

**READ THIS FIRST**

Notice to the Design Engineer, this document is part of Facilities and Infrastructure standards for Electrical Systems. Designers are advised to NOT use this template (\*.doc) document as part of any project contract documents. Designers shall use the Port of Seattle MasterSpec specifications from the following link:

**<https://www.portseattle.org/page/guide-specifications>.**

Designers shall edit the corresponding Port's MasterSpec specification to meet the F&I Electrical Standard outlined in this specification. Note that Port's MasterSpec specifications contain specifications and languages for both Aviation and Maritime Divisions. F&I Standards are strictly for Aviation Division, and any Maritime related specs or languages should be removed from the project specifications.

**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 AND NOTES TO DESIGNER**

- A. This Section includes the following types of dry-type transformers rated 600 V and less of the following types:
  - 1. Single Phase, 3-167 kVA
  - 2. Three Phase, 3-1000 kVA
  - 3. Three Phase, K-Factor, 15-500 kVA
  - 4. Buck Boost Transformers
- B. Evaluate the use of extreme efficiency transformers meeting the DOE Candidate Standard Level 3 (CSL-3) with a life cycle cost analysis. See Electrical Systems Design Principles General Requirements for cost basis.
- C. K-Factor Transformers: Select K13 for 100% harmonic generating load (electronic ballasts, computers, data racks, etc.). Select K4 or K7 for loads that are half harmonic generating. For unique applications such as a transformer dedicated to a single harmonic load, K20 or K30 transformers may be appropriate.
- D. Wall or ceiling hung transformers are not allowed except with approval of F&I.

**1.3 ACTION SUBMITTALS**

- A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 1. Wiring Diagrams: Power, signal, and control wiring.

**1.4 INFORMATIONAL SUBMITTALS**

- A. Manufacturer Seismic Qualification Certification: Submit certification that transformers, accessories, and components will withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems." Include the following:
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
    - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Qualification Data: For testing agency.
- C. Source quality-control test reports.
- D. Field quality-control test reports.

**1.5 CLOSEOUT SUBMITTALS**

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

**1.6 QUALITY ASSURANCE**

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.
- C. Source Limitations: Obtain each transformer type through one source from a single manufacturer.
- D. 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.
- E. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

## **1.7 DELIVERY, STORAGE, AND HANDLING**

- A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

## **1.8 COORDINATION**

- A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

# **PART 2 - PRODUCTS**

## **2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. EATON
  2. General Electric Co.
  3. Powersmiths
  4. Siemens
  5. Square D
  6. Tierney.

## **2.2 GENERAL TRANSFORMER REQUIREMENTS**

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Cores: Grain-oriented, non-aging silicon steel.
- C. Coils: Continuous windings without splices except for taps.
  - 1. Internal Coil Connections: Brazed.
  - 2. Coil Material: Copper.
  - 3. Windings: Two-winding, dry-type, 3 phase units using 1-coil per phase in primary and secondary.
  - 4. Impedance (%Z): Between 3% and 5% unless otherwise approved by F&I, including K-rated transformers.

## **2.3 DISTRIBUTION TRANSFORMERS**

- A. Comply with NEMA ST 20 and list and label as complying with UL 1561.
- B. Comply with NEMA Standard TP-1 for transformers rated 15kVA to 1000kVA.
- C. Provide transformers that are constructed to withstand seismic forces specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- D. Description: Copper, two-winding, dry-type, 3-phase units using one coil per phase in primary and secondary, size as indicated.
- E. Enclosure:
  - 1. Indoor: Ventilated, NEMA 3R.
  - 2. Outdoor – Ramp and Airfield: Totally enclosed non-ventilated NEMA 3R Vacuum Pressure Insulated (VPI).
  - 3. Outdoor, other locations: Totally enclosed, non-ventilated, raintight NEMA 3R.
  - 4. Finish: ANSI 61 gray.
- F. Insulation Class: 185 deg C up to 15kVA rating, 220 deg C above 15kVA rating, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.
- G. Single Phase Transformers
  - 1. Rating: 3-16 kVA
  - 2. Primary Winding: 240/480V
  - 3. Secondary Winding: 120/240V
  - 4. Taps: (2)-2-1/2% FCAN, (4)-2-1/2% FCBN
- H. Three Phase Transformers
  - 1. Rating: 3-1000 kVA
  - 2. Primary Winding: 480/277V

3. Secondary Winding: 208Y/120V
  4. Taps: (2)-2-1/2% FCAN, (4)-2-1/2% FCBN
- I. Three Phase K-Factor Transformers
1. Rating: 15-500kVA
  2. Primary Winding: 480/277V
  3. Secondary Winding: 208Y/120V
  4. Taps: (2)-2-1/2% FCAN, (4)-2-1/2% FCBN
  5. K-Factor Rating: [K4] OR [K7] OR [K13]
  6. Features: Purpose-designed for high harmonic loads, 200% neutral, electrostatic shield.
- J. Isolation Transformers: Provide transformers as indicated above, with the following:
1. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
    - a. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
    - b. Include special terminal for grounding the shield.
    - c. Shield Effectiveness:
      - 1) Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.
      - 2) Common-Mode Noise Attenuation: Minimum of minus 120 dBA at 0.5 to 1.5 kHz; minimum of minus 65 dBA at 1.5 to 100 kHz.
      - 3) Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.
- K. Wall Brackets: Manufacturer's standard brackets. Provide noise attenuating hardware where adjacent to occupied space.
- L. Low-Sound-Level Requirements:
1. In Noise Sensitive Areas: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.
  2. In other areas: Sound level standards as defined in NEMA and ANSI.
  3. Avoid locating transformers in occupied areas.

## **2.4 AUTO TRANSFORMERS**

- A. Description: Self-cooled, two-winding dry type, rated for continuous duty and with wiring terminals suitable for connection as autotransformer. Transformers shall comply with NEMA ST 1 and shall be listed and labeled as complying with UL 506 or UL 1561.
- B. Taps: (2)-2-1/2% FCAN, (4)-2-1/2% FCBN
- C. Enclosure: Ventilated, NEMA 250, Type 2.
1. Finish Color: Gray.

- D. SOURCE QUALITY CONTROL
- E. Test and inspect transformers according to IEEE C57.12.91.
- F. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

### **PART 3 - INSTALLATION**

#### **3.1 EXAMINATION**

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- 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 requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer, but may be lower depending on application.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 TRANSFORMER INSTALLATION**

- A. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions, seismic codes applicable to Project, and requirements in Section 260529 "Hangers and Supports for Electrical Systems."
  - 1. Install indoor and outdoor transformers on 3-1/2" minimum housekeeping pad and secure to pad with suitable concrete inserts or imbedments to provide seismic zone 3 or higher restraint. Concrete shall be a minimum of 3000-psi.
    - a. Concrete bases shall be leveled to no more than 0.25 inches of deviation for every 3 feet in ALL directions.
    - b. Contractor shall notify F&I and AV Maintenance prior to concrete pour to measure concrete base and assess base's levelness.
    - c. Concrete bases shall have smooth finishes. Broom finishes are prohibited.
- B. Install transformer plumb and level. Provide vibration isolation pads for floor-mounted transformers suitable for isolating the transformer noise from the building structure.
- C. Provide grounding electrode, grounding electrode conductor and bonding jumper required for separately derived system per NEC Article 250-30.

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- D. Use flexible conduit, 2 feet minimum length for connection to transformer case. Make transformer connections at side of transformer enclosure.
- E. Verify continuity and tightness of grounding connections. Provide grounding electrode and bonding jumper required for separately derived system per NEC Article 250-30.
- F. Bring transformer to room temperature, or a minimum of 65°F for a period of 24 hours prior to energizing. Temperature as measured at transformer hot spot.
- G. Wall mounted and trapeze mounted transformer installation is not allowed without written permission from AV F&I.

**3.3 CONNECTIONS**

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
  - 1. Verify continuity and tightness of ground connections.
  - 2. Provide grounding electrode and grounding electrode conductor and bonding jumper required for separately derived system per NEC Article 250-30.
- B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

**3.4 IDENTIFICATION**

- A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant self-tapping stainless steel screws with blunt tips. Sheet metal screws are not allowed for this purpose. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."
- B. Torque Values: Provide self-adhesive machine printed label with connection torque values.

**3.5 FIELD QUALITY CONTROL**

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.
- B. Manufacturer's Field Service: For transformers greater than 750kVA, engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- C. Perform tests and inspections and prepare test reports.
- D. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification Section 7.2.1.1, Dry Type Transformers. Certify compliance with test parameters.
  2. Conform to IEEE Standard Test Code C57 for dry type units.
  3. Complete the attached test report.
- E. Remove and replace units that do not pass tests or inspections and retest as specified above.
- F. Infrared Scanning: After Substantial Completion but prior to Final Acceptance, perform an infrared scan of transformer connections.
1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
  2. The Port shall have the option of performing its own infrared inspection.
  3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.
- G. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

### **3.6 ADJUSTING**

- A. Adjust transformer taps to provide optimum voltage at equipment served throughout the normal operating conditions of the facility. 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 auto transformers to provide nameplate voltage of equipment being served, per requirements of NEC, at secondary terminals.
- C. Output Settings Report: Prepare a written report recording output voltages and tap settings.

### **3.7 IDENTIFICATION**

- A. Comply with requirements in Section 260553 - "Identification for Electrical Systems."
- B. Phenolic label shall comply with the following format:
1. Line #1 – transformer name
  2. Line #2 – kVA rating
  3. Line #3 – Primary voltage – secondary voltage (ex. 480-208/120V)
  4. Line #4 – Fed from: panel name feeding transformer.



**3.8 CLEANING**

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262200

Except as noted below:

Transformer Equipment and Insulation Test Report