Distribution Transformers

COOPER Power Systems

Reference Information

Harmonic Loads

R210-90-5

At Issue:

In recent years, harmonic loads on distribution systems (in which currents at higher-frequency multiples of the fundamental 60Hz frequency add to the fundamental current) have increased dramatically due to the increased use of ferromagnetic devices (motors, transformers), arcing devised (fluorescent lighting, welders) and electric power converters (adjustable-speed drives, UPS, SCR devices). Such higher frequency loads increase the heat generated within transformer windings and leads by as much as 300%. This can lead to premature failure of standard-design distribution transformers.

Recommendation:

Specify transformers with harmonic-resistant designs for applications subject to harmonic loads. Standard UL "K-factor" ratings can be used, or, better still, units can be custom-designed for the intended load.

Field measurement (magnitude and frequency spectrum) and harmonic analysis of the connected load can be performed by Cooper Power Systems' Engineering Group or by a third-party consultant to help identify your needs and define your transformer specification requirements.

If the harmonic-resistant transformer is being specified for a new equipment installation, the manufacturer of the equipment being installed should know the harmonic load content of that equipment. This harmonic information should also be included in the transformer specification.

Rationale:

Design Features

Harmonic-resistant designs are strengthened to maintain normal temperature rise under harmonic, full-load conditions.

Typical features of Cooper harmonic-resistant designs include:

- Heavier conductors, leads, and neutral buswork to handle harmonic currents.
- Extra cooling ducts within the coil, use of liquid dielectric, and additional external cooling to dissipate the additional heat.
- Reduced core flux density to keep harmonically-induced overvoltages from drawing excessive excitation current.
- Delta-connected primary winding to block the in-phase third harmonics from passing through the transformer.

Conclusion:

Choosing transformer designs from a field with pre-defined, standard K-factor increments can sometimes result in unnecessary costs when the "next-highest" K-factor must be chosen for a calculated harmonic load. Settling for standard K-factor ratings is not necessary.

Cooper Power Systems' engineers can design a transformer to fit the strict harmonic spectrum of an application. This allows each customer to purchase the exact amount of harmonic load capability needed to operate at full kVA rating under the harmonic loading conditions specified for the job.

The Cooper Connection:

Cooper Power Systems offers three-phase pad-mounted transformers in the following ratings:

- KVA Range: 45-7500 kVA
- Primary Voltage: 2,400 - 46,000 volts (with or without taps, dual voltages available)
- Secondary Voltage: 208Y/120 - 14,400 volts

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

- KVA Range: 75 kVA through 10,000 kVA (With temperature rise and fans, capacity of up to 14,000 kVA is possible.)
- 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
- 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

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

- 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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