

SECTION 26 1200 - MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following types of transformers with medium-voltage primaries:
 - 1. Liquid-filled distribution and power transformers (indoor).
 - 2. Dry type distribution and power transformers (indoor).
 - 3. Pad-mounted, Liquid-filled transformers (outdoor).
- B. Related Sections include the following:
 - 1. Division 26 Section "Low Voltage Switchgear" for requirements for transformers that form a part of a unit substation.

1.3 DEFINITIONS

- A. NETA ATS: Acceptance Testing Specification.

1.4 ACTION SUBMITTALS

- A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, location of each field connection, and performance for each type and size of transformer indicated.
- B. Material Safety Data Sheet (MSDS) for insulating fluid in liquid filled units.
- C. Shop Drawings: Diagram power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Underground primary and secondary conduit stub-up location.
 - 2. Dimensioned concrete base, outline of transformer, and required clearances.
 - 3. Ground rod and grounding cable locations.

- B. Source quality-control test reports.
- C. Field quality-control test reports.
- D. Follow-up service reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For transformer and accessories to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of transformers and are based on the specific system indicated.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with IEEE C2.
- D. Comply with DOE 2016 (dry type up to 35 kV primary and 2500 kVA).
- E. Liquid filled: Comply with ANSI C57.12.10, ANSI C57.12.28.
- F. Dry type: Comply with IEEE C57.12.01, ANSI C57.21.50, ANSI C57.12.51, IEEE C57.12.56, IEEE C57.12.91, and IEEE C57.94.
- G. Oil or dry type: IEEE C57.12.70 and IEEE C57.12.80.
- H. Comply with NFPA 70.
- I. Comply with FM Global requirements for liquid filled transformers.
- J. Comply with most current edition of the Northwestern University Design Standards.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store transformers protected from weather and so condensation will not form on or in units. Provide temporary heating according to manufacturer's written instructions.

1.9 PROJECT CONDITIONS

- A. ***(Delete This Paragraph If Not Required)*** [Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by The University or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. **Notify the University no fewer than [two] calendar weeks in advance of proposed interruption of electric service.**
 2. **Indicate method of providing temporary utilities.**
 3. **Do not proceed with interruption of electrical service without the University's Chief Electrician's written permission.**
 4. **The University Lock-out/Tag-out procedures shall be used with Contractor controlled locks and tags.**
 5. **Comply with NFPA 70E.]**
- B. Installation Pathway: Remove and replace building components and structures to provide pathway for moving transformers into place.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for transformers, including clearances between transformers and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- D. Service Conditions: IEEE C37.121, usual service conditions except for the following:
(Edit For Project Conditions)
1. Exposure to significant solar radiation.
 2. Exposure to fumes, vapors, or dust.
 3. Exposure to hot and humid climate or to excessive moisture, including steam, salt spray, and dripping water.
 4. Exposure to abnormal vibration, shock, or tilting.
 5. Exposure to excessively high or low temperatures.
 6. Unusual transportation or storage conditions.
 7. Unusual grounding-resistance conditions.
 8. Unusual space limitations.

1.10 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate installation of louvers, doors, spill retention areas, and sumps. Coordinate installation so no piping or conduits are installed in space allocated for medium-voltage transformers except those directly associated with transformers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ABB.
 2. Cooper Industries; Cooper Power Systems Division.
 3. Cutler-Hammer.
 4. GE Electrical Distribution & Control.
 5. Square D; Schneider Electric.

Select Paragraph 2.2, 2.3, or 2.4 below per Project Requirements

2.2 LIQUID-FILLED DISTRIBUTION AND POWER TRANSFORMERS

- A. Description: IEEE C57.12.00 and UL 1062, liquid-filled, 2-winding transformers installed indoors, typically as part of a unit substation assembly.
- B. Primary terminations shall be designed for close coupling to a metal enclosed air load break switch section. Secondary terminations shall be designed for close coupling to **[a switchgear section] [a switchboard section]**.
- C. Insulating Liquid: Less flammable, silicone-based dielectric and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall be FM approved and have low toxicity and be nonhazardous.
- D. Insulation Temperature Rise: 65/55 deg C, based on an average ambient temperature of 30 deg C over 24 hours with a maximum ambient temperature of 40 deg C. Insulation system shall be rated to continuously allow an additional 12 percent kilovolt-ampere output, at 65 deg C temperature rise, without decreasing rated transformer life.
- E. High-voltage and low-voltage windings shall be copper. Insulation between layers of the windings shall be by thermally set insulating paper or equal.
- F. **Optional [Surge Arresters: Distribution class, one for each primary phase; complying with IEEE C62.11 and NEMA LA 1; within high-voltage compartment.]**
- G. Basic Impulse Level: 95 for 15 kV.
- H. Full-Capacity Voltage Taps: Four nominal 2.5 percent taps, 2 above and 2 below rated primary voltage; with externally operable tap changer for de-energized use and with position indicator and padlock hasp.
- I. Cooling System: Class OA/FA, self-cooled, and with forced-air-cooled rating. Cooling systems shall include auxiliary cooling equipment (fans), automatic controls, and status indicating lights necessary to obtain an additional 15% capacity on units 300 through 2000 kVA and an additional 25% capacity on units 2500 kVA and over. A separate control power source shall be provided for fans and controls.
- J. Sound level may not exceed sound levels listed in NEMA TR 1, without fans operating.
- K. Impedance: +/- 7-1/2%.
- L. Accessories: Lifting lugs and provisions for jacking under base. Transformers shall have a steel base and frame allowing use of pipe rollers in any direction, and an insulated, low-voltage, neutral bushing with removable ground strap. Include the following additional accessories:
 - 1. Liquid-level gage.
 - 2. Pressure-vacuum gage.
 - 3. Liquid temperature indicator.
 - 4. Drain and filter valves.
 - 5. Pressure relief device.
 - 6. Additional nameplate with FM approval data.
 - 7. Alarm contacts for gages and thermometer listed above.

8. SCADA interface.
9. Two stainless steel ground pads.

2.3 DRY TYPE DISTRIBUTION AND POWER TRANSFORMERS

- A. Description: NEMA and ANSI C57 compliant and UL 1062, 2-winding transformers installed indoors, typically as part of a unit substation assembly. UL listed.
- B. Primary terminations shall be designed for close coupling to **[a metal enclosed air load break switch section] [an air terminal chamber provided with the transformer]**. Secondary terminations shall be designed for close coupling to **[a switchgear section] [a switchboard section]**.
- C. Cores shall be manufactured from non-aging, cold rolled, high permeability grain oriented silicone steel.
- D. High and Low Voltage windings shall be Copper.
- E. Insulating System: Coils shall be insulated with 220° C Class H Nomex® insulation system. Environmental protection shall be provided by vacuum pressure impregnation with polyester resin (VPI).
- F. Insulation Temperature Rise: 115° C, based on an average ambient temperature of 30° C over 24 hours with a maximum ambient temperature of 40° C. Insulation system shall be rated to allow the transformer to be overloaded to the 150° C temperature rise, without decreasing rated transformer life.
- G. **Optional [Surge Arresters: Distribution class, one for each primary phase; complying with IEEE C62.11 and NEMA LA 1; within high-voltage compartment.]**
- H. Basic Impulse Level: **[60 for 5 kV] [95 for 15 kV]**.
- I. Full-Capacity Voltage Taps: Four nominal 2.5% taps, 2 above and 2 below rated primary voltage; accessible by removing the enclosure panels.
- J. Cooling System: Class OA/FA, self-cooled, and with forced-air-cooled rating. Fan cooling package shall be provided for automatically increasing the kVA rating by 33% and include auxiliary cooling equipment (fans), automatic controls to digitally monitor winding temperature and ambient temperature. Form C contacts shall be provided to trip the transformer off-line for excessive winding temperature. LED status indicating lights. A 4-20 mA analog signal shall be provided for remote indication or for use with SCADA systems. Power shall be provided from an internal fused control power transformer.
- K. Heavy gauge, sheet steel NEMA 1 enclosure, ventilated, with removable panels for access to taps. The complete case shall be capable of being knocked down to reduce size and weight for rigging. Rubber vibration isolation pads shall be installed by the manufacturer between the core and coil and the enclosure. Finish: manufacturer's standard ANSI 61 paint finish.
- L. Sound level may not exceed sound levels listed in NEMA TR 1, without fans operating.
- M. Impedance: +/- 7-1/2%.

- N. Accessories: Grounding pads, lifting lugs, and provisions for jacking under base. Transformers shall have a steel base and frame allowing use of pipe rollers in any direction, and an insulated, low-voltage, neutral bushing with removable ground strap. Include the following additional accessories:
1. Transformer Temperature Controller that monitors transformer windings and ambient temperature. The unit shall provide Fans, Alarm, and Trip output relays. Form C contacts shall be provided to trip the transformer off-line if the winding temperature exceeds the trip setting. A 4-20 mA analog signal shall be provided for remote indication or for use with SCADA systems. Control power shall be provided from internal control power transformer.
 2. Ventilation grilles.
 3. Provisions for rolling.
 4. Core ground strap.
 5. Two stainless steel ground pads.
 6. Diagrammatic nameplate.
 7. Alarm contacts for gages and thermometer listed above.
 8. SCADA interface.

2.4 PAD-MOUNTED, LIQUID-FILLED TRANSFORMERS

- A. Description: ANSI C57.12.13, ANSI C57.12.26, IEEE C57.12.00, for pad-mounted, 2-winding transformers, stainless-steel tank base, cabinet, and sills, typically installed outdoors.
- B. Insulating Liquid: Less flammable, silicone-based dielectric and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall be FM approved and have low toxicity and be nonhazardous.
- C. Insulation Temperature Rise: 65 deg C when operated at rated kVA output in a 40 deg C ambient temperature. Transformer shall be rated to operate at rated kilovolt ampere in an average ambient temperature of 30 deg C over 24 hours with a maximum ambient temperature of 40 deg C without loss of service life expectancy.
- D. High-voltage and low-voltage windings shall be copper. Insulation between layers of the windings shall be by thermally set insulating paper or equal.
- E. Basic Impulse Level: **[60 for 5 kV] [95 for 15 kV]**.
- F. Impedance: +/- 7-1/2%.
- G. Full-Capacity Voltage Taps: Four 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.
- H. Primary fusing: **(Select) Provide [full-range, current limiting fuses in [load-break] [non-load break] drywell canisters] [oil-immersed, load-break bay-o-net overload sensing fuses in series with under oil partial range current limiting fuses].**
- I. Surge Arresters: Distribution class, one for each primary phase; complying with IEEE C62.11 and NEMA LA 1; support from tank wall within high-voltage compartment.
- J. High-Voltage Terminations and Equipment: **(Select) [Live front with externally clamped, wet process, porcelain bushings and cable connectors suitable for terminating primary**

cable.] [(200 A dead front load break) (600 A dead break) wells and inserts for cable sizes shown on the drawings.]

(Select paragraph K or L below per project requirements.)

- K. Where a radial feed switch is shown on the drawings, provide a two-position, oil-immersed, gang-operated, rotary load-break switch. The switch mechanism shall be spring loaded and the operation shall be independent of operator speed. The switch shall have the following ratings:
1. Continuous current **[200] [600]** amperes. Momentary current 10,000 amps symmetrical (2 seconds). Make and latch 6,000 amps symmetrical. Load interrupting **[200] [600]** amps.
- L. Where a loop-feed operation (sectionalizing switch) is shown on the drawings, provide a four-position configuration arrangement, oil-immersed, gang-operated, rotary, load-break switch. The switch mechanism shall be spring-loaded and the operation shall be independent of operator speed. The switch shall have the following ratings:
1. Continuous current 600 amperes, Maximum phase-to-phase 15 kV, maximum phase-to-ground 8.3 kV, Momentary 10,000 amps for 10 cycles symmetrical.
- M. Accessories:
1. Drain Valve: 1 inch (25 mm), with sampling device.
 2. Dial-type thermometer.
 3. Liquid-level gage.
 4. 1 inch upper filter press and filling plug.
 5. Pressure-vacuum gage.
 6. Pressure Relief Device: Self-sealing with an indicator.
 7. Mounting provisions for low-voltage current transformers. **[Delete If Not Required]**
 8. Mounting provisions for low-voltage potential transformers. **[Delete If Not Required]**
 9. Alarm contacts for gages and thermometer listed above.
 10. SCADA interface.
 11. Additional nameplate with FM approval data.
 12. ANSI tank grounding provisions shall be furnished in both compartments.

2.5 NETWORK COMMUNICATIONS

- A. Coordinate remote monitoring communication module package with the University's SCADA system for successful transmission and remote readout of monitoring data.
- B. Connect remote monitoring communication modules to the University's SCADA system through appropriate network interface unit.
- C. The manufacturer shall wire between all communications capable devices within the transformer, including electronic meters, with the same protocol and wire to a set of easily accessible terminal blocks.

2.6 IDENTIFICATION DEVICES

- A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

2.7 SOURCE QUALITY CONTROL

- A. Factory Tests: Perform design and routine tests according to standards specified for components. Conduct transformer tests according to IEEE C57.12.90 for liquid filled transformers and C57.12.91 for dry types.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for medium-voltage transformers.
- B. Examine roughing-in of conduits and grounding systems to verify the following:
 - 1. Wiring entries comply with layout requirements.
 - 2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and that requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install pad mounted transformers on concrete bases designed by a Structural Engineer retained by the Contractor.
- B. Install indoor transformers on 4-inch (100-mm) high (Evanston: 6" high east of Sheridan Rd.) concrete housekeeping pads.
 - 1. Anchor transformers to concrete pads according to manufacturer's written instructions.
 - 2. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Division 03 Sections.
 - 3. Install dowel rods to connect concrete pad to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of pad.
 - 4. Install epoxy-coated anchor bolts, for supported equipment, that extend through concrete pad and anchor into structural concrete floor.
 - 5. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
- C. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

3.3 IDENTIFICATION

- A. Identify field-installed wiring and components and provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."
- B. A laminated copy of the Material Safety Data Sheet (MSDS) for insulating fluid in liquid filled units shall be provided at the unit.

3.4 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- C. Provide all communications wiring between remote monitoring and communication modules and the University's SCADA system. Verify that each transformer's address for microprocessor-communication packages corresponds to data network requirements.
- D. Verify tightness and torque all accessible bolted electrical connections to manufacturer's specified values using a calibrated torque wrench. Provide a list of all torqued connections and values.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. After installing transformers but before primary is energized, verify that grounding system at substation is tested at specified value or less.
 - 2. After installing transformers and after electrical circuitry has been energized, test for compliance with requirements.
 - 3. Perform visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Test Reports: Prepare written reports to record the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Test results that do not comply with requirements and corrective actions taken to achieve compliance with requirements.
- E. Transformers shall not be permanently energized until all test reports have been submitted and approved by NU Electric Shop.

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FOR: _____
ISSUED: 03/29/2017

3.6 FOLLOW-UP SERVICE

- A. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each transformer. Remove front and rear panels so joints and connections are accessible to portable scanner.
1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 2. Record of Infrared Scanning: Prepare a certified report that identifies transformer checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.
 3. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchgear 11 months after date of Substantial Completion.

END OF SECTION 26 1200