal are connected to a single phase low voltage source. The low voltage winding of the transformer in which the voltage induced is connected to the ratio meter's low voltage terminals. Connection of terminals must be in correct polarity. The reading of the ration turns are measured through the indicators on the dial. In this case, the ratio meter must be balanced for the correct ratio using dial switches, where the balance is indicated by a null detector. For a given vector connection, how the windings are interconnected is determine by the polarity of the windings. So, if the interconnection of the windings is incorrect, the ratio cannot be measured. Hence the use of ratio meter does not require separate verification of vector connection.



Fig. 1 Turns Ratio Meter

2.1.3 Permitted Tolerance

The permitted tolerances are +/-0.5% of the declared no load voltage ratio or 10% of the impedance whichever is lower as per IEC and ANSI.

2.1.4 Readings

The testing distribution transformer has 6 windings on 1 phase limb as shown in figure.

	Phase R	Phase Y	Phase B
1	7.16	7.06	6.42
2	7.20	7.93	7.19
3	7.15	7.35	7.35
4	7.50	7.37	7.32
5	7.82	7.69	7.46
6	7.11	7.39	7.85
Total Turns (per Phase)	43.94	44.79	43.56

We can observe from the table that the turns ratio in phase Y and Phase B violates the permitted tolerance. so few modifications are needed. To, keep the turns ratio within the permitted theoretical value. Winding number 1 of Phase Y has to be replaced by winding number 1 of Phase B.

	Phase R	Phase Y	Phase B
1	7.16	6.42	7.06
2	7.20	7.93	7.26
3	7.15	7.35	7.35
4	7.50	7.37	7.32
5	7.82	7.69	7.46
6	7.11	7.39	7.85
Total Turns (per Phase)	43.94	44.15	44.20

So total turns ratio for phase Y and B after modification will be 44.15 and 44.20 respectively which is within the permitted tolerance.

2.2 Induced Over Potential Test

2.2.1 Purpose

Induced over potential voltage test verifies the inter turn and insulation (between adjacent turns), interlayer insulation (paper insulation between adjacent layers), inter phase clearances and other insulation structures within the Transformer.

2.2.2 Method

First, keep the high voltage primary winding of transformer open circuited. Apply three phase voltage to the low-voltage secondary winding. The magnitude of the applied voltage should be twice of the rated voltage of low-voltage secondary winding. The frequency should be two times the frequency at which the equipment is supposed to operate during its life span. This test is performed for 60 seconds. Initial applied voltage should be 1/3 the full test voltage. The test is considered successful if Transformer withstand the full test voltage without any breakdown.

2.2.3 Readings

Voltage	Frequency
810 V	99.37 Hz

2.3 High Voltage test

2.3.1 Purpose

This test is carried out to check the capability of the equipment to withstand the intended voltage application by testing it with application of over voltages as prescribed by the standards. This test ensures that the two windings in the same phase has to be required physical clearance. It also verifies the minimum required clearance between windings and core at top and bottom, outer winding to tank side, inner winding to core, switch contacts, bushings to ground, tapping leads to ground, and minimum air clearance.

2.3.2. Method

For high voltage test on HV Side, the low voltage windings are connected together and earthed. The high voltage winding are connected together and the supply of 15KV is given for 11000/440 volt distribution transformer. This test is carried out for 60 seconds. If the transformer can withstand the supply without any failure for 60 seconds then test is said to be successful.

2.4 Open Circuit Test

2.4.1 Purpose

The open circuit test in transformer is carried out to find the no-load losses in the transformer. These losses are also known as the core losses.

2.4.2. Method

In this test first of all the high voltage windings are kept open and the low voltage side is connected with the wattmeter, ammeter and voltmeter. Then with the help of the variac, supply at rated frequency is applied to the low voltage winding up to the rated voltage of low voltage winding. The readings of the current, voltage and power are noted from connected instruments. With the help of the readings the core loss of the transformer is determined.

2.4.3 Permitted Tolerance

No Load Loss -- +5% of guaranteed values

2.4.4 Readings

Voltage	Current	Losses
436 V	1.21A	113.2W



Fig. 2 Control Panel for Testing

2.5 Short Circuit Test

2.5.1 Purpose

The short circuit test is carried out to determine the full-load losses in the transformer. It is also known as copper losses.

2.5.2 Method

The short circuit test is carried out by keeping the low voltage windings shorted. The high voltage side is connected with the ammeter, wattmeter and voltmeter. The voltage at rated frequency is given to the high voltage winding of the transformer, which is increased by using variac until the ammeter indicates the rated current of the high voltage side. Then the readings are noted and with the help of the reading the copper loss of the transformer is determined.

2.5.3 Permitted Tolerance

Full Load Loss at 75°C -- +5% of guaranteed value

2.5.4 Readings

Voltage	Current	Losses
429 V	2.827 A	677 W

2.6 Megger Test

2.6.1 Purpose

This test is carried out to ensure the satisfactory function of insulation system of an distribution transformer. It is also known as insulation resistance test of transformer.

2.6.2 Method

Equipment used for this test is known as Megger. To measure the insulation resistance value in between the low voltage and high voltage windings, leads of Megger are to be connected to low voltage and high voltage bushing studs. Megger leads are to be connected to high voltage bushing studs and earth point of Transformer tank to measure insulation resistance between HV winding and Earth. Similarly, between low voltage bushing studs and earth point of Transformer tank to measure insulation resistance between LV winding and Earth.



Fig. 3 Megger

2.7 Oil Breakdown Strength Test

2.7.1 Purpose

This test is carried out to check whether the dielectric strength of oil is compatible for secure operation of a transformer or not.

2.7.2 Method

A sample of the transformer oil is taken to assess the dielectric breakdown strength. The oil is filled in the testing vessel which has the two electrodes placed 2.3 mm apart from each other. With the help of variac, voltage is applied to the electrodes and continuously increased up to the breakdown voltage. At a specific value of voltage breakdown occurs and applied voltage collapse to Zero. Note down the voltage level at which the breakdown occurs. Recommended breakdown voltage is 50 to 60 KV.

2.8 Conclusion

In this paper, we have discussed about the method of various routine test which are performed on all individual transformers along with its purpose. Testing results shows that transformer parameters satisfy all standards as mentioned above and transformer is ready for commissioning.

References

- 1 Geno Peter P. 'A Review about Testing of Distribution Transformers'
- 2 ABB, "Testing of power transformer" Zurich, 2003.
- 3 IEEE/ANSI Standards General Requirements for Liquid Immersed Distribution , Power, Regulating Transformers",2000.
- 4 IEEE/ANSI Standards C57.123"IEEE Guide for Transformer Loss Measurement",2002