SECTION 26 12 19
PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, installation, connection, and testing of the pad-mounted, liquid-filled, medium-voltage transformers, indicated as transformers in this section.

1.2 RELATED WORK

A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.

B. Section 26 05 13, MEDIUM-VOLTAGE CABLES: Medium-voltage cables.

C. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Low-voltage conductors.

D. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.

E. Section 26 05 73, OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY: Short circuit, coordination and arc-flash study, and requirements for a coordinated electrical system.

F. Section 26 11 16, SECONDARY UNIT SUBSTATIONS.

1.3 QUALITY ASSURANCE

A. Quality Assurance shall be in accordance with Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 FACTORY TESTS

A. Factory Tests shall be required.

B. Factory Tests shall be in accordance with Paragraph, MANUFACTURED PRODUCTS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirement:

1. Transformers shall be thoroughly tested at the factory to ensure that there are no electrical or mechanical defects. Tests shall be conducted as per IEEE Standards. Factory tests shall be certified. The following tests shall be performed:
   a. Perform insulation-resistance tests, winding-to-winding and each winding-to-ground.
   b. Perform turns-ratio tests at all tap positions.

1.5 SUBMITTALS

A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:

1. Shop Drawings:
   a. Submit sufficient information to demonstrate compliance with drawings and specifications.
   b. Include electrical ratings, nameplate data, impedance, outline drawing with dimensions and front, top, and side views, weight, mounting details, decibel rating, termination information, temperature rise, no-load and full-load losses, regulation, overcurrent protection, connection diagrams, and accessories.
   c. Complete nameplate data, including manufacturer’s name and catalog number.
2. Manuals:
   a. When submitting the shop drawings, submit companion copies of complete maintenance and operating manuals, including technical data sheets, wiring diagrams, and information for ordering replacement parts.
      1) Identify terminals on wiring diagrams to facilitate installation, maintenance, and operation.
      2) Indicate on wiring diagrams the internal wiring for each piece of equipment and interconnections between the pieces of equipment.
      3) Approvals will be based on complete submissions of manuals, together with shop drawings.
   b. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.
      1) Update the manual to include any information necessitated by shop drawing approval.
      2) Show all terminal identification.
      3) Include information for testing, repair, troubleshooting, assembly, disassembly, and recommended maintenance intervals.
      4) Provide a replacement parts list with current prices. Include a list of recommended spare parts, tools, and instruments for testing and maintenance purposes.

B. Certifications:

1. One day prior to the final inspection, submit the following certifications.
   a. Certification by the manufacturer that the transformers conform to the requirements of the drawings and specifications.
   b. Certification by the Contractor that the transformers have been properly installed, connected, and tested.

1.6 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.

B. American Society for Testing and Materials (ASTM):

D3487-16.....Standard Specification for Mineral Insulating Oil Used in Electrical Apparatus

C. Institute of Electrical and Electronic Engineers (IEEE):

48-09.....Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5kV Through 765kV or Extruded Insulation Rated 2.5kV Through 500kV

386-16.....Separable Insulated Connector Systems for Power Distribution Systems Above 600 V

592-07.....Exposed Semiconducting Shields on High-Voltage Cable Joints and Separable Connectors

C2-17.....National Electrical Safety Code

C37.47-11.....Specification for High Voltage (>1000V) Distribution Class Current-Limiting Fuses and Fuse Disconnecting Switches

C57.12.00-15.....Liquid-Immersed Distribution, Power and Regulating Transformers

C57.12.10-13.....Liquid-Immersed Power Transformers

C57.12.25-90.....Pad-Mounted, Compartmental-Type, Self-Cooled, Single-Phase Distribution-Transformers with Separable Insulated High Voltage Connectors; High Voltage, 34500 Grd Y/19920 Volts and Below; Low-Voltage 240/120 Volts; 167 kVA and Smaller Requirements

C57.12.28-14.....Pad-Mounted Equipment - Enclosure Integrity

C57.12.29-14.....Pad-Mounted Equipment – Enclosure Integrity for Coastal Environments

C57.12.34-15.....Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers, 5 MVA and Smaller; High Voltage, 34.5 kV Nominal System Voltage and Below; Low Voltage, 15kV Nominal System Voltage and Below

C57.12.90-15.....Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers

C62.11-12.....Metal-Oxide Surge Arresters for AC Power Circuits

D. International Code Council (ICC):

IBC-15.....International Building Code

E. National Electrical Manufacturers Association (NEMA):

TR 1-13.....Transformers, Regulators, and Reactors

F. National Fire Protection Association (NFPA):

70-17.....National Electrical Code (NEC)

G. Underwriters Laboratories Inc. (UL):

467-13.....Grounding and Bonding Equipment

H. United States Department of Energy (DOE):

10 CFR Part 431.....Energy Efficiency Program for Certain Commercial and Industrial Equipment

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Transformers shall be in accordance with ASTM, IEEE, NFPA, UL, as shown on the drawings, and as specified herein. Each transformer shall be assembled as an integral unit by a single manufacturer.

B. Transformers shall be complete, continuous duty, integral assembly, grounded, tamper-resistant, and with liquid-immersed windings.

C. Ratings shall not be less than shown on the drawings.

D. Completely fabricate transformers at the factory so that only the external cable connections are required at the project site.

E. All surfaces of the transformer that will be in contact with the concrete pad shall be treated with corrosion-resistant compounds and epoxy resin or a rubberized sealing compound.

2.2 COMPARTMENTS

A. Construction:

1. The medium- and low-voltage compartments shall be separated with a steel barrier that extends the full height and depth of the compartments.
2. The compartments shall be constructed of sheet steel (gauge to meet ANSI requirements) with bracing and with reinforcing gussets using jig welds to assure rectangular rigidity.
3. All bolts, nuts, and washers shall be zinc-plated steel.
4. Sufficient space shall be provided for equipment, cabling, and terminations within the compartments.
5. Affix transformer nameplate permanently within the low-voltage compartment. Voltage and kVA rating, connection configuration, impedance, date of manufacture, and serial number shall be shown on the nameplate.

B. Doors:

1. Provide a separate door for each compartment with provisions for a single padlock to secure all doors. Provide each compartment door with open-position doorstops and corrosion-resistant tamperproof hinges welded in place. The medium-voltage compartment door shall be mechanically prevented from opening unless the low-voltage compartment door is open.
2. The secondary compartment door shall have a one-piece steel handle and incorporate three-point locking mechanisms.

2.3 BIL RATING

A. 5 kV class equipment shall have a minimum 60 kV BIL rating.

2.4 TRANSFORMER FUSE ASSEMBLY

A. The contractor shall field locate and verify transformer fuse assembly types.

2.5 PRIMARY CONNECTIONS

A. The contractor shall field locate and verify primary connection types.

2.6 MEDIUM-VOLTAGE SWITCH

A. The transformer primary disconnect switch shall be an oil-immersed, internal, gang-operated, load-interrupter type, rated at ampacity and system voltage as shown on the drawings, with a minimum momentary withstand rating of not less than the calculated available fault current shown on the drawings.

B. For radial feeds, switch shall be a two-position, on-off, manual switch located in the medium-voltage compartment and hot-stick-operated.

2.7 MEDIUM-VOLTAGE TERMINATIONS

A. The contractor shall field locate and verify all medium-voltage termination types.

B. Ground metallic cable shield with a cable shield grounding adapter, consisting of a solderless connector enclosed in watertight rubber housing covering the entire assembly, bleeder wire, and ground braid.

2.8 LOW-VOLTAGE EQUIPMENT

A. Mount the transformer secondary main molded case circuit breaker, low-voltage bushings, and hot stick in the low-voltage compartment.

B. The low-voltage leads shall be brought out of the tank by epoxy pressure tight bushings, and shall be standard arrangement.

C. Tin-plate the low-voltage neutral terminal and isolate from the transformer tank. Provide a removable ground strap sized in accordance with the NEC and connect between the secondary neutral and ground pad.

D. Mount the main breaker off of the transformer tank to allow sufficient ventilation and ensure that the heat from the transformer tank will not be transmitted through conduction. Circuit breakers shall be of the ambient compensating-type, with interrupting ratings for the available fault current.

2.9 TRANSFORMERS

A. Transformer ratings shall be as shown on drawings. kVA ratings shown on the drawings are for continuous duty without the use of cooling fans.

B. Temperature rises shall not exceed the NEMA TR 1 of 65˚ C (149˚ F) by resistance.

C. Transformer insulating material shall be mineral oil in accordance with ASTM D 3487.

D. Transformer impedance shall be not less than 4-1/2% for sizes 150 kVA and larger. Impedance shall be as shown on the drawings.

E. Sound levels shall conform to NEMA TR 1 standards.

F. Primary and Secondary Windings for Three-Phase Transformers:

1. Primary windings shall be delta-connected.
2. Secondary windings shall be wye-connected, except where otherwise indicated on the drawings. Provide isolated neutral bushings for secondary wye-connected transformers.
3. Secondary leads shall be brought out through pressure-tight epoxy bushings.

G. Primary windings shall have four 2-1/2% full-capacity voltage taps; two taps above and two taps below rated voltage.

H. Core and Coil Assemblies:
   1. Cores shall be grain-oriented, non-aging, silicon steel to minimize losses.
   2. Core and coil assemblies shall be rigidly braced to withstand the stresses caused by rough handling during shipment, and stresses caused by any possible short-circuit currents.
   3. Coils shall be continuous-winding type without splices except for taps. Material shall be copper.
   4. Coil and core losses shall be optimum for efficient operation.
   5. Primary, secondary, and tap connections shall be brazed or pressure type.
   6. Provide end fillers or tie-downs for coil windings.
I. The transformer tank, cover, and radiator gauge thickness shall not be less than that required by ANSI.
J. Accessories:
   1. Provide standard NEMA features, accessories, and the following:
      a. No-load tap changer. Provide warning sign.
      b. Lifting, pulling, and jacking facilities.
      c. Globe-type valve for oil filtering and draining, including sampling device.
      d. Pressure relief valve.
      e. Liquid level gauge and filling plug.
      f. A grounding pad in the medium- and low-voltage compartments.
      g. A diagrammatic nameplate.
      h. Dial-type liquid thermometer with a maximum reading pointer and an external reset.
      i. Hot stick. Securely fasten hot stick within low-voltage compartment.
   2. The accessories shall be made accessible within the compartments without disassembling trims and covers.
K. Transformers shall meet the energy conservation standards for transformer per the United States Department of Energy 10 CFR Part 431.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install transformer, as shown on the drawings, in accordance with the NEC, and as recommended by the manufacturer.
B. Anchor transformers with zinc-platted bolts and as shown on drawings.
C. Mount transformer on existing concrete slab.

D. Grounding:

1. Ground each transformer in accordance with the requirements of the NEC. Install ground rods per the requirements of Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS, to maintain a maximum resistance of 5 ohms to ground.
2. Connect the ground rod to the ground pads in the medium- and low-voltage compartments.
3. Install and connect the cable shield grounding adapter per the manufacturer’s instructions. Connect the bleeder wire of the cable shield grounding adapter to the loadbreak or deadbreak elbow grounding point with minimum No. 14 AWG wire, and connect the ground braid to the grounding system with minimum No. 6 AWG bare copper wire. Use soldered or mechanical grounding connectors listed for this purpose.

3.2 ACCEPTANCE CHECKS AND TESTS

A. Perform manufacturer’s required field tests in accordance with the manufacturer's recommendations. In addition, include the following:

1. Visual Inspection and Tests:
   a. Compare equipment nameplate data with specifications and approved shop drawings.
   b. Inspect physical and mechanical condition. Check for damaged or cracked bushings and liquid leaks.
   c. Verify that control and alarm settings on temperature indicators are as specified.
   d. Inspect all field-installed bolted electrical connections, using the calibrated torque-wrench method to verify tightness of accessible bolted electrical connections, and perform thermographic survey after energization under load.
   e. Vacuum-clean transformer interior. Clean transformer enclosure exterior.
   f. Verify correct liquid level in transformer tank.
   g. Verify correct equipment grounding per the requirements of Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.
   h. Verify the presence and connection of transformer surge arresters, if provided.
   i. Verify that the tap-changer is set at rated system voltage.

3.3 FOLLOW-UP VERIFICATION

A. Upon completion of acceptance checks, settings, and tests, the Contractor shall demonstrate that the transformers are in good operating condition and properly performing the intended function.

3.4 SPARE PARTS

A. Deliver the following spare parts for the project to the COR two weeks prior to final inspection:

1. Six insulated protective caps.
2. One spare set of medium-voltage fuses for each size and type of fuse used in the project.
3. One spare set of three cable fault indicators.

3.5 INSTRUCTION

A. The Contractor shall instruct maintenance personnel, for not less than one 2-hour period, on the maintenance and operation of the equipment on the date requested by the COR.

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