

### Power Factor

#### At Issue:

The insulation power factor of a transformer is the ratio of the resistive current to the total current flowing in the transformer's insulation structure when tested under a sinusoidal voltage and prescribed conditions. (Another commonly used measurement, dissipation factor, divides the amount of resistive current by the amount of capacitive current flowing through the insulation.) A particular power (or dissipation) factor value is not necessarily significant. According to ANSI C57.12.90, Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers, "A factory power-factor test will be of value for comparison with field power-factor measurements to assess the probable condition of the insulation. It has not been feasible to establish standard power-factor values for liquid-immersed transformers."

#### Recommendation:

ANSI Standard C57.12.90 does not endorse any fixed or standard percentage power factor level for transformers. When specifying transformers, absolute values for power factor should not be defined.

#### Rationale:

##### Moisture Barrier

Rectangular wound transformers made by Cooper Power Systems have solid, cured insulation barriers built from multiple layers of "B" stage epoxy-coated insulation. The epoxy coating creates a mechanically strong high-to-low, and winding-to-core, barrier.

In competitors' round coil designs, where insulation material constitutes a lesser percentage of the winding barrier, oil is the principal dielectric between windings. Oil has an inherently lower power factor level than insulation paper. Therefore, the Cooper design typically will have a higher power factor than the round coil design, even when each transformer holds exactly the same amount of moisture in its insulation.

##### Best Value/Lowest Cost Design

Cooper's rectangular coil construction has insulation packed between coils, and between the coils and core, to withstand short circuit forces.

On a Cooper rectangular wound design, specifying a limit on power factor could be quite constricting. In a request for bid, this could result in the quotation of a special, more costly design. Most users recognize this and do not stipulate a power factor limit in their product specifications.

#### Measurement/Performance Factors

Power Factor should be used only as a relative measurement of insulation condition—not as an absolute value. Methods of construction, core grounding techniques, and the use of switches, bushings, and other components can all have an effect on the power factor reading, as well as on overall transformer performance.

#### Conclusion:

Cooper Power Systems believes that long term reliability can best be enhanced by specifying impulse tests, by requiring short circuit certification for all transformer designs specified, by properly protecting the transformer with correctly rated lightning arresters, by not overloading the transformer beyond the ANSI C57.91 loading guide limitations, and by adhering to a maintenance program for the transformer.

#### The Cooper Connection:

Cooper Power Systems offers three-phase and single-phase substation transformers in the following ratings:

##### Three-phase:

- KVA Range: 75 kVA through 10000 kVA (With temperature rise and fans, capacity of up to 14000 kVA is possible.)
- Primary Voltage: 2,400 - 46,000 volts (with or without taps, dual voltages available)
- Secondary Voltage: 208Y/120 (through 1500 kVA only) through 14,400 volts

Temperature Rise: 55°, 55/65°, 65° (Optional: special temp rise)

Basic Insulation Level: 30 kV BIL through 250 kV BIL

SUSS - Secondary unit substation

PUSS - Primary unit substation

SOSS - Secondary open substation

POSS - Primary open substation

##### Single-Phase:

- KVA Range: 333 kVA through 4000 kVA
- Primary Voltage: 2,400 - 46,000, with or without taps; dual voltages available
- Secondary Voltage: 208Y/120 (through 1500 kVA only) through 14,400 Volts
- SOSS
- POSS

Units meet all applicable ANSI, NEMA, and IEEE standards. The primary ANSI standard that governs substation transformers built by Cooper Power Systems is C57.12.10. Several other ANSI standards that govern the construction, loading and testing of pad-mounted and substation transformers are C57.12.00, C57.12.70, C57.12.80, C57.92, and C57.105.



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