 5	Title: YALE OFFICE OF FACILITIES PROCEDURE MANUAL Chapter: 01 - Yale Design Standard Division: Electrical Standards	Section: 26 24.07 Dry-Type Transformers (600 Volts and Less)
		Date: 6/15/16
		Author: Office of Facilities
CC: Project Folder		

Change History

Date	Description of Change	Pages / Sections Modified	Change Approver Initials
6/15/16	Updated division section from 16461 to 26 24 07, removed references to other section	-	mgl44
10/17/14	Add paragraph 6 at the end of section F	28 – 16461, F. #6 (Dry-Type Transformers (600Volts and Less))	SO

A. Summary


This section contains design criteria for low-voltage, dry-type transformers, general purpose power distribution and lighting.

B. System Design and Performance Requirements

1. Design transformers for continuous operation (24 hours per day) at rated KVA, with normal life expectancy.
2. All transformers must be of a delta-wye configuration, except where small loads require buck-boost transformers connected as autotransformers to change from 240 volts to 208 volts, or vice versa.
3. Transformer impedance levels must be minimum of three percent to limit short- circuit currents on secondary systems.
4. Transformers serving loads which generate excessive harmonics in the grounded circuit conductor, as defined for in system design Standard: Conductors and Cable, must be selected with K-factor ratings suitable for the load served. Such transformers must be of a delta-wye configuration, three-legged core construction, with full-width copper electrostatic shielding. Because there is no low-impedance path for the third harmonic current, three single-phase transformers and open delta arrangements are not acceptable.
5. Transformers rated up to 225 kVA must be air cooled. All transformers must have copper windings. Distribution transformers that exceed rated 300 kVA and over shall use secondary substation Standard Transmission Distribution with no exception.

C. Submittals

Submit the following design and construction documentation.

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1. Designer Submittals

Submit calculations for selection and sizing of all transformers, including:

- Connected load
- Future loads
- Harmonics
- Temperature considerations

2. Construction Documents

- Shop drawings and product data
- Factory test results
- Operation and maintenance instructions

D. Product Standards

Ensure that all products conform to the following standards:

- NEMA ST20, Dry-Type Transformers, for general applications
- NEMA TR27, Commercial, Institutional, and Industrial Dry-Type Transformers
- UL 506, Specialty Transformers
- UL 1561, Large General Purpose Transformers
- ANST Standard Doc for determining energy efficiency for distribution transformers
- ANSI C57.12.90 Test Code for distribution power transformers
- Latest D.O.E. Efficiency for Transformers


E. Manufacturers

Subject to compliance with the design requirements, provide products by one of the following manufacturers:

- Asea Brown Boveri
- General Electric
- Eaton
- Square D


F. Equipment

1. Transformers must be dry-type with an insulation grade of 220°C total temperature

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system based on an 80°C rise. All insulation materials must be flame-retardant and must not support combustion, as defined in ASTM D635, Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastic in a Horizontal Position.

2. Transformer cores must be constructed with high-grade, non-aging, grain-oriented silicone steel, with high magnetic permeability and low hysteresis and eddy current losses. Maximum magnetic flux densities must be substantially below the saturation point. Core volume must allow efficient transformer operation at 10 percent above the highest tap voltage. Core laminations must be tightly clamped and compressed. Coils must be wound with electrical-grade copper wiring and continuous-wound construction.
 - a. On units rated below 15 KVA, the core and coil assembly must be completely encapsulated in a proportioned mixture of resin and aggregate to provide a moisture-proof, shock-resistant seal.
 - b. On units rated at 15 KVA and above, the core and coil assembly must be impregnated with a non-hydroscopic, thermo-setting varnish and cured to reduce hot spots and seal out moisture. Install the assembly on a vibration-absorbing pad and bolt it securely to the base to minimize sound transmission.
3. Transformer sound levels shall not exceed the following:
 - 9 KVA and below: 40 dBA
 - 10–50 KVA: 45 dBA
 - 51–150 KVA: 50 dBA
 - 151–225 KVA: 55 dBA
4. Equip transformers with voltage taps in the primary winding, as follows:
 - 2 KVA and below: no taps required
 - 3–9 KVA: two, five percent FCBN
 - 10–25 KVA: four, 2-1/2 percent FCBN
 - Above 25 KVA: four, 2-1/2 percent FCBN and two, 2-1/2 percent FCAN
5. Transformers enclosures located indoors must be NEMA 1. Transformers located outdoors must be NEMA 3R. Wiring compartments must be suitable for conduit entry and large enough to allow convenient wiring. The core must be visibly grounded to the enclosure.

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- a. On units rated below 15 KVA, the enclosures must be totally enclosed, non-ventilated, and equipped with lifting eyes.
 - b. On units rated at 15 KVA and above, enclosures must be ventilated and equipped with lifting holes.
6. All transformers associated with emergency / alternative electrical systems shall be located in a separate room that has a minimum fire rating of 2 hours. The normal and emergency / alternative systems shall be in separate rooms.

G. Quality Control Testing

1. Perform ratio tests on the rated voltage connection and on all tap connections.
2. Perform polarity and phase-relation tests on the rated voltage connection.
3. Perform applied and induced potential tests.
4. Perform the following additional tests on transformers larger than 100 KVA:
 - Resistance measurements on all windings on the rated voltage connection of each unit and at the tap extremes of the first unit made of a new design
 - No-load and excitation current at rated voltage on the rated voltage connection

H. Installation Guidelines

1. Secure transformers to the building structure in compliance with the seismic provisions of the State Building Code, but in such a manner that vibrations are not transmitted to the structure during operation.
2. Make provisions to prevent heat buildup within transformers and within rooms containing transformers.

I. Quality Control

Perform insulation resistance and moisture tests prior to energizing a transformer.

“END OF SECTION”