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| Version | Date | Description of Revisions |
| 1 | August 30, 2006 | Approved final document. |
| 2 | February 19, 2010 | Modified ‘Related Sections’ |
| 3 | March 15, 2011 | Minor changes from Legal reviews |
| 4 | June 25, 2013 | Final Draft – Consolidated Comments Spec Update Project. Incorporation of new Commissioning and Computerized Maintenance Management System Data Requirements Specification cross references. |
| 5 | July 30, 2014 | Changes to reflect renaming of commissioning specification and final review (AV) |
| **6** | **February 4, 2015** | **Finalized Specification – Reference eDOCS #5630504 v7 (AV) with updated standards** |
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NOTE:

This is a CONTROLLED Document. Any documents appearing in paper form are not controlled and should be checked against the on-line file version prior to use.

**Notice:** This Document hardcopy must be used for reference purpose only.

**The on-line copy is the current version of the document.**

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## Related Sections

### [Under "Related Sections", identify other Sections that are related to, and/or dependent on, the work results or information specified elsewhere. The list should be limited to Sections with specific information that the reader might expect to find in this Section, but is specified elsewhere. For example, if hardware for aluminum entrances is specified in the aluminum entrance Section, a cross-reference would be appropriate in the finish hardware Section. The purpose of this cross-referencing is for information only, to aid in finding those other requirements—not to define the scope of the Section.

### Cross-referencing here may also be used to coordinate assemblies or systems whose components may span multiple Sections and which must meet certain performance requirements as an assembly or system.

### Contractor is responsible for coordination of the Work. Contractor is responsible for being familiar with and incorporating all required elements of cross-referenced Specifications cited.

### This Section is to be completed/updated during the design development by the Consultant. If it is not applicable to the section for the specific project it may be deleted.]

### [List Sections specifying installation of products supplied but not installed under this Section and indicate specific items.]

### Section [\_\_\_\_\_\_ – \_\_\_\_\_\_\_\_\_\_\_\_]: Execution requirements for ...[item]... specified under this Section.

### [List Sections specifying products installed but not supplied under this Section and indicate specific items.]

### Section [\_\_\_\_\_\_ – \_\_\_\_\_\_\_\_\_\_\_\_]: Product requirements for ...[item]... for installation under this Section.

### [List Sections specifying related requirements.]

### Section [\_\_\_\_\_\_ – \_\_\_\_\_\_\_\_\_\_\_\_]: [Optional short phrase indicating relationship].

### Sections:

#### Section 01250 – Substitutions

#### Section 01300 - Submittals

#### Section 01425 - Computerized Maintenance Management System Data Requirements

#### Section 01810 – Equipment Testing and Facility Commissioning

#### *[Division 13 – SCADA and Instrumentation -insert applicable specifications]*

#### Section 16010 – Electrical General Requirements

### Product requirements for [item]... for installation under this Section

## References

### Canadian Standards Association (CSA)

#### CAN/CSA C802.2-2012 Minimum Efficiency Values for Dry-Type Transformers

#### CAN/CSA-C22.2 No.47-13, Air-Cooled Transformers (Dry Type).

#### CAN/CSA C9-2 (R2011), Dry-Type Transformers.

#### NFPA 70E/CSA-Z462-15, Workplace Electrical Safety (ARC Flash Standard)

### National Electrical Manufacturers Association (NEMA)

#### NEMA Premium® guidelines (2007)

#### NEMA ST20-2014, Dry Type Transformers for General Applications

#### NEMA TP 1-2002, Guide for Determining Energy Efficiency for Distribution Transformers

#### NEMA TP 2-2005, Standard Test Method for Measuring the Energy Consumption of Distribution Transformers

#### NEMA 250-2014, Enclosures for Electrical Equipment (1000 V Maximum)

#### IP65/NEMA 4 rated enclosures

### NFPA

#### NFPA (Fire) 70 (2014) National Electrical Code (NEC)

##### NFPA 70E, Standard for Electrical Safety in the Workplace (2012)

### Canadian Regulations

#### SOR/94-651 Canadian Energy Efficiency Regulations

### UL, ULC

#### UL 1561 Dry-Type General Purpose and Power Transformers

### IEEE

#### C57.12.91-2011 - IEEE Standard Test Code for Dry-Type Distribution and Power Transformers

#### C57.110-2008 - IEEE Recommended Practice for Establishing Liquid-Filled and Dry-Type Power and Distribution Transformer Capability When Supplying Non-sinusoidal Load Currents.

#### 259-1999 (R2010), IEEE Standard Test Procedure for Evaluation of Systems of Insulation for Dry-Type Specialty and General-Purpose Transformers

### Department of Energy (US) CSL 3 class efficiency.

### Electrical Safety Authority (ESA) [Consultant to add specific applicable standards from ESA to this subsection].

## Measurement and Payment

*[Choose one of the following payment language provisions that best suits the individual project.*

*If this Section is not specifically referenced by an item in the Bid Form, please use the following language:*

### The work of this Section will not be measured separately for payment. All costs associated with the work of this Section shall be included in the Contract Price.

*OR If this Section is specifically referenced in the Bid Form, use the following language and identify the relevant item in the Bid Form:*

### All costs associated with the work of this Section shall be included in the price(s) for Item No(s). \_\_\_ in the Bid Form.

*If the work of this Section is to be measured and paid for by several different methods, please amend the standard wording given above to reflect the different methods of measurement and payment.*]

## Submittals

### Submit the following Product data for each type and size of transformer indicated in the Contract Documents:

#### Physical: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features.

#### Product warranty.

#### Details of contributions to LEED, including energy and atmosphere credits.

##### Provide proposed energy savings in Annual kWh and Peak Demand kW compared to a NEMA TP-1 (2002) efficiency baseline for the transformers on the project.

#### Efficiency Data

##### No load and full load losses in accordance with NEMA TP 1-2002.

##### Linear load Efficiency data at 1/6, 1/4, 1/2, 3/4, and full load.

##### Linear Load Efficiency at 35% loading tested in accordance with NEMA TP-2 (2002).

##### Efficiency under K7 load profile at 15%, 25%, 50%, 75%, 100% of nameplate rating.

### 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.

#### Wiring Diagrams: Power, signal, and control wiring.

### Qualification Data: Contractor shall provide the Consultant with the testing agency qualifications that prove the company is capable of performing required tests on the transformer(s).

### Source quality control test reports from the manufacturer.

### Field quality-control test reports.

### Operation and maintenance data for transformers to include in emergency, operation, and maintenance manuals.

### Submit in accordance with Section 01300 – Submittals.

## Source Quality Control

### Testing Agency Qualifications: An independent agency, approved by the Consultant, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association (NETA) or is a nationally recognized testing laboratory (NRTL).

### Source Limitations: Obtain each transformer type from a single manufacturer.

### Electrical Components, Devices and Accessories: Listed and labelled as defined in Article 100 of NFPA 70 and in accordance with Canadian Electrical Code (CEC) by a testing agency acceptable to the authorities having jurisdiction (including but not limited to the Electrical Safety Authority (ESA)), and marked for intended use *[Consultant to amend this subsection as required]*.

### Comply with the requirements of IEEE C57.12.91 2011, Test Code for Dry-Type Distribution and Power Transformers.

### Comply with IEEE C57.110-2008, IEEE, IEEE Recommended Practice for Establishing Liquid-Filled and Dry-Type Power and Distribution Transformer Capability When Supplying Non-sinusoidal Load Currents.

### Test procedures shall be in accordance with 259-1999 (R2010), IEEE Standard Test Procedure for Evaluation of Systems of Insulation for Dry-Type Specialty and General-Purpose Transformers.

## Field Quality Control

### Perform tests and inspections and prepare test reports.

#### Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

### Tests and Inspections:

#### Perform each visual and mechanical inspection and electrical test stated in the NETA Acceptance Testing Specification. Certify compliance with test parameters.

#### Test transformers for losses and efficiency. Verify that the results are consistent with the loss data provided on the submittal documenting compliance with DOE CSL 3 class efficiency (US Department of Energy).

### Remove and replace units that do not pass tests or inspections and re-test as specified above.

### Infrared Scanning: Two months after Substantial Performance of the Work, perform an infrared scan of transformer connections.

#### Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration to Consultant.

#### Perform two follow-up infrared scans of transformers, one at 4 months and the other at 11 months after Substantial Completion.

#### 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.

### Test Labelling: On completion of satisfactory testing of each unit, attach a dated and signed “Satisfactory Test” label to tested component.

### All reports and equipment information shall be in accordance with Section 01425 - Computerized Maintenance Management System Data Requirements.

## Submittals for Review/Approval

### The following shall be submitted to the Consultant:

#### Test reports on transformers in accordance with IEEE C57.12.91 2011.

#### Factory Sound-Level Tests: Sound-level test reports on equipment for this Project.

# PRODUCTS

## Transformers

### Design [1].

#### Open delta configuration not permitted.

#### Type: ANN.

#### [Single] [3] phase, [\_\_\_\_\_\_] kVA, [\_\_\_\_\_\_] V input, [\_\_\_\_\_\_] V output, 60 Hz.

#### Voltage taps: standard.

#### Insulation: Class 185°C temperature rise - 80°C over an ambient of 40°C.

#### Basic Impulse Level (BIL): [standard].

#### Hi pot: standard.

#### Average sound level: [standard].

#### Enclosure: CSA # 2 (Drip proof).

#### Mounting: [floor] [wall].

#### Finish: in accordance with Section 16010 – Electrical General Requirements.

#### Rating: [ ] kVA

#### Winding – Copper – delta connected primary wye connected secondary with neutral grounding provision.

#### Efficiency performance shall meet the NEMA Premium® guidelines; 30% lower losses than U.S. DOE 10 CFR Part 431 (and/or TP 1-2002) and the Canadian Energy Efficiency Regulations SOR/94-651 (and/or C802.2) efficiency standards when measured under a linear load profile.

#### Description: Factory-assembled and tested, air-cooled units for 60 Hz service.

#### Cores: Grain-oriented, non-aging silicon steel.

#### Coils: Continuous windings without splices except for taps.

#### Internal Coil Connections: Brazed or pressure type.

#### Coil Material: Copper.

## Distribution Transformers

### [Consultant to amend following section as appropriate]

### Provide a 25-year pro-rated Product Warranty.

### Comply with the requirements of NEMA ST 20, and [Consultant to amend this subsection and specify relevant items under these standards such as listing and labeling requirements] in compliance with UL 1561.

### Cores: One leg per phase.

### Enclosure: Ventilated, NEMA 250-2014, Type 2.

#### Core and coil shall be impregnated within resin compound, sealing out moisture and air.

### Transformer Enclosure Finish: Comply with NEMA 250-2014.

#### Finish Color: Manufacturer’s Standard.

### Taps for Transformers smaller than 3 kVA: None.

### Taps for Transformers 7.5kVA to 24 kVA: One 5% tap above and one 5% tap below normal full capacity.

### Taps for Transformers 25 kVA and larger: Two 2.5% taps above and four 2.0% taps below normal full capacity.

### Insulation Class: 220°C, UL-component-recognized insulation system with a maximum of 130°C rise above 40°C ambient temperature.

### Energy Efficiency for Transformers Rated 15 kVA and larger:

#### Comply with the requirements of 10 CFR Part 430, July 29, 2004, Federal Register – US Department of Energy, Office of Energy Efficiency and Renewable Energy. Energy Conservation Program for Commercial and Industrial Equipment: Energy Conservation Standards for Distribution Transformers; Proposed Rule.

#### Meet or exceed the requirements of DOE 10 CFR Part 430 CSL3 Efficiency, tested in accordance with NEMA TP-2 (2005):

##### 15kVA: 97.6%

##### 30kVA: 98.1%

##### 45kVA: 98.3%

##### 75kVA: 98.6%

##### 112.5kVA: 98.8%

##### 150kVA: 98.9%

##### 225kVA: 98.9%

##### 300kVA: 99.0%

##### 500kVA: 99.1%

##### 750kVA: 99.2%

### K-Factor Rating: Transformers shall be K-Factor 7 or higher rated and in compliance with the requirements of UL 1561 for non-sinusoidal load current-handling capability to the degree defined by the designated K-factor.

#### Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to the designated K-factor.

#### Indicate the value of the K-factor on the transformer nameplate.

### Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize inter-winding capacitance.

#### Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.

#### Include a special terminal for grounding the shield.

#### Shield Effectiveness:

##### Capacitance between Primary and Secondary Windings: Shall not exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.

##### Common-Mode Noise Attenuation: Minimum of minus 120 dB at 0.5 to 1.5 kHz; minimum of minus 65 dB at 1.5 to 100 kHz.

##### Normal-Mode Noise Attenuation: Minimum of minus 52 dB at 1.5 to 10 kHz.

### Wall Brackets: Manufacturer’s standard brackets.

### Fungus Proofing: Apply a permanent fungicidal treatment for coil and core.

### Low-Sound-Level Requirements: NEMA ST 20 standard sound levels when factory tested in accordance with IEEE C57.12.91-2011.

## Safety Options - NFPA 70E/CSA-Z462-15 ARC Flash Standard

### Integrated External Measurement Port

#### Include external ports with 600V safety class twist-lock connectors for quick and safe access to the transformer’s primary and secondary voltages and currents with revenue 0.3 class accuracy. Accurate and dynamic temperature data shall be provided via thermistors located in each leg of the transformer.

### Integrated Power/Energy/Power Quality Meter

#### The meter shall have the capability to telemeter data to SCADA and other monitoring systems.

#### The meter shall be factory-installed on the transformer, connected to the transformer secondary, complete with fused voltage connections, revenue class 0.3 CTs individually characterized to 0.1% and CT shunting block.

#### Provide a local display of real time energy and power quality information as it related to the load fed from the transformer.

#### Parameters measured include: V, I, THD (V, I), PF, Hz, kW, kVA, kVAR, kWh.

#### Remote communications: Modbus TCP over Ethernet using built-in software for access via a standard web browser. Refer to Division 13 – SCADA and Instrumentation.

#### Education for Sustainability System Ready: Ensure that the integrated power meter specified above shall come complete with the necessary built-in connectivity including Ethernet/Modbus TCP and external IP capability to support a web-based building benchmarking and education for sustainability system that graphically illustrates the performance of the building relative to environmental and energy strategies, including LEED.

### Integrated Infrared Inspection Window

#### Allows safe external thermal imaging of fully energized electrical components without removing the transformer cover.

#### IP65/NEMA 4 rated both open and closed enclosures.

### Lockable Hinged Front Access Doors

#### The access doors shall allow safe and rapid access to the transformer without the need to undo multiple screws and handle heavy metal cover plates that are in close proximity to live electrical points.

#### Doors shall be capable of being secured using a padlock.

## Equipment Identification

### Label size: 7.

### Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Provide equipment identification in accordance with Section 16010 - Electrical General Requirements.

# EXECUTION

## Installation

### Mount dry type transformers up to 75 kVA as indicated in the Contract Documents.

### Mount dry type transformers above 75 kVA on the floor.

### Ensure adequate clearance around the transformers for ventilation.

### Install transformers in a level upright position.

### Remove shipping supports only after the transformer is installed and prior to putting the transformer into service.

### Loosen isolation pad bolts until no compression is visible.

### Make primary and secondary connections in accordance with the wiring diagram.

### Energize transformers after installation is complete.

* 1. Commissioning

### For all commissioning activities on systems where components of this Section are integral to functionality, refer to Section 01810 – Equipment Testing and Facility Commissioning. All inspection and testing activities shall be completed in accordance with the commissioning plan that shall be provided to the Consultant prior to the commencement of commissioning activities.

**END OF SECTION**