

SECTION 16330 - MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Distribution and power transformers with medium-voltage primaries, 600 volts through 69 kV. Types of transformers specified in this Section include:
1. Dry type secondary substation.
 2. Pad-mounted type.
 3. Liquid filled secondary substation type.
 4. Pole-mounted transformers.
 5. Cast coil dry type.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01300, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
1. Summary Sheet: Submit sheet that lists in tabular or matrix style the manufacturer, model and applicable part number for each piece of equipment. List shall include ratings, selected options, and recommended maintenance schedule.
 2. Shop Drawings for each transformer, including dimensional plans, sections, and elevations showing minimum clearances, installed devices, and materials lists.
 3. Product data for each product specified.
 4. Wiring diagrams from manufacturer differentiating between manufacturer-installed and field-installed wiring.
- B. Product Test Reports: Certified copies of manufacturer's design and factory tests as follows.
1. Turns ratio.
 2. Polarity.
 3. Resistance.
 4. Impedance.
 5. Load losses.
 6. No load losses.
 7. Dielectric oil type and characteristics (if applicable)
 8. Exciting current.
 9. Regulation at 80 percent power factor.
 10. Impulse test (transformers larger than 750 kVA only).
 11. Corona test (transformers larger than 1500 kVA only).
- C. Power company approval for all transformers interfacing with power company connections. Submit one copy of product data signed by power company.

1.03 QUALITY ASSURANCE

- A. IEEE C57.12.00 - Standard General Requirements for Liquid Immersed Distribution, Power, and Regulating Transformers (ANSI).

- B. IEEE C57.12.01 - Standard General Requirements for Dry-Type Distribution and Power Transformers.
- C. ANSI C57.12.22 - Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers with High Voltage Bushings; 2,500 kVA and Smaller: High Voltage, 34,500 GrdY/19,920 Volts and Below; Low Voltage, 480 Volts and Below Requirement.
- D. ANSI C57.12.26 - Standard for Transformers—Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers for use with Separable Insulated High Voltage Connectors: High Voltage, 34,500 GrdY/19,920 Volts and Below; 2,500 kVA and Smaller.
- E. ANSI C57.12.28 - Switchgear and Transformers, Pad-Mounted Equipment Enclosure Integrity.
- F. ANSI C57.12.50 - Requirements for Ventilated Dry-Type Distribution Transformers, 1–500 kVA Single-Phase and 15–500 kVA Three-Phase, with High Voltage 601–34,500 Volts, Low Voltage 120–600 Volts.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. ASEA Brown Boveri.
 - 2. Cooper Power Systems.
 - 3. General Electric Co.
 - 4. Hevi-Duty Electric.
 - 5. ABB National.
 - 6. Niagara Transformer Corp.
 - 7. Square D Co.

2.02 TRANSFORMERS, GENERAL

- A. Medium-Voltage Transformers: Factory assembled and tested, general-purpose, air-cooled, dry type or liquid filled as indicated on the drawings, and having characteristics and capacities as indicated in this specification and on the drawings.
- B. Windings: 2-winding type, designed for operation with high-voltage windings connected to the system, indicated on Drawings. Provide 4- or 5-legged cores for all wye-wye connected transformers.
- C. Finishes: Thoroughly clean interior and exterior prior to coating enclosure and equipment, including bolted joints, with rust inhibiting primer coat. Provide 2 finish coats of manufacturer's standard color finish.
- D. Forced Air-Cooled Transformers shall comply with the following requirements:
 - 1. Forced air cooling equipment shall consist of cooling fans, temperature sensing devices, and controls complete with housing, mounting devices, conduit, and wiring. Operation of cooling fans shall be automatically and sequentially controlled by temperature sensing devices. A manually operable switch shall be connected in parallel with automatic control contacts.

- Controls shall be enclosed in a cabinet located on the side of transformer 60 inches or less above base.
2. Cooling Fans: Propeller type, with aluminum blades and TEFC motors, direct drive. Motor circuits shall be individually fused or thermally protected. Fans shall have OSHA fan guards.
 3. Fan Control: Thermally operated winding temperature control devices.
- E. Provisions for Future Forced Air Cooling: Include the following provisions where future forced air cooling is required:
1. Top-Liquid Temperature Sensing on Liquid-Filled Transformers: Thermally operated control device with thermal element mounted in a well, and provisions for mounting control cabinet, conduit, and fans.
 2. Winding Temperature Sensing on Dry-Type Transformers: Insulated wells in all 3 coils for future installation of sensors directly in air ducts of each coil to monitor coil temperature, and provisions for future mounting of cooling fans, control cabinet, and conduit.
- F. Windings: Copper or aluminum.
- G. Provide fully insulated neutral terminal for wye-connected windings.
- H. Equip each transformer with a permanent stainless steel nameplate which includes serial number, shop order number, transformer class, number of phases, frequency, kVA rating, primary and secondary voltage, tap voltages, connection and vector diagrams, manufacturer's name, percent impedance, temperature rise, weight of core, coils and fittings, weight and volume of fill liquid (if applicable), and BIL of high and low voltage windings.

2.03 DRY-TYPE TRANSFORMERS

- A. Comply with NEMA Standard ST 20, "Dry-Type Transformers for General Applications" and ANSI/IEEE Standard C.57.12.01, "General Requirements for Dry-Type Distribution and Power Transformers." Transformers shall have the following features and ratings:
1. Enclosure: Indoor, ventilated.
 2. Enclosure: Outdoor, ventilated.
 3. Enclosure: Totally enclosed, nonventilated.
 4. Insulation Class: 220 degrees C.
 5. Insulation Temperature Rise: 150 degrees C maximum rise above 40 degrees C.
 6. Basic Impulse Insulation Level: 60 kV for 5.0 kV class.
 7. Basic Impulse Insulation Level: 75 kV for 8.7 kV class.
 8. Basic Impulse Insulation Level: 95 kV for 15.0 kV class.
- B. Full Capacity Voltage Taps: Four nominal 2.5 percent taps, 2 above and 2 below rated high voltage.
- C. Impedance: 5.75 percent unless otherwise indicated.
- D. Surge Arresters: Low flash-over type, factory installed and connected to high-voltage terminals, complying with NEMA Standard LA 1. Provide metal-oxide type with ethylene propylene housing.

2.04 CAST COIL DRY-TYPE TRANSFORMERS

- A. Comply with NEMA Standard ST 20, "Dry-Type Transformers for General Applications," and ANSI/IEEE Standard C.57.12.01, "General Requirements for Dry-Type Distribution and Power Transformers." Transformers shall have the following features and ratings:
 - 1. Enclosure: Outdoor, ventilated, weather resistant.
 - 2. Insulation Class: 155 degrees C.
 - a. Core shall be constructed of miter-cut, high-grade, grain-oriented, non-aging silicon steel. Core leg cross section shall be of cruciform shape to conform to the inside geometry of a round coil. Core laminations shall be free of burrs and stacked without gaps. The core framing structure shall be rigid construction and so designed to provide full clamping pressure upon the core and to provide points for applying blocking and jacking to support the coils.

- B. Construction: Both HV and LV windings shall be of copper or aluminum conductors. Primary and secondary windings shall be of the same material. HV and LV windings shall each be separately cast as one rigid tubular coil, and arranged coaxially. Each cast coil shall be fully reinforced with glass cloth, and cast under vacuum to ensure complete void-free resin impregnation throughout entire insulation system. Coils shall be supported by cast epoxy bottom supports and space blocks and spring-loaded top blocks to absorb thermal expansion and contraction of the coils. There shall be no rigid mechanical connection between HV and LV coils.
 - 1. The windings must not absorb moisture, and shall be suitable for both storage and operation in adverse environments, including prolonged storage in 100 percent humidity at temperatures from -40 to +40 degrees C and shall be capable of immediately being switched on after such storage without pre-drying.
 - 2. Core and coil shall be supported on resilient mounting that shall effectively dampen vibration to the transformer enclosure.

- C. Bus and Termination: Terminations shall be of the manufacturer's standard and shall incorporate a functional design which provides appropriate current density and bolting surface capability. Aluminum conductor-to-copper-bus transition shall be by bolt-less connections using DuPont Detaclad (or equal) explosively bonded aluminum-copper plates, to which the aluminum conductor shall be welded, and the copper silver soldered.
 - 1. Outdoor, weather-resistant, ventilated enclosure shall be provided. The base shall be of welded structural steel (11 gauge, minimum) to permit jacking, rolling, and skidding in any direction, and shall have 2 ground pads. Removable panels shall be provided for access to the tap connections, disassembly for moving and installation in limited space, and for inspection and maintenance. Front and rear panels shall be provided with top and bottom weather-resistant ventilation grills to provide adequate cooling and to prevent rain and snow from entering the enclosure.

- D. Insulation Temperature Rise: 80 degrees C maximum rise above 40 degrees C.

- E. Basic Impulse Insulation Level: 75 kV for 5.0 kV class.

- F. Full Capacity Voltage Taps: Four nominal 2.5 percent taps, 2 above and 2 below rated high voltage.

- G. Impedance: 5.75 percent unless otherwise indicated.

- H. Surge Arresters: Low flash-over type, factory installed and connected to high-voltage terminals, complying with NEMA Standard LA 1. Provide metal-oxide type with ethylene propylene housing.

2.05 PAD MOUNTED TRANSFORMERS

- A. Comply with ANSI/IEEE C57.12.26 and with the following features and ratings:
1. Insulating Liquid: Mineral oil, conforming to ASTM D 3487, "Specifications for Mineral Insulating Oil Used in Electrical Apparatus," Type II, tested in accordance with ASTM D 117, "Guide to Test Methods and Specifications for Electrical Insulating Oils of Petroleum Origin."
 - a. Insulation Temperature Rise: 65 degrees C.
 - b. Basic Impulse Insulation Level: 60 kV for 5.0 kV class.
 - c. Basic Impulse Insulation Level: 75 kV for 8.7 kV class.
 - d. Basic Impulse Insulation Level: 95 kV for 15.0 kV class.
 2. Full-Capacity Voltage Taps: Four nominal 2.5 percent taps, 2 above and 2 below rated high voltage, with externally operable tap changer for de-energized use, with position indicator.
 3. High-Voltage Terminals: Arranged for radial feed, with 3-phase, 2-position, gang-operated load-break switch, oil immersed in transformer tank, with hook-stick-operated handle in the primary compartment.
 4. High-Voltage Terminals: Arranged for loop feed with 3-phase, 4-position, gang-operated load-break switch, oil immersed in transformer tank, with hook-stick-operated handle in the primary compartment.
 5. Primary Fuses: Current limiting type in dry-fuse holder wells, mechanically interlocked with oil switch to prevent disconnect under load.
 6. Surge Arresters: Comply with NEMA Standard LA 1, Distribution Class, supported from tank wall within high-voltage compartment, one for each primary phase.
 - a. Provide Ohio Brass Co. metal-oxide type surge-arresters with ethylene propylene housing. Provide a barrier around the arresters which complies with Power Company's requirements.
 7. Separable Insulated Connectors: Insulated bushing, parking stand, feed-through bushing, and dead-front elbow-type lightning arrester for each high-voltage terminal. Provide 3 portable insulated bushings for parking-energized load-break connectors on parking stands.
 8. Secondary Feeder Breaker: Where shown molded case type, mounted in secondary compartment; frame, trip, and interrupting ratings as indicated; complying with UL Standard 489, "Molded Case Circuit Breakers and Circuit Breaker Enclosures."
 9. Impedance: 5.75 percent unless otherwise indicated.
 10. Accessories: Provide the following accessories:
 - a. One-inch drain valve with sampling device.
 - b. Dial-type thermometer.
 - c. Liquid level gauge.
 - d. Pressure-vacuum gauge.
 - e. Pressure relief device, self-sealing with indicator.
 - f. Mounting provision for low-voltage current transformers and potential transformers.
 - g. Busway opening in low-voltage compartment.
 - h. Alarm contacts for above gauges.
 - i. Key interlock on HV compartment door.

2.06 LIQUID-FILLED SUBSTATION TRANSFORMERS

- A. Conform to ANSI/IEEE Standard C57.12.00, "General Requirements For Liquid-Immersed, Distribution, Power, and Regulating Transformers," and C57.12.13, "Conformance Requirements for Liquid Filled Transformers Used in Unit Installation Including Unit Substations," and the following requirements:

1. Insulating Liquid: Mineral oil conforming to ASTM D 3487, "Specifications for Mineral Insulating Oil Used in Electrical Apparatus," Type II, tested in accordance with ASTM D 117, "Guide to Test Methods and Specifications for Electrical Insulating Oils of Petroleum Origin."
 2. Insulating Liquid: Silicone insulating liquid, UL listed as a "Less Flammable" transformer insulating liquid. Liquid shall have the ability to extinguish small arcing and shall have a minimum fire point of 330 degrees C, a maximum convective heat release of 350 Btu per cubic foot when tested in accordance with ASTM standards, and a minimum dielectric strength of 35 kV.
- B. Insulation Temperature Rise: 65 degrees C.
1. Basic Impulse Insulation Level: 60 kV for 2.5 kV class.
 2. Basic Impulse Insulation Level: 75 kV for 5.0 kV class.
 3. Basic Impulse Insulation Level: 95 kV for 8.7 kV class.
 4. Basic Impulse Insulation Level: 110 kV for 15.0 kV class.
- C. Full-Capacity Voltage Taps: Four nominal 2.5 percent taps, 2 above and 2 below rated high-voltage, with externally operable tap changer for de-energized use and with position indicator and padlock hasp.
- D. Cooling System: ANSI/IEEE Standard C57.12.00, Class OA.
- E. Cooling System: ANSI/IEEE Standard C57.12.00, Class OA/FA.
- F. Cooling System: Equipped for future forced-air cooling; Class OA/FFA.
- G. Impedance: 5.75 percent unless otherwise indicated.
- H. Accessories: The following accessory items are required:
1. Drain Valve: 1-inch drain valve with sampling device.
 2. Dial-type thermometer.
 3. Magnetic liquid level gauge.
 4. Pressure-vacuum gauge.
 5. Pressure relief device: Self-sealing, with indicator.
 6. Upper filter pressure connection.
 7. Alarm contacts for above gauges.
 8. Grounding and bonding components complying with UL Standard 467, "Grounding and Bonding Equipment."
 9. Vacuum-Pressure Bleeder: Outdoor units only.

2.07 POLE-MOUNTED TRANSFORMERS

- A. Comply with applicable NEMA, ANSI, and REA standards.
- B. Insulating Liquid: Mineral oil, conforming to ASTM D 3487, "Specifications for Mineral Insulating Oil Used in Electrical Apparatus."
- C. Insulating Temperature Rise: 65 degrees C.
1. Basic Impulse Insulation Level: 60 kV for 2.5 kV class.
 2. Basic Impulse Insulation Level: 75 kV for 5.0 kV class.
 3. Basic Impulse Insulation Level: 95 kV for 8.7 kV class.

- D. Full Capacity Voltage Taps: Four nominal 2.5 percent taps, 2 above and 2 below rated high voltage with tap changer accessible from top through a handhole cover.
- E. High-Voltage Terminals. Cover mounted high voltage porcelain bushings with tin-plated eyebolt terminal, keyed to prevent turning.
- F. Low-Voltage Terminals: Porcelain bushings with tin-plated eyebolt terminal, keyed to prevent turning.
- G. Impedance: As indicated.
- H. Accessories: Provide the following accessories:
 - 1. ANSI support lugs (hanger brackets).
 - 2. Lifting lugs.
 - 3. Oil: Fill plug with cover ground strap.
 - 4. Tank ground pad.

PART 3 - EXECUTION

3.01 ADJUSTING

- A. Adjust transformer taps to provide optimum voltage conditions at utilization equipment.

END OF SECTION