

## SECTION [26 12 16.13][16270.16.3]

### MEDIUM VOLTAGE DRY TYPE VPI TRANSFORMERS

#### Square D Power-Dry II™ VPI Substation Transformers by Schneider Electric

##### Schneider Electric Editor's Note:

This guide specification is written in accordance with the Construction Specifications Institute (CSI) Master Format. This section must be carefully reviewed and edited by the architect or the engineer to meet the requirements of the project. Coordinate this section with other specification sections within the Contract Documents and Drawings.

To properly use / edit this document, show formatting and hidden text by selecting ¶ on the menu or by typing (Ctrl+\*) simultaneously. Except for these introductory and closing paragraphs, green hidden text will not print. Text in red is optional. Red text in [brackets] denotes multiple options where one or more should be chosen. All red text should be edited and changed to black for final project conformation. In addition, these introductory paragraphs should be deleted or changed to hidden text. Additional guidance and specifications can be found at <https://www.schneider-electric.us/e2e>

## PART 1 - GENERAL

### 1.1 SUMMARY

- A. Scope: Provide labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, erection, and installation for medium voltage dry type VPI substation transformers (also identified as MV XFMR, XFMR) as required for the complete performance of the work, and as shown on the Drawings and as herein specified.
- A. Related Sections: Related sections include, but shall not be limited to, the following:
  - 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
  - 2. Applicable general requirements for electrical Work specified within Division 26 Specification Sections apply to this Section.
  - 3. Refer to specification Section 26 11 13 Unit Substations for additional requirements.

### 1.2 REFERENCES

- A. The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest date as of the date of the Contract Documents, unless otherwise specified.
  - 1. Canadian Standards Association (CSA)
    - a. C88, "Power Transformers and Reactors"
    - b. C22.2 No. 47, "Air-Cooled Transformers (Dry Type)"
    - c. C9, "Dry-Type Transformers"
  - 2. Institute of Electrical and Electronics Engineers, Inc. (IEEE)
    - a. IEEE C57.12.01, "Standard General requirements for Dry Type Distribution and Power transformers including those with Solid Cast or Resin-Encapsulated Windings."
    - b. IEEE C57.12.28, "Switchgear and Transformers, Pad-Mounted Equipment - Enclosure Integrity"
    - c. IEEE C57.12.50, "Requirements for Ventilated Dry-Type Distribution Transformers, 1–500 kVA Single-Phase and 15–500 kVA Three-Phase"
    - d. IEEE C57.12.51, "Requirements for Ventilated Dry-Type Power Transformers, 501 kVA and larger Three-Phase, with High Voltage 601–34,500 Volts, Low Voltage 208Y/120–4,160 Volts"

- e. IEEE C57.12.55, “Conformance Standard for Transformers—Dry-Type Transformers Used in Unit Installations, including Unit Substations”
  - f. IEEE C57.12.56, “Standard Test Procedure for Thermal Evaluation of Insulation Systems for Ventilated Dry-Type Power and Distribution Transformers”
  - g. IEEE C57.12.58”, Guide for Conducting a Transient Voltage Analysis of a Dry-Type Transformer Coil”
  - h. IEEE C57.12.59, “Guide for Dry-Type Transformer Through-Fault Current Duration”
  - i. IEEE C57.12.70, “Terminal Markings and Connections for Distribution and Power Transformers”
  - j. IEEE C57.12.80, “Standard Terminology for Power and Distribution Transformers”
  - k. IEEE C57.12.91, “Test Code for Dry-Type Distribution and Power Transformers”
  - l. IEEE C57.94, “Recommended Practice for Installation, Application, Operation, and Maintenance of Dry-Type General Purpose Distribution and Power Transformers”
  - m. IEEE C57.96, “Guide for Loading Dry-Type Distribution and Power Transformers”
  - n. IEEE C57.105, “Guide for Application of Transformer Connections in Three-Phase Distribution Systems”
  - o. IEEE C57.124, “Recommended Practice for the Detection of Partial Discharges and the Measurement of Apparent Charge in Dry-Type Transformers”
- 3. International Organization for Standardization (ISO):
    - a. ISO 9001, “Quality Management Systems - Requirements”
  - 4. National Electrical Manufacturers Association (NEMA)
    - a. TR 1, “Transformers, Regulators and Reactors”
  - 5. Underwriters Laboratories, Inc. (UL):
    - a. UL 1561, “Standard for Dry-Type General Purpose and Power Transformers”
  - 6. USA Federal Regulations, Policies and Acts
    - a. Energy Policy and Conservation Act 1975 & Energy Policy Act 2005
    - b. 10 CFR 429 - Certification, Compliance, and Enforcement for Consumer Products and Commercial and Industrial Equipment
    - c. 10 CFR 431 – Energy Efficient Program for Certain Commercial and Industrial Equipment

### 1.3 DEFINITIONS

- A. Unless specifically defined within the Contract Documents, the words or acronyms contained within this specification shall be as defined within, or by the references listed within this specification, the Contract Documents, or, if not listed by either, by common industry practice.
  - 1. MV: Medium voltage
  - 2. VPI: Vacuum-Pressure Impregnated
  - 3. XFMR: Transformer
  - 4. AA: Ambient Air Natural Convection Cooling
  - 5. AA/FA: Ambient Air / Forced Air refers to XFMR using AA for lower and FA for heavier loading conditions
  - 6. FA: Forced Air

### 1.4 SUBMITTALS

Most submittal requirements including those for electrical equipment of all types are specified elsewhere. Additional requirements should only be listed herein if they only pertain to XFMRs and not to electrical equipment in general.

- A. General: Submittals shall be in accordance with the requirements of Section [01 33 00][01300] Submittals and Section [26 00 10][16010] Electrical, in addition to those specified herein.

1. Submit sufficient information to determine compliance with the Contract Documents. Identify submittal data with the specific equipment tags and/or service descriptions to which they pertain. Submittal data shall be clearly marked to identify the specific model numbers, options, and features of equipment and work proposed.
2. Deviations from the Contract Documents shall be indicated within the submittal. Each deviation shall reference the corresponding drawing or specification number, show the Contract Document requirement text and/or illustration, and shall be accompanied by a detailed written justification for the deviation.

## 1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Manufacturer shall be a firm engaged in the manufacture of specified products of types and sizes required, and whose products have been in satisfactory use in similar service for a minimum of ten years.
  1. The manufacturer shall have a valid ISO 9001 certification and an applicable quality assurance system that is regularly reviewed and audited by a third party registrar. Manufacturing, inspection, and testing procedures shall be developed and controlled under the guidelines of the quality assurance system.
  2. The manufacturer or their representative shall have service, repair, and technical support services available 24 hours 7 days a week basis.
- B. Installer Qualifications: Installer shall be a firm that shall have a minimum of [10] years of successful installation experience with projects utilizing equipment similar in type and scope to that required for this Project [and shall be approved by the manufacturer's representative].
- C. All work performed and all materials used shall be in accordance with the [National Electrical Code], [Canadian Electrical Code] and with applicable local regulations and ordinances. Equipment assemblies, materials, and equipment shall be listed and labeled by Underwriter's Laboratories or by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Prior to delivery to the Project site, ensure that suitable storage space is available to store materials in a well ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity, and corrosive atmospheres. Materials shall be protected during delivery and storage and shall not exceed the manufacturer stated storage requirements. As a minimum, store indoors in clean, dry space with uniform temperature to prevent condensation. In addition, protect electronics from all forms of electrical and magnetic energy that could reasonably cause damage.
- B. Deliver materials to the Project site in supplier's or manufacturer's original wrappings and containers, labeled with supplier's or manufacturer's name, material or product brand name, and equipment tag number or service name as identified within the Contract Documents.
- C. Inspect and report any concealed damage or violation of delivery storage, and handling requirements to the Engineer.

## 1.7 WARRANTY

- A. General: Refer to [Section 01 77 00 - Closeout Procedures] [Section 01770 - Closeout Procedures].  
Schneider Electric extends the warranty of most equipment by 12 months at no additional cost when their service technicians perform functional testing, commissioning, and first parameter adjusting of the installed equipment.
- B. The manufacturer shall warrant products against defects in material and workmanship for [12 months from the date of commissioning or 18 months from the date of shipment – whichever comes first.][24 months from the date of commissioning or 36 months from the date of shipment, whichever comes first, provided that the manufacturer performs functional testing, commissioning and first parameter adjusting of

equipment.] During the warranty period the manufacturer shall repair or replace defective products. This warranty shall be in addition to any provided by the Contractor. The warranty shall exclude normal wear and tear under normal usage and any damage caused by abuse, modification, or improper maintenance by entities other than the manufacturer or its approved representative.

- C. Additional Owner Rights: The warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to and run concurrent with other warranties made by the Contractor under requirements of the Contract Documents.

## 1.8 SPECIAL TOOLS AND SPARE PARTS [- NOT USED]

- A. The Contractor shall provide a recommended spare parts list with the following information provided as a minimum:
1. Contact information for the closest parts stocking location to the Owner.
  2. Critical spare parts shall be identified as those parts being associated with long lead times and/or those being critical to the unit's operation.
  3. Maintenance spares shall be identified as being those parts required to regularly perform scheduled maintenance on the furnished equipment. These spares shall include, but shall not be limited to, consumable spares that are required to be exchanged during scheduled maintenance periods.
- B. Spare parts shall be provided for each type and size of unit furnished. At a minimum, the following shall be provided:
1. Provide the minimum spare parts recommended by the manufacturer.
- C. Any manufacturer specific special tool, not normally found in an electrician's toolbox, required to remove and install recommended or furnished spare parts shall be furnished.
- D. Spare parts shall be properly marked and packaged for long term storage. Printed circuit boards shall be provided in separate anti-static containers.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. [Basis-of-Design Product: Subject to compliance with requirements, provide Square D Power-Dry II™ VPI Substation Transformers.]
- B. Acceptable Products: MV XFMRs specified herein shall be the product of a single manufacturer. Products and manufacturers specified are to establish a standard of quality for design, function, materials, and appearance. Products shall be modified as necessary by the manufacturer for compliance with requirements. Provide the following specified product and manufacturer without exception, unless approved as a substitute by addendum to the Contract Documents prior to the bid date:
1. Square D Power-Dry II™ Substation Transformers by Schneider Electric
  2. [2nd manufacturer and model]
  3. [3rd manufacturer and model]

### 2.2 MV DRY TYPE VPI SUBSTATION TRANSFORMERS

- A. The transformer(s) shall be UL listed and labeled substation type per UL1561 with [side-mounted][top-mounted] primary and [side-mounted][top-mounted] secondary terminations. Transformers shall comply with 10 CFR 431 as registered on US Department of Energy's Compliance Certification Database per 10 CFR 429

- B. High voltage terminations shall be designed for close coupling to [a metal enclosed air load break switch section] [a switchgear section] [an air terminal chamber to be provided with the transformer]. Low voltage terminations shall be designed for close coupling to [a switchgear section] [a switchboard section] [an air terminal chamber to be provided with the transformers].
- C. Orientation shall be high voltage on the [left] [right] when facing the transformer front.
- D. The transformer(s) shall be rated [ kVA AA] [ / kVA AA/FFA] [ / kVA AA/FA]. High voltage: [ ] [delta] [wye] Low voltage [ ] [wye] [delta], [3-wire] [4-wire], 60 Hz with two 2-1/2% full capacity above normal and two 2-1/2% full capacity below normal primary taps. Impedance shall be [ %] [manufacturer's standard impedance],  $\pm 7-1/2\%$ . All transformers shall have an average temperature rise of [150° C] [115° C] [80° C] [80°/150° C] above a 40° C maximum, 30° C average ambient.
- E. Fan cooling equipment shall include 3-phase electronic winding temperature monitor controlled automatically by a Type K thermocouples placed in the low voltage air duct. The temperature monitor shall contain yellow and red indicating lights. The yellow lamp shall indicate fan power, while the red lamp signals that alarm and trip contacts have been activated. An adjustable analog milliampere output shall be required for remote indication. Alarm contacts shall be provided for fans, alarm, and trip function. An audible alarm shall sound when the highest phase temperature exceeds a preset point. The fans shall be able to operate in either manual or automatic mode. Minimum six fans shall be provided. Fan controller must be type Model 98A, POWERLOGIC ® system compatible. Forced air cooling system shall include: fans, control wiring, controller with test switch, current limiting fused in the power supply to the controller, indications lights, alarm silencing relay, auto/manual switch, and necessary accessories to properly control the system.
- F. The basic impulse levels (BIL) shall be a minimum of [60 kV for the 15 kV class] [optional 95 kV BIL] [10 kV for the 1.2 kV class].
- G. The coils shall be wound with [aluminum] [copper] conductors.
- H. All insulating materials are to be in accordance with IEEE Standard C57.12.01 for 220° C UL insulation system.
- I. All cores to be constructed of high grade, grain-oriented, non-aging silicon steel with high magnetic permeability, and low hysteresis and eddy current losses. Magnetic flux densities are to be kept well below the saturation point. Core laminations shall be step-lap miter cut at the core corners to reduce hot spots, core loss, excitation current, and sound level. The core shall be visibly grounded to the ground bus or ground pad by means of a flexible grounding conductor.
- J. The coils and all clamping structure shall be assembled on the core, and then dried at atmospheric pressure in an oven through which hot air is continuously circulated. The totally assembled core and coil assembly shall be vacuum pressure impregnated in polyester varnish. The total VPI process shall apply a one (1) cycle polyester protective shield of varnish to the core and coils. The varnish shall be cured on the core and coil assembly following an established temperature vs. time baking cycle in a hot air circulating oven. The VPI process shall effectively impregnate the entire core and coil assembly, which results in a unit, which is virtually impermeable to moisture, dust, salt air and other industrial contaminants.
- K. The VPE Process shall apply in multiple processes a Silicone Varnish. The VPE process provides a higher degree of protection from Moisture.
- L. The transformer enclosures shall be fabricated of heavy gauge, sheet steel construction and ventilated [indoor][outdoor] as required by plans. Enclosures are to be provided with lifting provisions on the base structure and shall have jacking pads designed to be flush with the enclosure. The base is to be constructed of steel members to permit skidding or rolling in any direction. Rubber vibration isolation pads shall be installed by the manufacturer between the core and coil and the enclosure.
- M. The paint color shall be [ANSI 49] [ANSI 61].

- N. Transformer sound levels shall be warranted by the manufacturer not to exceed the values specified in IEEE Std. C57.12.01.
- O. Metal-oxide, gapless-type distribution class lightning arresters shall [not] be installed by the manufacturer on the high voltage side of the transformer to provide additional protection against high voltage lightning or switching surges. **Resistor-Capacitor (RC) Snubber shall be included.**

Regarding switching surges, use of cast coil Transient Voltage Resistant Transformers (TVRT), not VPI, is recommended in case additional protection is required. If MV Dry Type VPI Transformer requires installation of the above, consider the RC Snubber.

### 2.3 TESTING

- A. Testing shall be done in accordance with IEEE C57.12.91 and shall include, as the minimum, the following tests:
  - 1. Ratio
  - 2. Polarity
  - 3. Phase Rotation
  - 4. No-Load Loss
  - 5. Excitation Current
  - 6. Impedance Voltage
  - 7. Load Loss
  - 8. Applied Potential
  - 9. Induced Potential
  - 10. QC Impulse Test
  - 11. Temperature Test[. Typical test data from previous testing may be used.]
  - 12. Sound Test[. Typical test data from previous testing may be used.]
  - 13. **Partial Discharge testing**

### 2.4 MARKINGS AND LABELING

- A. All identification and warning labels and nameplates exterior to the MV Transformer shall be resistant to weather, UV, and their intended installation environment.
- B. Each MV Transformer shall be provided with an engraved nameplate identifying the project specific equipment tag and service description.
- C. Warning labels and nameplates shall be present at access locations to advise personnel of possible hazards.

### 2.5 ELECTRICAL POWER MANAGEMENT SYSTEM [- NOT USED]

EPMS systems, such as Schneider Electric EcoStruxure™ Power, provide many benefits throughout the lifecycle of an electrical distribution system through the connection, monitoring and analysis of the system and its connected equipment. Equipment connectivity and application support are critical to achieving the benefits of a safe, reliable, efficient and compliant system architecture.

- A. The equipment specified herein shall provide the necessary communications connectivity and functionality required to support the functionality of a remote monitoring system or Electrical Power Management System (EPMS). This shall include, but not be limited, to the following:
  - 1. Communications connectivity using the specified Modbus serial or Modbus TCP/IP Ethernet network protocols of the EPMS and related EPMS connected equipment necessary to provide functionality. Equipment may be connected through a communications gateway as shown or specified; otherwise Ethernet and protocol connectivity shall be provided within the equipment.
  - 2. **Compliance with Cyber security requirements.**



3. Remote EPMS application functionality for equipment configuration[ and operational control]; electrical power monitoring; power quality monitoring, compliance and correction; and alarm monitoring with event log.
4. Refer to the Electrical Power Management System specification section for additional requirements.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. In addition to the requirements specified herein, execution shall be in accordance with the requirements of specifications Section [26 00 10][16010], Section [26 08 00][16080] and Drawings.
- B. Examine equipment exterior and interior prior to installation. Report any damage and do not install any equipment that is structurally, moisture, or mildew damaged.
- C. Verification of Conditions: Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the Owner and the Engineer, of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.
- D. Pre-Installation Conference: Prior to commencing the installation, an onsite pre-installation conference shall review the material selections, installation procedures, and coordination with other trades. Attendees shall include, but shall not be limited to, the Contractor, the Installer, manufacturer's representatives, and any trade that requires coordination with the work. Date and time of the pre-installation conference shall be acceptable to the Owner and the Engineer
- E. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.
- F. Install equipment in accordance with reviewed product data, final shop drawings, manufacturer's written instructions and recommendations, and as indicated on the Drawings.
- G. Provide final protection and maintain conditions in a manner acceptable to the manufacturer that shall help ensure that the equipment is without damage at time of Substantial Completion.

### 3.2 FACTORY ACCEPTANCE TESTING [- NOT USED]

### 3.3 FIELD QUALITY CONTROL [- NOT USED]

Schneider Electric extends the warranty of most equipment by 12 months at no additional cost when their service technicians perform functional testing, commissioning and first parameter adjusting of the installed equipment.

- A. Functional testing, commissioning, and first parameter adjusting shall be carried out by a factory-trained manufacturer's field service representative. This manufacturer's field service technician shall provide all material, equipment, labor and technical supervision to perform inspection, testing and adjustments to ensure equipment is installed, adjusted, and tested in accordance with the manufacturer's recommendations and is ready for operation. The manufacturer's field service technician shall replace damaged or malfunctioning equipment and report to the Engineer any discrepancies or issues with the installation.
- B. The manufacturer's representative shall, upon satisfactory completion of inspection and testing, attach a label to all serviced devices indicating the date serviced and testing company responsible.

### 3.4 FIELD TESTING AND COMMISSIONING [- NOT USED]

- A. Operational Readiness Testing

1. The Contractor shall inspect and test furnished equipment and associated systems for conformance to the contract documents, including equipment manufacturer's recommendations, and readiness for operation. The test shall include the following as a minimum:
  - a. Visually inspect for physical damage and proper installation
  - b. Perform tests in accordance with manufacturer's instructions
  - c. Perform tests to ensure compliance with Contract Documents
  - d. Perform tests that equipment is ready for operation
  - e. Touch-up paint all chips and scratches with manufacturer-supplied paint and transfer remaining paint to Owner
2. Contractor shall submit an operational readiness test report documenting all test results, including all assumptions, conditions, allowances and corrections made during the test. **The report shall provide a listing of all modifications and adjustments made onsite to include any settings / parameters not identified as factory defaults within the equipment's O&M documentation.** The test report shall include a signed statement from the Contractor, installer(s) and the factory-trained manufacturer's representative(s) certifying that the furnished equipment and associated system have been installed, configured, and tested in accordance with the manufacturer's recommendations, completely conforms to the requirements of the Contract Documents and is ready for operation.

#### **B. Functional Demonstration Testing**

1. **Prior to scheduling functional demonstration testing the Contractor shall submit a signed statement from the Contractor, installer(s) and the factory-trained manufacturer's representative(s) certifying that the furnished equipment and associated system have been installed, configured, and tested in accordance with the manufacturer's recommendations, completely conforms to the requirements of the Contract Documents and is ready for operation.**
2. **The Contractor shall completely demonstrate the functionality and performance of the equipment and associated systems in the presence of Owner and Engineer, observing and documenting complete compliance with the Contract Documents.**
3. **The Contractor shall submit a written report documenting successful completion of functional demonstrating testing including all assumptions, conditions, allowances and corrections made during the test.**

### **3.5 TRAINING [- NOT USED]**

- A. O&M Training: Onsite training specific to the equipment furnished shall be provided to the Owner's staff by a factory trained manufacturer's representative. Training duration shall be sufficiently adequate to cover the operation and maintenance of the equipment and shall consist of not less than **[1][2 repeated]** session(s) with **[2]** hours of onsite classroom and hands-on instruction for a minimum of **[4]** attendees per session.
  1. **The instructor shall provide sufficient time and detail in each session to cover the following as a minimum:**
    - a. **Theory of operation**
    - b. **Major components of equipment**
    - c. **Operation of equipment**
    - d. **Configurations of equipment**
    - e. **Maintenance, troubleshooting and repair**
    - f. **Replacement of component level parts**
  2. **[The submitted O&M manuals shall be used for training.][Manuals and documentation shall be provided to each participant for training.]**



## END OF SECTION [26 12 16.13][16270.16.3]

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