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IEEE Standard Terminology for Power and Distribution Transformers

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Abstract: This standard is a compilation of terminology and definitions related to electric power and distribution transformers and associated apparatus. It also includes similar terminology relating to power systems and insulation that is commonly involved in transformer technology.

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3.449 terminal: (A) A conducting element of an equipment or a circuit intended for connection to an external conductor. (B) A device attached to a conductor to facilitate connection with another conductor.

3.450 terminal board: A plate of insulating material that is used to support terminations of winding leads.

NOTE 1—The terminations, which may be mounted studs or blade connectors, are used for making connections to the supply line, the load, other external circuits, or among the windings of the machine.

NOTE 2—Small terminal boards may also be termed terminal blocks or terminal strips.

3.451 terminal connector: A connector for attaching a conductor to a lead, terminal block, or stud of electric apparatus.

3.452 terminal pair: An associated pair of accessible terminals corresponding to a phase of a winding.

3.453 tertiary winding: An additional winding in a transformer that can be connected to a synchronous condenser, a reactor, an auxiliary circuit, etc. For transformers with wye-connected primary and secondary windings, it may also help

a) To stabilize voltages to the neutral, when delta connected.

b) To reduce the magnitude of third harmonics when delta connected.

c) To control the value of the zero-sequence impedance.

d) To serve load.

See also: stabilizing winding.

3.454 thermal burden rating of a voltage transformer: The volt-ampere output that the transformer will supply continuously at rated secondary voltage without causing the specified temperature limitations to be exceeded.

3.455 thermal duplicate: A transformer whose thermal design characteristics are identical to a design previously tested, or whose differences in thermal characteristics are within agreed upon variations, such that the thermal performance of the thermal duplicate transformer shall comply with performance guarantees established by standards or specifications.

3.456 thermally upgraded paper: Cellulose based paper that has been chemically modified to reduce the rate at which the paper decomposes. Ageing effects are reduced either by partial elimination of water forming agents (as in cyanoethylation) or by inhibiting the formation of water through the use of stabilizing agents (as in amine addition, dicyandiamide). A paper is considered as thermally upgraded if it meets the life criteria as defined in IEEE Std C57.100 [B14]; 50% retention in tensile strength after 65,000 hours in a sealed tube at 110 C or any other time/temperature combination given by the equation:

$$Life(hours) = \varepsilon^{\frac{15{,}000}{(T+273)} - 28.028}$$

where

Life - is the life in hours

T - is the aging temperature in °C

Because the thermal upgrading chemicals used today contain nitrogen, which is not present in Kraft pulp, the degree of chemical modification is determined by testing for the amount of nitrogen present in the treated paper. Typical values for nitrogen content of thermally upgraded papers are between 1 and 4 percent when measured in accordance with ASTM D-982 [B2].

3.457 thermometer method of temperature determination: The determination of the temperature by mercury, alcohol, resistance, or thermocouple thermometer, with any of these instruments being applied directly to the medium in which the temperature is being determined.

3.458 three-phase circuit: A three-phase circuit is a combination of circuits energized by alternating electromotive forces that differ in phase by one third of a cycle, that is, 120 degrees.

NOTE—In practice, the phases may vary several degrees from the specified angle.

3.459 three-wire type current transformer: One that has two insulated primary windings and one secondary winding and is for use on a three-wire, single-phase service.

NOTE—The primary windings and the secondary winding are permanently assembled on the core as an integral structure. The secondary current is proportional to the phasor sum of the primary currents.

3.460 tight (suffix): Apparatus is designed as watertight, dusttight, etc., when so constructed that the enclosing case will exclude the specified material under specified conditions.

3.461 top-oil temperature: The temperature of the top layer of the insulating fluid in a transformer, representative of the temperature of the top liquid in the cooling flow stream. Generally measured 50 mm below the surface of the liquid.

3.462 top-oil temperature rise: The arithmetic difference between the top-oil temperature and the ambient temperature. *Syn:* top-oil rise.

3.463 total losses (transformer or regulator): The sum of the no-load and load losses, excluding losses due to accessories.

3.464 transformer: A static electric device consisting of a winding, or two or more coupled windings, with or without a magnetic core, for introducing mutual coupling between electric circuits. Transformers are extensively used in electric power systems to transfer power by electromagnetic induction between circuits at the same frequency, usually with changed values of voltage and current.

3.465 transformer correction factor (TCF): The ratio of the true watts or watthours to the measured secondary watts or watthours, divided by the marked ratio.

NOTE 1—The transformer correction factor for a current or voltage transformer is the ratio correction factor multiplied by the phase-angle correction factor for a specified primary circuit power factor.

NOTE 2—The true primary watts or watthours are equal to the watts or watthours measured, multiplied by the transformer correction factor and the marked ratio.

NOTE 3—The true primary watts or watthours, when measured using both current and voltage transformers, are equal to the current transformer ratio correction factor multiplied by the voltage transformer ratio correction factor multiplied by the marked ratios of the current and voltage transformers multiplied by the observed watts or watthours. It is usually sufficiently accurate to calculate true watts or watthours as equal to the product of the two transformer correction factors multiplied by the marked ratios multiplied by the observed watts or watthours.

3.466 transient insulation level (TIL): An insulation level expressed in kilovolts of the crest value of the withstand voltage for a specified transient wave shape; that is, lightning or switching impulse.

3.467 transition impedance (in an LTC): A resistor or reactor consisting of one or more units that bridge adjacent taps for the purpose of transferring load from one tap to the other without interruption or appreciable change in the load current, at the same time limiting the circulating current for the period that both taps are used. Normally, reactance type LTCs use the bridging position as a service position, and therefore, the reactor is designed for continuous loading. *See also:* transition impedance (IEC 50).

3.468 triplex transformer: A transformer constructed of three coils, each having its own core, magnetically independent from each other, and contained in one enclosure to function as a three phase transformer.

3.469 true ratio: The ratio of the root-mean-square (rms) primary voltage or current to the rms secondary voltage or current under specified conditions.

3.470 turn ratio of a current transformer: The ratio of the secondary winding turns to the primary winding turns.

3.471 turn ratio of a transformer: The ratio of the number of turns in a higher voltage winding to that in a lower voltage winding.

NOTE—In the case of a constant-voltage transformer having taps for changing its voltage ratio, the nominal turn ratio is based on the number of turns corresponding to the normal rated voltage of the respective windings, to which operating and performance characteristics are referred.

3.472 turn ratio of a voltage transformer: The ratio of the primary winding turns to the secondary winding turns.

3.473 two-core regulating transformer: A phase-shifting and/or regulating transformer consisting of a series unit, which is connected in series in the line circuit and a main or exciting unit that excites the secondary of the series unit to produce the phase-angle shift or voltage change.

3.474 two-phase circuit: A polyphase circuit of three, four, or five distinct conductors intended to be so energized that in the steady state the alternating voltages between two selected pairs of terminals of entry, other than the neutral terminal when one exists, have the same periods, are equal in amplitude, and have a phase difference of 90 degrees. When the circuit consists of five conductors, but not otherwise, one of them is a neutral conductor.

NOTE—A two-phase circuit as defined here does not conform to the general pattern of polyphase circuits. Actually, a two-phase, four-wire or five-wire circuit could more properly be called a four-phase circuit, but the term two-phase is in common usage. A two-phase three-wire circuit is essentially a special case, as it does not conform to the general pattern of other polyphase circuits.

3.475 ungrounded: A system, circuit, or apparatus without an intentional connection to ground except through potential-indicating or measuring devices or other very high impedance devices.

3.476 uninhibited oil: Mineral transformer oil to which no synthetic oxidation inhibitor has been added.

3.477 unit substation: A substation consisting primarily of one or more transformers that are mechanically and electrically connected to and coordinated in design with one or more switchgear or motor control assemblies, or combinations thereof.

3.478 unit substation transformer: A transformer that is mechanically and electrically connected to, and coordinated in design with, one or more switchgear or motor-control assemblies, or combinations thereof. *See also:* articulated unit substation, integral unit substation, primary unit substation, secondary unit substation.

3.479 variable voltage transformer: An autotransformer in which the output voltage can be changed (essentially from turn to turn) by means of a movable contact device sliding on the shunt winding turns.

3.480 varying duty: A requirement of service that demands operation at loads, and for periods of time, both of which may be subject to wide variation.