

SECTION 26 22 00

~~~ PROJECT NOTE ~~~~~

ARCHITECT OF RECORD/ENGINEER OF RECORD IS RESPONSIBLE FOR REVIEWING THIS SPECIFICATION SECTION IN DETAIL FOR COORDINATION WITH THE PROJECT SCOPE OF WORK.

ALL "PROJECT NOTE" TEXT IS TO BE REMOVED FOLLOWING REVIEW OF THE CONTENT OF EACH NOTE BY THE ARCHITECT OF RECORD/ENGINEER OF RECORD.

EDIT THE DOCUMENT FOOTER TO INCLUDE THE PROJECT NAME AND NUMBER.

EDIT THE DOCUMENT HEADER TO INDICATE THE ARCHITECT OF RECORD PROJECT ISSUE" DATE. THE "CPS CONTROL" DATE SHOULD NOT BE EDITED.

ANY MODIFICATIONS TO THE TECHNICAL STANDARDS IN THIS SECTION - INCLUDING THE REMOVAL OR ADDITION OF MANUFACTURERS - MUST BE APPROVED BY CPS.

REQUESTS FOR MODIFICATION ARE TO BE SUBMITTED TO THE DESIGN MANAGER DURING THE DESIGN PHASE FOR REVIEW AND APPROVAL.

~~~ END OF PROJECT NOTE ~~~~~

LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL

~~~ PROJECT NOTE ~~~~~

SELECT PROJECT SPECIFIC TRANSFORMER TYPES TO BE INCLUDED WITHIN THE SCOPE OF PROJECT. BUCK-BOOST TRANSFORMERS NOT TYPICAL.

~~~ END OF PROJECT NOTE ~~~~~

1.01 SECTION INCLUDES

- A. General purpose transformers.
- B. K-factor transformers rated for nonlinear loads.
- C. Buck-boost transformers.
- D. Control transformers.

1.02 REFERENCE STANDARDS

- A. 10 CFR 431, Subpart K - Energy Efficiency Program for Certain Commercial and Industrial Equipment - Distribution Transformers; Current Edition.
- B. IEEE C57.12.91 - IEEE Standard Test Code for Dry-Type Distribution and Power Transformers; 2011.
- C. IEEE C57.94 - IEEE Recommended Practice for Installation, Application, Operation, and Maintenance of Dry-Type Distribution and Power Transformers; 2015.
- D. IEEE C57.96 - IEEE Standard Guide for Loading Dry-Type Distribution and Power Transformers; 2013.
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- F. NECA 409 - Standard for Installing and Maintaining Dry-Type Transformers; 2015.
- G. NEMA ST 20 - Dry-Type Transformers for General Applications; 2014.
- H. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
- I. NEMA TP 1 - Guide for Determining Energy Efficiency for Distribution Transformers; 2002.

- J. NEMA TP 2 - Standard Test Method for Measuring the Energy Consumption of Distribution Transformers; 2005.
- K. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2017.
- L. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.
- M. UL 506 - Standard for Specialty Transformers; Current Edition, Including All Revisions.
- N. UL 1561 - Standard for Dry-Type General Purpose and Power Transformers; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate the work with placement of support framing and anchors required for mounting of transformers. Concrete, reinforcement, and formwork requirements as specified in Division 03.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. See Section 01 33 29 - LEED Sustainable Design Reporting, when required.
- C. Product Data: Include voltage, kVA, impedance, tap configurations, insulation system class and rated temperature rise, efficiency, sound level, enclosure ratings, outline and support point dimensions, weight, required clearances, service condition requirements, and installed features.
 - 1. Vibration Isolators: Include attachment method and rated load and deflection.
 - 2. K-factor Rated Transformers: Include K-factor ratings.
 - 3. Buck-boost Transformers: Include voltage selection tables and wiring diagrams for autotransformer configurations.
 - 4. Shielded Transformers: Include shielding method and noise attenuation performance.
- D. Shop Drawings: Provide dimensioned plan and elevation views of transformers and adjacent equipment with all required clearances indicated.
 - 1. Small Power Centers: Include panel arrangements.
- E. Product certificates signed by manufacturers certifying that their products comply with the specified requirements.
- F. Source Quality Control Test Reports: Include reports for tests designated in NEMA ST 20 as design and routine tests.
- G. Field Quality Control Test Reports.
- H. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- I. Maintenance Data: Include recommended maintenance procedures and intervals.
- J. Project Record Documents: Record actual locations of transformers.

1.05 QUALITY ASSURANCE

- A. Conform to requirements of the City of Chicago Electrical Code.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three (3) years documented experience.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the City of Chicago Electrical Code, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers".

- F. Factory Sound-Level Tests: Conduit sound-level tests on equipment for this Project.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

1.07 FIELD CONDITIONS

- A. Ambient Temperature: Do not exceed the following maximum temperatures during and after installation of transformers.
 - 1. Greater than 10 kVA: 104 degrees F maximum.
 - 2. Less than 10 kVA: 77 degrees F maximum.

1.08 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. ABB/GE: www.geindustrial.com/#sle.
- B. Eaton Corporation: www.eaton.com
- C. Schneider Electric; Square D Products: www.schneider-electric.us
- D. Siemens Industry, Inc: www.usa.siemens.com.
- E. Magnetek Power Electronics Group; www.magnetek.com.
- F. Sola/Hevi-Duty; www.solahevidutysales.com

2.02 TRANSFORMERS - GENERAL REQUIREMENTS

- A. Description: Factory-assembled, dry type transformers for 60 Hz operation designed and manufactured in accordance with NEMA ST 20 and listed, classified, and labeled as suitable for the purpose intended.
- B. Unless noted otherwise, transformer ratings indicated are for continuous loading according to IEEE C57.96 under the following service conditions:
 - 1. Altitude: Less than 3,300 feet.
 - 2. Ambient Temperature:
 - a. Greater than 10 kVA: Not exceeding 104 degrees F.
 - b. Less than 10 kVA: Not exceeding 77 degrees F.
- C. Core: High grade, non-aging silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Keep magnetic flux densities substantially below saturation point, even at 10 percent primary overvoltage. Tightly clamp core laminations to prevent plate movement and maintain consistent pressure throughout core length.
- D. Impregnate core and coil assembly with non-hydroscopic thermo-setting varnish to effectively seal out moisture and other contaminants.
- E. Basic Impulse Level: 10 kV.
- F. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.
- G. Isolate core and coil from enclosure using vibration-absorbing mounts.
- H. Nameplate: Include transformer connection data, ratings, wiring diagrams, and overload capacity based on rated winding temperature rise. nameplates and label products are specified in Section 26 05 53 - Identification for Electrical Systems.

2.03 GENERAL PURPOSE TRANSFORMERS

- A. Description: Self-cooled, two winding transformers listed and labeled as complying with UL 506 or UL 1561; ratings as indicated on the drawings.
- B. Primary Voltage: As indicated elsewhere in the construction documents.
- C. Secondary Voltage: As indicated elsewhere in the construction documents.
- D. Insulation System and Allowable Average Winding Temperature Rise:
 - 1. Class 220 degrees C insulation system with 115 degrees C average winding temperature rise above 40 degrees ambient temperature.
- E. Coil Conductors: Continuous copper windings with terminations brazed or welded.
- F. Winding Taps:
 - 1. Less than 3 kVA: One 5 percent tap above normal full capacity..
 - 2. 3 kVA through 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.
 - 3. 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.
- G. Energy Efficiency: Comply with 10 CFR 431, Subpart K, current edition.
- H. Sound Levels: Standard sound levels complying with NEMA ST 20. Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.
- I. Mounting Provisions:
 - 1. Less than 15 kVA: Suitable for wall mounting.
 - 2. 15 kVA through 75 kVA: Suitable for wall, floor, or trapeze mounting.
 - 3. Larger than 75 kVA: Suitable for floor mounting.
- J. Transformer Enclosure: Comply with NEMA ST 20.
 - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor clean, dry locations: Type 2.
 - b. Outdoor locations: Type 3R.
 - 2. Construction: Steel.
 - a. Less than 15 kVA: Totally enclosed, non-ventilated.
 - b. 15 kVA and Larger: Ventilated.
 - 3. Finish: Manufacturer's standard grey, suitable for outdoor installations.
 - 4. Provide lifting eyes or brackets.
- K. Accessories:
 - 1. Mounting Brackets: Provide manufacturer's standard brackets.
 - 2. Weathershield Kits: Provide for ventilated transformers installed outdoors to provide a listed NEMA 250, type 3R assembly.
 - 3. Lug Kits: Sized as required for termination of conductors as indicated on the drawings.
- L. Energy Efficiency for Transformers Rated 15 kVA and Larger:
 - 1. Complying with NEMA TP 1, Class 1 efficiency levels.
 - 2. Tested according to NEMA TP 2.

2.04 K-FACTOR TRANSFORMERS RATED FOR NONLINEAR LOADS

- A. Description: Self-cooled, two winding transformers listed and labeled as complying with UL 1561, and designed to supply nonlinear loads to the degree designated by the UL defined K-factor; ratings as indicated on the drawings.
- B. K-factor Rating: K-4, or higher as indicated in construction documents.
- C. Insulation System and Allowable Average Winding Temperature Rise: Class 220 degrees C insulation system with 115 degrees C average winding temperature rise above 40 degrees ambient temperature.

- D. Coil Conductors: Continuous copper windings with terminations brazed or welded. Individually insulate secondary conductors and arrange to minimize hysteresis and eddy current losses at harmonic frequencies. Size secondary neutral conductor at twice the secondary phase conductor ampacity.
- E. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
- F. K-factor shall not exceed value indicated. Provide value of K-factor on transformer nameplate.
- G. Transformer shall incorporate electrostatic shield grounded to the transformer core, designed per requirements as stated in "Accessories" Paragraph below.
- H. The neutral bus shall be sized and configured for at least 200 percent of the secondary full load current.
- I. Transformer impedance shall be a minimum of 3 and a maximum of 5 percent.
- J. Winding Taps:
 - 1. Less than 3 kVA: One 5 percent tap above normal full capacity..
 - 2. 3 kVA through 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.
 - 3. 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.
- K. Neutral Bus: Sized to accommodate twice the rated secondary current.
- L. Energy Efficiency: Comply with 10 CFR 431, Subpart K.
- M. Sound Levels: Standard sound levels complying with NEMA ST 20.
- N. Mounting Provisions:
 - 1. Up to 75 kVA: Suitable for wall, floor, or trapeze mounting.
 - 2. Larger than 75 kVA: Suitable for floor mounting.
- O. Electrostatic Shield: Provide grounded full-width copper electrostatic shield between primary and secondary windings to attenuate electrical noise.
- P. Transformer Enclosure: Comply with NEMA ST 20.
 - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor clean, dry locations: Type 2.
 - b. Outdoor locations: Type 3R.
 - 2. Construction: Steel, ventilated.
 - 3. Finish: Manufacturer's standard grey, suitable for outdoor installations.
 - 4. Provide lifting eyes or brackets.
- Q. Accessories:
 - 1. Mounting Brackets: Provide manufacturer's standard brackets.
 - 2. Weathershield Kits: Provide for ventilated transformers installed outdoors to provide a listed NEMA 250, type 3R assembly.
 - 3. Lug Kits: Sized as required for termination of conductors as indicated on the drawings.
 - 4. Vibration isolators to reduce transfer of a vibration.
- R. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

~~~ PROJECT NOTE ~~~~~
BUCK-BOOST TRANSFORMERS NOT TYPICAL IN PROJECTS. VERIFY REQUIREMENTS PRIOR TO COMPLETION OF CONTRACT DOCUMENTS.
~~~ END OF PROJECT NOTE ~~~~~

2.05 BUCK-BOOST TRANSFORMERS

- A. Description: Self-cooled, four winding, buck-boost transformers listed and labeled as complying with UL 506 or UL 1561, and suitable for field connection as an autotransformer; ratings as indicated on the drawings.
- B. Insulation System and Allowable Average Winding Temperature Rise:
 - 1. Less than 0.25 kVA: Class 105 degree C insulation system with 55 degrees C rise.
 - 2. 0.25 kVA and Larger: Class 180 degree C insulation system with 115 degree C rise.
- C. Coil Conductors: Continuous windings.
- D. Lugs: Suitable for terminating conductors sized for full rated load ampacity of transformer when operating in buck-boost configuration indicated.
- E. Mounting Provisions: Suitable for wall mounting.
- F. Transformer Enclosure: Comply with NEMA ST 20.
 - 1. Environment Type per NEMA 250: Type 3R.
 - 2. Construction: Steel, totally enclosed, non-ventilated.
 - 3. Finish: Manufacturer's standard grey, suitable for outdoor installations.

2.06 CONTROL AND SIGNAL TRANSFORMERS

- A. Description: Self-cooled, two-winding dry type.
- B. Comply with NEMA ST 1 "Specialty transformers" and UL Standard UL 506 "Specialty Transformers".
- C. Enclosure: Suitable for the environment.
 - 1. Finish Color: Manufacturers standard paint over corrosion resistant pretreatment and primer.
- D. Ratings: Continuous Duty. Where ratings are not indicated, provide capacity exceeding peak load by 50 percent minimum.

2.07 SOURCE QUALITY CONTROL

- A. Factory test transformers according to NEMA ST 20.
- B. Sound Level Tests: Perform factory test designated in NEMA ST 20 as "design" test on each production unit.
- C. Test and inspect transformers according to IEEE C57.12.91.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that suitable support frames and anchors are installed where required and that mounting surfaces are ready to receive transformers.
- C. Perform pre-installation tests and inspections on transformers per manufacturer's instructions and as specified in NECA 409. Correct deficiencies prior to installation.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship).
- B. Install products in accordance with manufacturer's instructions.
- C. Install transformers in accordance with NECA 409 and IEEE C57.94.
- D. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- E. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

- G. Use flexible conduit, under the provisions of Section 26 05 33.13 - Conduit for Electrical Systems, 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.
- H. Tighten electrical connections and terminals according to manufacturer's published torque-tightening values. Where manufacturer's values are not furnished use those specified in UL 486A-486B.
- I. Arrange equipment to provide minimum clearances as specified on transformer nameplate for air circulation for cooling, and in accordance with manufacturer's instructions and the City of Chicago Electrical Code.
- J. Mount wall-mounted transformers using integral flanges or accessory brackets furnished by the manufacturer.
 - 1. Install transformers level and plumb with wall brackets fabricated by transformer manufacturer.
- K. Mount floor-mounted transformers on properly sized 3 inch high concrete pad constructed in accordance with Section 03 30 00.
- L. Mount floor-mounted transformers using vibration isolators suitable for isolating the transformer noise from the building structure.
 - 1. Transformers above 300 kVA located within the building shall be mounted on isolation units utilizing type MS springs. Spring units shall have a minimum static deflection of 1.5 inches.
 - 2. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions.
- M. Mount trapeze-mounted transformers as indicated.
- N. Provide grounding and bonding in accordance with Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- O. Remove shipping braces and adjust bolts that attach the core and coil mounting bracket to the enclosure according to manufacturer's recommendations in order to reduce audible noise transmission.
- P. Where not factory-installed, install lugs sized as required for termination of conductors as indicated.
- Q. Where furnished as a separate accessory, install transformer weathershield per manufacturer's instructions.
- R. Identify transformers in accordance with Section 26 05 53 - Identification for Electrical Systems.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS Sections 7.2.1.1 and 7.2.1.2. Tests and inspections listed as optional are not required.
 - 1. 167 kVA single phase, 500 kVA three phase and smaller:
 - a. Perform turns ratio tests at all tap positions.
 - 2. Larger than 167 kVA single phase and 500 kVA three phase:
 - a. Verify that control and alarm settings on temperature indicators are as specified.
 - b. Perform excitation-current tests on each phase.
 - c. Measure the resistance of each winding at each tap connection.
 - d. Perform an applied voltage test on all high- and low-voltage windings-to-ground.
- D. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.04 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 CLEANING

- A. Clean dirt and debris from transformer components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

3.06 COMMISSIONING AND DEMONSTRATION

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.
- C. Output Settings Report: Prepare a written report recording output voltages and tap settings.
- D. After completing installation, cleaning and testing, touch up scratches and mars on finish to match original finish.

END OF SECTION 26 22 00