



TRANSFORMER TEST PLAN

General Overview

This test plan is the general outline of the methods or procedures used for the tests being conducted at the Commerce, CA facility. The full details are omitted and shall be in accordance with the applicable standards for the procedures specified.

The transformers are tested in accordance with the latest version of the following ANSI/IEEE standards as applicable:

- C57.12.90 test code for liquid filled transformers.
- C57.12.91 test code for dry type transformers.

Performance qualification shall be judged in accordance with ANSI/IEEE C57.12.00 for liquid filled and C57.12.01 for dry type transformers. The test results will be tabulated and certified on the standard Test Report Form.

The following routine tests will be conducted on all units as required by the above standards.

1. Winding Resistance: Resistance of each Primary and Secondary winding shall be measured with a digital micro-ohmmeter.
2. Turn Ratio: The transformer shall be tested for turn ratio of each coil's Primary to Secondary turns on all the tap connections by transformer turn ratio bridge.
3. Polarity and Phase Relation: The polarity and phase relation shall be checked simultaneously with the turn ratio test.
4. No Load Losses and Exciting Current: This shall be tested at 100% rated voltage and at other specified voltage(s) at rated tap connection using digital or analog meters. The measurements will be made at the Primary or Secondary terminals with other winding(s) open circuited.
5. Impedance and Load Loss: The test shall be made by signal phase voltage method. One winding, preferably the lower voltage winding will be short circuited with negligible load impedance shorting bars. Single phase voltage shall be applied and adjusted to circulate full load rated current on each pair of the open winding in turn and the readings will be recorded. For three winding transformers the test shall be

conducted between each pair of windings at the lower of its rated kVA rating. The percentage impedance and load losses will be calculated from the readings noted using digital or analog instruments and converted to the operating temperature of the transformer.

6. Applied Potential Test: The test shall be done at 60 Hertz. Applicable test voltage shall be applied on each primary and secondary winding in turn with all other windings and parts connected to ground and the return circuit of the test transformer. Duration of the test shall be one minute.
7. Induced Potential: The test shall be conducted at 400 hertz for 18 seconds. Twice the rated voltage shall be applied at the low voltage winding with other winding(s) open circuited.

The following design and prototype tests are only performed when requested by the customer or when there is not on file a record of the tests being performed on a duplicate or essentially duplicate unit.

1. Impulse Test: The test will be done by applying 1.2 x 50 microsecond impulse wave of negative polarity on liquid filled and positive polarity on dry type transformers. The test shall consist of one reduced (50 to 70% of full) voltage and current wave followed by two chopped voltage waves and one of each full voltage and current wave. The values shall be as per transformer specifications. The test waves shall be recorded on Polaroid film from the oscilloscope connected to the resistance divider of the impulse generator.
2. Temperature Rise Test: For liquid filled units, the test shall be conducted by short circuiting lower voltage terminals and applying 3 phase voltage to the higher voltage terminals circulating the applicable load current in the windings in accordance with the standards.

For dry type units, the test will be conducted either by the above method or by impedance kVA method.

The temperatures of the various spots on the unit will be monitored and recorded every hour by attaching thermocouples at those spots. The transformer will be kept under load until all the temperatures are stabilized. The power to unit shall be shut down thereafter and the hot resistance shall be measured at the intervals of thirty seconds for up to six minutes after shut down. A graph will be plotted for time vs. hot resistance and extrapolated to zero time for determining the hot resistance at the time of shut down. The

temperature rise shall be calculated from the hot resistance at the time of shut down.

1. Audible Sound Level Test: Sound level will be measured using A-weighting characteristics with a portable sound level meter confirming to ANSI S1.4-1971, type 2. Measurements shall be made at one foot to the surface of the unit all around at an interval of three feet from each other. The ambient sound level shall be kept as low as possible during the measurements and will be a least 5 dB lower than the combined average sound level of the transformer.
2. Partial Discharge Test: Partial discharge test will be done for dry type transformers for winding of 5 kV class and above. The measurements will be recorded in pico coulombs with respect to the voltage.