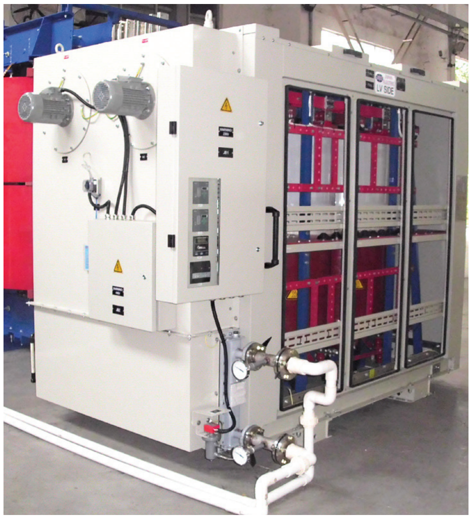
Standard Testing

Production Tests	Description
Check of Phase Displacement	The polarity of single-phase transformers and the connection symbol of three-phase transformers shall be checked by ratio bridge.
Measurement of Voltage Ratio	The voltage ratio shall be measured on each tapping by ratio bridge.
Measurement of Winding Resistance	The winding resistance shall be measured by resistance tester. Winding resistance and winding temperature shall be measured at the same time. The winding temperature shall be measured by sensors placed in the duct between the high-voltage and low-voltage windings.
Measurement of No-Load Loss and Current	The no-load loss and the no-load current shall be measured on one of the windings at rated frequency and at rated voltage. The remaining windings shall be left open-circuited.
Measurement of Short-Circuit Impedance and Load Loss	The short-circuit impedance and load loss shall be measured at rated frequency with voltage applied to the terminals of HV winding, with the terminals of the other winding short-circuited.
PEI (Peak Efficiency Index) and Load Factor Measurements and Calculation	$PEI = 1 - \frac{2(P_0 + P_{c0})}{S_r\sqrt{\frac{P_0 + P_{c0}}{P_k}}}$ Where: P_0 is the no-load losses measure at rated voltage and rated frequency on the rated tap. P_{C0} is the electrical power required by the cooling system for no load operation. P_k is the measured load loss at rated current and rated frequency on the rated tap corrected to the reference temperature. S_r is the rated power of the transformer or autotransformer on which P_k is based. $k_{PEI} = \sqrt{\frac{P_0+P_{c0}+P_{ckPEI}}{P_k}}$ (p.u.) P_{ckPEI} is the additional electrical power required (in addition to P_{c0}) by cooling system for operation at k_{PEI}
Efficiency Calculation	$EI_A = \frac{kS_r-(P_0+P_{c0})-(k^2P_k+P_{ck}(k))}{kS_r}$ (p.u.) Where: P_0 is the no-load loss measured at rated voltage in W, rated frequency and on rated tap. P_{C0} is the electrical power in W required by the cooling system for no-load operation derived from the type test measurement of the power taken by the fan and pump motors. P_k is the measured load loss in W at rated current and rated frequency on the rated tap corrected to reference temperature according to the requirement below. $P_{ck}(k)$ is the additional electrical power in W required (in addition to P_{c0}) by the cooling system for operation at load factor k, derived from the type test measurement of the power taken by the fan and pump motors. S_r is the rated power in VA of the transformer or autotransformer as defined in IEC 60076-1, on which P_k is based. k is the load factor.
Insulation Resistance Measurements	Insulation-resistance tests are carried out with all circuits of equal voltage above ground connected together, other windings and the core should be connected to ground. Circuits or groups of circuits of different voltages above ground shall be tested separately. For example: H.V. - L.V. and ground L.V. - H.V. and ground Core-ground The applied DC voltage for measuring insulation-resistance is usually 2.5kV and the duration is 60s. The test shall be discontinued immediately in the event the current begins to increase without stabilizing.
Applied Voltage Test	The test shall be carried out on each separate winding of the transformer in turn. The full test voltage shall be applied for 60s between all accessible terminals of the winding under test connected together and all accessible terminals of the remaining windings, core, frame, and tank or casing of the transformer, connected to earth. The test is successful if no collapse of the test voltage occurs.
Induced Voltage Withstand Test	The test voltage shall be twice the rated voltage. The duration of the test at full voltage shall be 60s for any test frequency up to and including twice the rated frequency. When the test frequency exceeds twice the rated frequency, the duration of the test shall be (see right): $120\times = \frac{\text{rated frequency}}{\text{test frequency}}$ s, but not less than 15s
Partial Discharge Measurement	The general procedure for partial discharge testing is as follows: the voltage is raised to the pre-stress level of 1.8 times rated voltage, held for 30 seconds, and is then reduced to the voltage level equivalent to 1.3 times rated voltage of the winding under test. After maintaining the 1.3 times rated voltage level for three minutes, make the partial discharge measurement. The maximum acceptable level of partial discharge for solid cast windings is 10 pC. If partial discharge inception doesn't occur, or is less than the intensity listed, the transformer is considered partial discharge free.
PT100 Test	Resistance value according to Rpt100=100+0.39T. The tolerance shall be within ±2Ω. All wires and cable shields, if available, shall be short-circuited and tested as one complete unit toward earth.

Optional Testing

Optional Tests	Description
Lightning Impulse Test	The test impulse wave shall be 1.2us±30%/50us±20%. The test voltage shall be of negative polarity. The test sequence per line terminal shall be one calibration at a voltage between 50% and 75% of the full voltage followed by three impulses at full voltage.
Measurement of Sound level	For dry type transformers without enclosures, the prescribed contour shall be spaced 1m away from the principal radiating surface. For all other transformers, the prescribed contour shall be spaced 1m away. For transformers with a height of <2.5m, the prescribed contour shall be on a horizontal plane at half the height. (one-third and two-thirds of the height for >2.5m). The microphone positions shall be not more than 1m apart.
Temperature Rise Test	Simulated load method is employed. Temperature rise is established by combining the short-circuited test and the open-circuit test. The test procedure shall be performed in two steps in any sequence: the winding short-circuited test is carried out until stabilization of the core and the winding temperature. The open-circuit test is carried out until stabilization of the core and the winding temperature.
Excitation Test	The principal position shall be 0%. The induced AC voltage from the LV side shall be applied. The test is to prove if the transformer is able to operate continuously at the worst case grid conditions without saturating the core. The increments of test voltage shall be in steps of 0.1 p.u.
Coupling Rod Stiffness Test	A static force equal to the requirements shall be applied to the center of coupling rod in a single point for 2s. The force shall be applied five times. A remaining deformation of maximum 5mm is accepted.
Measurement of Harmonic Current Distortion at Maximum Continuous Voltage	The tapping position shall be 0%. The test frequency shall be nominal frequency. The specified maximum voltage for continuous operation shall be applied. The harmonic currents shall be measured on LV side of transformer. It shall be proven that the transformer's harmonic current distortion is within limits.
Rain Test (Weather Tight)	IPX1 vertically falling drops shall have no harmful effects. IPX2 vertically falling drops shall have no harmful effects when the enclosure is titled at any angle up to 15° on either side of the vertical. IPX3 water sprayed at an angle up to 60° on either side of the vertical shall have no harmful effects. IPX4 water splashed against the enclosure from any direction shall have no harmful effects. IPX5 water projected in jets against the enclosure from any direction shall have no harmful effects. IPX6 water projected in powerful jets against the enclosure from any direction shall have no harmful effects.
Coupling Factor Measurement Test	Is2 current is measured in the short-circuited secondary winding when injecting current Is1 through the other secondary winding and with the primary short-circuited. Secondary windings uncoupling factor shall be Is2/Is1<0.2.

"E" Core Finished Without Upper Yoke Assembly.



Water Cooled Transformer for Maximum Protections and Performance.

Standard Core and Coil Design Prior to Testing.