# SECTION 26 12 16
# MEDIUM VOLTAGE TRANSFORMER, DRY TYPE, VPI – DOE 2016

## PART 1 - GENERAL

1.1 SCOPE

A. This specification provides the technical requirements for the design, manufacture and test of dry-type secondary unit substation transformers. Provide all accessories and equipment as described herein and shown on Project Drawings as necessary for a complete installation.

1.2 RELATED DOCUMENTS

A. ***[Related Sections included the following:***
   1. ***Section 26 24 13 - Switchboards]***

1.3 SUBMITTALS

A. The manufacturer shall provide the following information for review and evaluation by the Engineer:
   1. Shop Drawings showing outline, nameplate information and connection diagrams.

B. Manufacturer shall provide final, as- built drawings. Installation, Operation and Maintenance manuals shall also be supplied.

1.4 RELATED STANDARDS

A. The ventilated dry-type transformers and protection devices in this specification are designed and manufactured according to latest revision of the following standards.
   1. IEEE C57.12.01, General Requirements for Dry-Type Distribution and Power Transformers Including Those with Solid Cast and / or Resin-Encapsulated Windings ANSI C57.12.51, Requirements for Ventilated Dry-Type Power Transformers, 501 KVA and Larger, Three-Phase with High-Voltage 601 to 34 500 Volts, Low Voltage 208Y/120 to 4160 Volts
   2. ANSI C57.12.01, Service conditions shall be as specified in Usual Service Conditions
   3. ANSI C57.12.55, Dry-Type Transformers in Unit Installations, Including Unit
      a. Substations –Conformance Standard
   4. ANSI/IEEE C57.98, Guide for Transformer Impulse Tests
   5. IEEE C57.12.91, Test Code for Dry-Type Distribution and Power Transformers
   6. IEEE C57.94, Recommended Practice for Installation, Application, Operation and Maintenance of Dry-Type General Purpose Distribution and Power Transformers
   7. IEEE C57.96, Guide for Loading Dry-Type Distribution and Power Transformers
   8. NEMA ST 20, Dry Type Transformers for General Applications
   9. American Society of Testing and Materials (ASTM)
   10. National Electrical Code (NEC)
   11. UL 1562
   12. ***[U.S. Department of Energy 10 CFR Part 431 Energy Conservation Program: Energy Conservation Standards for Distribution Transformers; Final Rule, dated April 18, 2013. These efficiency standards shall take effect January 1, 2016. All transformers covered in the scope of this document and this specification, manufactured after December 31, 2015, shall be compliant with the new standard.]***
   **[Editor's note: This standard, known as DOE 2016, applies to transformers rated 2500 kVa or less. For transformers 2501 kVa and larger, this RELATED STANDARD does not apply.]**

1.5 QUALITY ASSURANCE

A. The manufacturer shall have a well-documented quality assurance program, which includes procedures for all activities in order entry, design, material procurement, manufacturing processes, testing, shipping and post shipment.

B. The manufacturer shall have specialized in the design, manufacture and assembly of dry-type distribution transformers for a minimum of 10 years.

C. The transformer shall be manufactured by a company, which is certified ISO 9001or ISO 9002 as a minimum, for design and manufacture of Power Dry Type Transformers.

D. The test floor shall have documented calibration program. All equipment shall receive regular calibrations. Calibration standards shall be traceable to National Bureau of Standards. Records of all equipment calibration shall be made available to the Buyer upon request.

E. Measured values of electric power, voltage, current, resistance and temperatures are used in the calculations of reported data. To ensure sufficient accuracy in the measured and calculated date the test system accuracy requirements listed in ANSI C57.12.01 Table 3 shall be met as a minimum.

1.6 DELIVERY, STORAGE AND HANDLING

A. Handle and store equipment in accordance with manufacturer's Installation and Maintenance Manuals. One (1) copy of this document to be provided with the equipment at time of shipment.

## PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The medium voltage, dry-type substation transformer shall be provided by Siemens or pre-approved equal. Approved manufacturers are as follows:
1. SIEMENS
2. ***[ ]***

2.2 TECHNICAL REQUIREMENTS

A. Construction
1. The transformer shall be of dry type Vacuum Pressure Impregnated (VPI) construction, the preferred open-wound dry type technology and shall be mounted in a suitably ventilated ***[indoor] [outdoor]*** enclosure.
2. Primary terminations shall be ***[bus connection inside transformer enclosure for close-coupling to high voltage load interrupter switch] [cable connection in air-filled terminal chamber].***
3. Secondary terminations shall be ***[bus connection inside transformer enclosure for close-coupling to low voltage switchboard/switchgear] [busway] [cable connection in air-filled terminal chamber].***

B. Core Design
1. The transformer core shall be constructed of high-grade non-aging silicon steel laminations with high magnetic permeability and low hysteresis and eddy current losses. Magnetic flux densities are to be kept well below the saturation point. A step-lap mitered core joint shall be used to minimize losses, exciting currents and sound levels. The core laminations shall be clamped together with heavy steel members.

C. Temperature Rise
1. The transformer shall be design for a temperature rise of ***[80 deg C with an AA rating] [80 deg C with an AA/FA rating] [80/115/150 deg C with an AA/AA/AA rating without fans] [80/115/150 deg C with an AA/AA/FA rating with fans] [80/150 deg C with an AA/FA rating]*** and shall be built utilizing Class 220°C insulation, regardless of the temperature rise specified. The transformer shall not exceed the specified temperature rise when the unit is operated continuously at full nameplate rating. The transformer shall be capable of carrying 100% of the nameplate rating in a 30°C average, not to exceed 40°C maximum ambient in any 24-hour period.

D. Coil Design

1. The high voltage and low voltage windings shall be constructed using ***[copper] [aluminum]*** conductors. The conductors shall be insulated with 220°C insulation. Transformer windings, insulation class 1.2 kV (600v) and below, shall be wound using foil or sheet conductors. A sheet wound coil allows free current distribution within the axial width of the conductor/coil to essentially eliminate axial forces under short circuit.
2. Transformer windings, insulation class 2.5 kV (2400v) and above, shall be wound using wire conductors. The high voltage winding shall be wound over the low voltage winding with sufficient mechanical bracing to prevent movement during fault conditions and sufficient solid Class 220°C insulation to isolate the high voltage winding dielectric potential from the low voltage windings.
3. Taps
   a. ***[Transformer primary winding shall have four 2-1/2 percent full capacity taps; two above and two below rated nominal voltage. No load tap connections shall be made by re-connectable links on the face of the primary winding and shall be located behind removable panels on the front of transformer enclosure. Taps shall be for de-energized operation only.]***
   b. ***[Special Taps – Specify range including steps above and below nominal]***
   c. ***[No taps required].***

E. Core And Coil Assembly
1. After installation of windings on core and stacking of the top yoke core steel, core and coil assembly is to be secured with a rigid frame. Primary and secondary coordination bus assemblies, as required for connection to associated switchgear are to be of welded or bolted construction.

F. Vacuum Pressure Encapsulation Process
1. Each coil assembly shall be vacuum pressure impregnated in polyester varnish. The VPI process shall apply a one (1) cycle polyester protective shield of varnish to the coils shall effectively impregnate the entire core and coil assembly that results in a unit which is virtually impermeable to moisture, dust, dirt, salt air and other industrial contaminants. ***[Optional - The totally assembled core and coils and all clamping structure and bus work shall then be dried at atmospheric pressure in an oven through which hot air is continuously circulated. Then, given a dip and bake cycle of polyester varnish and cured in a time baking cycle in a hot air circulating oven].***

G. Dielectric Withstand
1. The impulse rating of the transformer must equal or exceed the basic impulse level specified by ANSI for the applicable voltage class. The basic impulse level shall be inherent to the winding design and is to be obtained without the use of supplemental surge arrestors.

H. Vibration Isolation
1. The transformer shall have vibration isolation pads installed between core and coil assembly and enclosure base structures to prevent the transmission of structure borne vibration.

I. Enclosure
1. The enclosure shall be constructed of heavy gauge sheet steel and shall be finished in ANSI 61 paint color applied using an electrostatically deposited dry powder paint system. All ventilating openings shall be in accordance with NEMA and NEC standards for ventilated enclosures. The base of the enclosure shall be furnished with ground pads located on opposite diagonal corners. The base shall have jacking pads and shall be constructed of heavy steel members to permit skidding or rolling in any direction. The core shall be visibly grounded to the enclosure frame by means of a flexible grounding strap.
2. NEMA 3R protection against rain, sleet and external ice construction.

J. Nameplate

1. Transformer shall be furnished with a non-corrosive diagrammatic nameplate per ANSI C57.12.01, permanently attached with non-corrosive hardware. The diagrammatic nameplate shall include the name of the transformer supplier as well as the location where the transformer was manufactured and tested.

K. Forced Air Cooling

1. Forced air cooling, when required, shall increase the self-cooled rating of the transformer by 33 1/3% for units rated 5000 kVA and below and 25% for units 5001 kVA and larger. The FA increase shall be possible with forced cooling without exceeding the specified maximum temperature rise. The additional FA capacity is intended for emergency and/or peak loading on a temporary overload basis. Sensors placed in the low voltage winding's air ducts shall regulate the forced air-cooling automatically. Forced air cooling shall include: three phase electronic digital temperature monitor, fans, control wiring, control panel with test switch, indicating lights, alarm and alarm silencing switch.

L. ***[Overload Capabilities***

1. ***When 80°C and 115°C winding temperature rise are specified, they can be designed with inherent overload capabilities. An 80°C rise unit would be capable of continuous operation at 35% above nameplate rating and a 115°C rise unit would be capable of continuous operation at 15% above nameplate rating. This overload capability would be achieved on the AA and FA rating and could be accomplished by allowing the transformers' ultimate rise to be 150°C.]***

2.3 FACTORY TESTING

A. After completion, each transformer shall undergo the following routine production tests per ANSI C57.12.01 and ANSI C57.12.91. Testing shall be accomplished using calibrated test equipment, which have recorded accuracy traceable to National Institute of Standards Technologies (NIST). Certification of Calibration shall be provided with test reports if requested.

1. Megger
2. Ratio
3. Resistance
4. Phase relation
5. Load Loss, Impedance and Regulation
6. No Load Loss and Excitation Current
7. Applied Potential Test
8. Induced Potential Test

B. A 100% QC Impulse test shall be performed on each transformer furnished.

C. ***[A temperature rise test shall be performed on the first unit of each new design.]. [Provide temperature test data from an "electrically similar" unit-more feasible].*** The temperature rise of the windings at rated KVA loading shall not exceed maximum rise specified during operation at 30 degrees C average ambient, which does not exceed 40 degrees C in a 24 hour period.

D. ***[A sound level test shall be performed on the first unit of each new design.] [Provide test data from an "electrically similar" unit-more feasible].*** Sound level shall not exceed the maximum specified by ANSI C57.12.01 for applicable KVA size of dry-type transformer.

E. Provide certified production test reports for all manufactured transformers.

2.4 ACCESSORIES

A. Standard transformer accessories shall include:

1. Diagrammatic instruction nameplate
2. Provisions for lifting and jacking
3. Removable enclosure panel for access to HV taps when de-energized
4. Ground cable
5. ***[Continuous copper ground bus] [Stainless steel ground pads]***

6. Line voltage adjustment taps, 2 - FCAN and 2 - FCBN, All at 2 ½%

B. Documentation for Owner's review:
   1. Outline, nameplate and connection diagram drawings.
   2. Installation/Operation/Maintenance Manual
   3. Certified Production Test Report(s) containing minimum information per ANSI C57.12.91

## PART 3 - EXECUTION

3.1 INSTALLATION

A. Install transformer as shown on Project Drawings and in accordance with manufacturer's Instruction/Installation Manual.

B. Provide concrete pad with sufficient structural support and in accordance with local codes and standards. Concrete pad requirements should be coordinated with transformer manufacturer.

C. Grounding should be per Project Drawings and in accordance with local codes and standards and in compliance with the NEC.

3.2 ADJUSTMENTS AND CLEANING

A. Remove debris from job site and wipe dust and dirt from all components.

B. Repaint marred and scratched surfaces with touch up paint to match original finish.

3.3 TESTING

A. Field-testing will be conducted at the expense of the Owner, if required for final acceptance.

B. Refer to Section ***[26 xx xx] [16040]***, "Electrical Tests, Adjustments and Inspection."

3.4 WARRANTY

A. Equipment manufacturer warrants that all goods supplied are free of non-conformities in workmanship and materials for one year from date of initial operation, but not more than eighteen months from date of shipment.

**END OF SECTION**