METROLINX

Dry Type Transformer Specification

Specification 26 12 16

Revision 01
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Amendment Record Sheet

Amendment in Clause No.	Date of Amendment	Description of Changes
Cover page	March 2023	Removed 'Capital Projects Group'
1.2.3, 1.3.2, 2.8	March 2023	Added 'the latest version of the' and Updated numbering for Electrical Identification and Nomenclature specification

LIST OF CONTENT

1. GENERAL

1.1. SCOPE OF WORK

1.1.1. Design, labour, products, equipment and services necessary for dry-type transformer Work.

1.2. DESIGN REQUIREMENTS

1.2.1. The equipment furnished and the equipment installation, wiring methods and materials used shall conform to the latest edition of the Ontario Electrical Safety Code, Electrical Safety Authority (ESA) Bulletins and Supplements issued by the Electrical Safety Authority, and the applicable Metrolinx Standards. In case of any conflicts, the more stringent requirement shall apply.

1.2.2. Design electrical equipment and systems to all applicable standards of CSA, ULC, IEEE, ESA.

1.2.3. Design electrical equipment and systems to the latest version of the GO DRM.

1.2.4. Design electrical equipment and systems to standards and codes to be latest editions adopted by and enforced by local authorities having jurisdiction (AHJ).

1.2.5. Equipment shall bear a label of one of the certification organizations accredited by the Standards Council of Canada.

1.2.6. Distribution Transformers

a) This type of transformer shall be used in Metrolinx owned outdoor power distribution systems design.

b) The transformer shall be sized to accommodate future loads by providing minimum 25% spare capacity for unknown future loads. Where the transformer is the main service transformer for a site this value shall be 50%, refer to Section 26 05 00.

c) Equipment ratings shall be selected from industry standard ratings only.

d) Transformer kVA rating shall be based continuous operation in the environmental conditions provided in Section 26 05 00 and the insulation class.

e) Brace transformer winding and other parts to withstand the electromagnetic forces corresponding to the first cycle asymmetric current (2.55 I sym) for:

1) A three-phase short circuit at the transformer secondary terminals; and

2) A phase to neutral short circuit on any winding with neutral brought out.

f) Unless otherwise mentioned in the Contract Documents the values and tolerances of sound level, impedance, losses and insulation level must follow CSA-C9 standards.

g) Design shall allow remote monitoring of all transformer alarms contacts by Metrolinx supervisory system.

h) Design transformer with K-Factor appropriate for load. Design shall consider the known future load profile when making the assessment.

i) Design maximum impedance levels at 170 °C such that for units above 30 kVA impedance shall not exceed 5.5%.

1.3. RELATED WORKS

1.3.1. Section 26 05 00 Electrical General Requirements.

1.3.2. Section 26 05 53 Electrical Identification and Nomenclature

1.3.3. Section 26 12 13 Liquid Filled transformers.

1.4. REFERENCE STANDARDS

1.4.1. Ontario Electrical Safety Code (OESC).

1.4.2. Ontario Building Code (OBC).

1.4.3. Metrolinx Standards, Drawings and Specifications.

1.4.4. GO Design Requirement Manual (DRM).

1.4.5. Metrolinx Electrical Safety Document.

1.4.6. CSA Z462, Workplace Electrical Safety.

1.4.7. CAN3 C235, Preferred Voltage Levels for AC Systems, 0 to 50,000V.

1.4.8. ANSI 61, Gray Colour.

1.4.9. ASTM A653, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc Iron Alloy-Coated (Galvanealed) by Hot-Dip Process.

1.4.10. CAN/CGSB -1.88, Gloss Alkyd Enamel, Air Drying and Baking.

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

1.4.12. CSA C9, Dry-Type Transformers.

1.4.13. EEMAC, Electrical and Electronic Manufacturer's Association Canada.

1.4.14. NEMA, National Electronic Manufacturers Association.

1.4.15. ANSI C57.12.51, Requirements for Ventilated Dry-Type Power Transformers, 501 kVA and Larger Three-Phase, with High Voltage 601-34,500 Volts, Low Voltage 208Y/120 4160 Volts.

1.4.16. ANSI C57.12.55, Conformance Standard for Transformers – Dry-Type Transformers Used in Unit Installations, Including Unit Substations.

1.4.17. ANSI C57.12.70, Terminal Markings and Connections for Distribution and Power Transformers.

1.4.18. CAN/CSA-C802.3, Maximum Losses for Power Transformers.

1.4.19. IEEE C57.12.01, Standard General Requirements for Dry-Type Distribution and Power Transformers Including those with Solid Cast and/or Resin-Encapsulated Windings.

1.4.20. IEEE C57.12.91, Test Code for Dry-Type Distribution and Power Transformers.

1.4.21. IEEE C57.94, Recommended Practice for Installation, Application, Operations, and Maintenance of Dry-Type General Purpose Distribution and Power Transformers.

1.4.22. IEEE C57.124, Recommended Practice for the Detection of Partial Discharges and the Measurement of Apparent Charge in Dry-Type Transformers.

1.4.23. NEMA ST-20, Dry Type Transformers for General Applications.

1.4.24. ANSI Z55.1, Gray Finishes for Industrial Apparatus and Equipment.

1.4.25. ANSI/IEEE No. C62.1, Surge Arresters.

1.4.26. NEMA TR-1, Transformers, Regulators and Reactors.

1.4.27. IEEE C57.94, Installation, Application, Operation, and Maintenance of Dry Type General Purpose Distribution and Power Transformers.

1.5. SPARE PARTS

1.5.1. Not applicable.

1.6. TRAINING

1.6.1. Not applicable.

1.7. WARRANTY

1.7.1. The contractor shall provide a manufacturer warranty for the work of this section with a minimum warranty period of two years after acceptance by Metrolinx.

1.8. DELIVERY, STORAGE AND HANDLING

1.8.1. Shipping and handling in accordance with Manufacturer's instructions.

1.8.2. Contractor to protect equipment from weather and moisture by covering with heavy plastic or canvas and by maintaining heat within enclosure in accordance with manufacturer's instructions.

1.8.3. Preparation for shipment to include protection of equipment and accessories against corrosion, dampness, breakage, or vibration injury in transportation and handling. Package to prevent tampering or pilfering and approved and accepted by transportation companies.

1.8.4. Furnish necessary bus connections, wire jumpers, bolts, nuts, washers, etc., suitably packaged and marked to facilitate field assembly. Identify each shipping container with name of contents, Contract number, Substation Name and equipment number permanently marked and readily visible.

1.9. SUBMITTALS

1.9.1. Product Data Package:

a) Submit manufacturer's product data indicating:

1) Performance criteria, characteristics, limitations, cable entry and exit locations, weight and dimensions;

2) Product storage, preparation, handling and installation requirements;

3) Name plate information; and

4) Drawings and wiring diagrams.

1.9.2. Shop Drawings

a) Submit manufacturer's shop drawings indicating:

1) Mounting devices, terminals, taps, internal and external component layout, grounding;

2) kVA rating;

3) Primary and secondary voltages;

4) Frequency;

5) Single phase/three phase;

6) Polarity or angular displacement;

7) Full load efficiency;

8) Regulation at unity power factors (pf);

9) Basic impulse level;

10) Insulation type;

11) Primary and secondary winding type; and

12) Cable rating, weight and dimension.

b) Certificates

1) Submit Product manufacturer's written test certificates for:

i) Voltage ratio;

ii) Polarity or angular displacement;

iii) No-load losses;

iv) Load loss;

v) Impedance;

vi) Exciting current;

vii) Temperature rise;

viii) Sound level;

ix) Radio influence voltage;

x) Partial discharges (corona);

xi) Basic insulation impulse level;

xii) Insulation resistance test;

xiii) Winding resistance test;

xiv) Short circuit test; and

xv) Dielectric withstand, applied and induced.

1.9.3. Reports

a) Provide the following reports:

1) Performance criteria and maintenance data;

2) Safety precautions;

3) Operating instructions and precautions;

4) Maintenance and troubleshooting guidelines/protocol;

5) Product storage, preparation, handling and installation requirements;

6) Testing and commissioning documentation; and

7) Submit testing and commissioning documentation in accordance with Section on Commissioning.

1.9.4. Operation and Maintenance Manuals

a) Submit the following for incorporation into operations and maintenance manuals:

1) Identification: manufacturing name, type, year, serial number, number of units, capacity and identification to related systems;

2) Functional description detailing operation and control of components;

3) Performance criteria and maintenance data;

4) Safety precautions;

5) Operating instructions and precautions;

6) Component parts availability including names and addresses of spare part suppliers;

7) Maintenance and troubleshooting guidelines/protocol; and

8) Product storage, preparation, handling and installation requirements.

1.10. QUALITY ASSURANCE

1.10.1. Refer to Section 26 05 00.

1.10.2. Conduct shop inspections and tests to CSA C9 and CAN/CSA C22.2 No. 47.

1.10.3. Arrange for Metrolinx to witness above at manufacturer's factory as part of factory acceptance testing. Notify Metrolinx 21 calendar days prior to set up the factory acceptance testing schedule.

1.10.4. Each transformer shall be completely tested. Certified test reports shall be furnished to Metrolinx.

1.10.5. Metrolinx reserves the right to witness all factory tests.

2. PRODUCTS

2.1. GENERAL

2.1.1. The equipment shall be able to withstand the environmental conditions stated in Section 26 05 00 without damage or degradation of operating characteristics.

2.2. DISTRIBUTION TRANSFORMERS

2.2.1. General

a) Transformer shall be built to CSA C9 Standard Ratings.

b) Certified sound levels shall be accordance with CSA.

c) Basic impulse level (BIL) ratings shall be accordance with CSA.

d) All transformers shall incorporate vibration pads between windings and tank for noise reduction.

e) Transformer grounding provisions shall consist of two ground pads. One ground pad shall be furnished near the neutral bushing if supplied. In addition, one ground pads shall be provided in each cable termination enclosure. Tapped holes with bolts shall be provided for 2-hole NEMA standard lugs. Ground pads to be stainless steel Grounding pad in each termination compartment installed shall be within 100 mm of compartment door and easily accessible location.

f) Transformer 75 kVA and smaller shall be wall mounted on brackets. Larger units shall be floor mounted.

g) Dry type transformers single-phase or three-phase shall meet minimum efficiency values as per CSA 802.2 -2006 Energy efficiency standard and bear an approved label with the verification agency logo or mark near the nameplate.

h) Surge arresters shall be located as close as possible to primary winding terminals when required on the Contract Documents.

i) A stainless-steel nameplate -mounted at eye-level height on the transformer and contained the following information: A stainless steel nameplate -mounted at eye-level height on the transformer and contained the following information:

1) Graphic representation of high voltage and low voltage winding connections;

2) kVA ratings at cooling class ratings and temperature rises;

3) Transformer impedance for ONAN rating;

4) Low voltage rating and full load current;

5) Fault withstand rating;

6) All other pertinent information normally listed on the nameplate; and

7) Serial number.

2.2.2. Materials

a) Busbars: Copper silver-plated.

b) Steel sheet: ASTM A653, coating designation Z275; galvanized steel sheet.

c) Enclosure: Heavy Duty, fabricated from galvanized steel sheet complete with heavy duty floor. Partitions and baffles of same material as enclosure. Rubber vibration pads at mounting locations. Include drip shields in damp locations, provisions for lifting and suitable for floor mounting.

d) Wall mounting brackets and fasteners: Galvanized to suit site conditions.

e) Terminal, winding, ground bus and conductor material: Copper.

f) Fasteners: Galvanized expansion bolt type.

2.2.3. Finish

a) Exterior colour in accordance with ANSI 61 gray, or manufacturer's standard colour.

b) Outside of enclosure completely painted. Use suitable surface preparation(s), pre-treatment(s), sealer(s) and primer(s) as applicable.

c) Interior surfaces of enclosure and compartments as well as parts of transformer requiring paint finish. Apply two coats of finish, CAN/CGSB-1.88 alkyd base enamel over primer, white, gloss finish. Factory standard finish providing equivalent level of quality and features, subject to approval, may be proposed under alternatives.

d) Provide touch-up paint.

2.2.4. Windings

a) All transformers shall be copper wound core type. Core shall be cast resin type.

b) Locate taps at front of coils for accessibility.

c) Construct transformer of separate primary and secondary coils, coaxially mounted.

d) Construct both Primary and Secondary coils in epoxy or polyester resin, using Epoxy Vacuum Impregnation or vacuum pressure impregnation process.

e) Insulation temperature Class

1) For 0.25 to 0.5 kVA, Class B.

2) For 0.75 to 10 kVA, Class F.

3) For 15 to 2000 kVA, Class H.

f) Provide electrostatic shielding between primary and secondary windings.

2.2.5. High Voltage Terminations

a) Supply a full-length air terminal enclosure suitable for installation of conduit seal, stress cones, cable terminations.

b) Space heater shall be provided for condensation control in primary terminal enclosure. Self powered thermostat is required.

c) Allow for safe maintenance access.

d) Manufacture shall use reusable insulated boots designed for cable terminations.

2.2.6. Low Voltage Terminations

a) Provide an air terminal enclosure with bushings suitable for the low voltage configuration indicated on the Contract Documents

1) Cablebus

2) Cables – manufacturer shall use insulated boots shall be supplied for secondary connections.

b) Space heater shall be provided for condensation control in low voltage (secondary) terminal enclosure. Self powered thermostat is required.

c) Allow for safe maintenance access.

d) Low voltage neutral shall be brought to a neutral bushing that is isolated from ground. Double connection type shall be provided. This shall be connected on site to the site ground system which can be solidly grounded or high-resistance type in accordance with Contract Documents.

2.2.7. Tap Changer

a) An externally operated tap changer, for de-energized operation, shall be provided on the high voltage winding. The tap changer handle shall have provisions for padlocking, in any operating position, and shall provide visible indication of the tap position without unlocking. For a given winding, the number 1 or the letter A shall be assigned to the tap having the greatest number of effective turns.

b) Unless otherwise noted, the tap changer shall have full capacity taps as follows:

1) Above 5 kVA: -5%, -2.5%, 0%, +2.5% and 5% of rated primary voltage; and

2) Below 5 kVA or 240 V primary: -5%, 0%, and 5% of rated primary voltage.

c) On load tap changer shall be used only under special conditions with Metrolinx approval.

2.2.8. Enclosures

a) Transformer enclosure(s) shall be heavy duty ventilated, EEMAC 3R for indoor or outdoor use.

b) Transformer arranged so all maintenance work can be carried out with access from front or back (not sides).

c) Design removable front cover for access to terminals.

d) Enclosures shall include hinged doors with facilities for padlocking.

e) Larger enclosures shall have sloped roofs.

f) Each compartment shall be illuminated with light controlled from externally accessible switch. Provide internal control power transformer for compartment illumination lights. Lamps shall be LED. Provide 15 A breaker or fuses and necessary accessories as required.

g) All electrical equipment including controls, accessories, etc., shall be installed in enclosures mounted on the transformer.

h) Enclosures shall include terminal strips for each power or control function. External wiring shall be provided with dedicated terminal strip(s).

i) Terminal strips shall be clearly identified.

2.2.9. Wiring

a) All control wiring shall be 600 V rated, #14 AWG, flexible stranded copper conductors or larger and tagged in accordance with identification requirements. CT wiring shall be #12 AWG minimum.

b) Wiring from the individual devices to the enclosure(s) shall be in rigid metallic or liquid-tight flexible conduit.

2.2.10. Accessories

a) Multi-stage winding temperature indicator for units above 400 kVA:

1) Dial or digital type indicator mounted on outside of transformer enclosure;

2) Minimum three stage type; and

3) Temperature indicator to monitor winding and transformer enclosure internal temperature.

b) All dial-type indicating devices shall be easily read from base level and one location.

2.2.11. Cooling

a) Cooling shall be dry type ANN, air cooled with ventilated enclosure to CSA C9 and CAN/CSA C22.2 No. 47.

2.2.12. Insulation

a) Insulation temperature Class

1) For 0.25 to 0.5 kVA, Class B.

2) For 0.75 to 10 kVA, Class F.

3) For 15 to 2000 kVA, Class H.

b) Insulation shall not support combustion, give off noxious fumes, or corrosive liquids.

2.2.13. Sound level

a) Certified sound levels, determined in accordance with CSA ad NEMA, shall not exceed the following:

1) Transformer Rating Maximum Sound Level (Air Cooled Dry Transformer):

i) 0 - 9 KVA 40 dB;

ii) 10 - 50 KVA 45 dB;

iii) 51 - 150 KVA 50 dB;

iv) 151 - 300 KVA 55 dB;

v) 301 - 2000 KVA 60 dB; and

vi) all other sizes shall be to NEMA ST20.

2.3. RESONANT TRANSFORMER

2.3.1. A resonant transformer is a transformer in which one or both windings has a capacitor across it and functions as a tuned circuit. Used at radio frequencies, resonant transformers can function as high Q factor bandpass filters. The transformer windings have either air or ferrite cores and the bandwidth can be adjusted by varying the coupling (mutual inductance). A common form of use is the IF (Intermediate Frequency) transformer, used in super heterodyne radio receivers. They are also used in radio transmitters.

2.3.2. Resonant transformers are also used in electronic ballasts for fluorescent lamps, high voltage power supplies and switching power supplies. One winding has a capacitor and acts as a tank circuit. The transformer is driven by pulses or square waves that serves to drive resonant sinusoidal oscillations in the tuned winding. Therefore, due to resonance effect a high voltage can be developed across the secondary.

2.4. VOLTAGE REGULATOR AND CONSTANT VOLTAGE TRANSFORMER

2.4.1. These transformers are not to be used in the design unless special permission is given by the owner.

2.4.2. With the arrangement of the magnetic properties of a transformer core, and installing a ferro-resonant tank circuit, the transformer can be arranged to keep the secondary winding voltage relatively constant for varying primary supply without additional circuitry or manual adjustment. Ferro-resonant transformers run hotter than standard power transformers because regulating action depends on core saturation, which reduces efficiency. The output waveform is heavily distorted unless careful measures are taken to prevent this. Saturating transformers provide a simple rugged method to stabilize an AC power supply.

2.5. INSTRUMENT TRANSFORMER

2.5.1. Instrument transformers are typically used to operate instruments from high voltage lines or high current circuits, which safely isolates measurement and control circuitry from the high voltages or currents. The primary winding of the transformer is connected to the high voltage or high current circuit, and the meter or relay is connected to the secondary circuit. Instrument transformers can be used as an isolation transformer.

2.5.2. Current transformer

a) Current transformers used in metering equipment for three-phase electricity supply. A current transformer (CT) is a device designed to provide a current in its secondary coil proportional to the current flowing in its primary coil or cable. Current transformers are commonly used in metering and protective relays in the electrical power industry.

b) The CT is typically described by its current ratio from primary to secondary. The secondary winding can be single ratio or have several tap points to provide a range of ratios. Care must be taken to make sure the secondary winding is not disconnected from its low-impedance load while current flows in the primary, as this may produce a dangerously high voltage across the open secondary and may permanently affect the accuracy of the transformer.

2.5.3. Potential Transformer (Voltage Transformer)

a) Potential Transformer (PT), are a parallel connected type of instrument transformer, used for metering and protection in high-voltage circuits or phasor phase shift isolation. Potential transformers are designed to present negligible load to the supply being measured and to have an accurate voltage ratio to enable accurate metering. A potential transformer may have several secondary windings on the same core as a primary winding, for use in different metering or protection circuits. The primary may be connected phase to ground or phase to phase. The secondary is usually grounded on one terminal.

2.6. POLYPHASE TRANSFORMER

2.6.1. The primary users of this type of transformer are the Utilities and are not to be used in the Metrolinx system without special permission.

2.6.2. Multiple single-phase transformers can be used to create a polyphase transformer, or all 3 phases can be connected to a single polyphase transformer.

2.6.3. For a three-phase transformer, the three primary windings are connected together, and the three secondary windings are connected together. Examples of connections are wye-delta, delta-wye, delta-delta and wye-wye. A vector group indicates the configuration of the windings and the phase angle difference between them. If a winding is connected to earth (grounded), the earth connection point is usually the center point of a wye winding. If the secondary is a delta winding, the ground may be connected to a center tap on one winding (high leg delta) or one phase may be grounded (corner grounded delta).

2.6.4. A special purpose polyphase transformer is the zigzag transformer. There are many possible configurations that may involve more or fewer than six windings and various tap connections.

2.6.5. Grounding transformer (Zigzag transformer)

a) Grounding transformers allow the three wire (delta) polyphase system supplies accommodate phase to neutral loads by providing a return path for current to a neutral. Grounding transformers most commonly incorporate a single winding transformer with a zigzag winding configuration but may also be created with a wye-delta isolated winding transformer connection.

b) The transformers can be built of indoor or outdoor applications. There are life expectancy, efficiencies and costs considerations in selecting between the transformer cooling methods.

2.7. ISOLATING TRANSFORMER

2.7.1. The designer is to use this type of transformer to solve electrical problems and provides safe power distribution system.

2.7.2. An isolation transformer links two circuits magnetically, with no metallic conductive path between the circuits. When it is necessary to prevent any leakage from the AC power system into another AC power system. Special purpose isolation transformers can shield, or prevent coupling of electromagnetic noise between circuits, or provide insulation which can withstand thousands of volts of potential difference between primary and secondary circuits.

2.8. IDENTIFICATION

a) Furnish colour coding in accordance with Metrolinx Electrical Identification and Nomenclature Specification 26 05 53.

b) Provide identification for equipment and the sub-components in accordance with Metrolinx Electrical Identification and Nomenclature Specification 26 05 53

c) Provide nameplates, warning signs and labels as required by the AHJ.

3. EXECUTION

3.1. FACTORY ASSEMBLY AND VERIFICATION

3.1.1. Assemble all components of transformer(s) in factory to ensure components fitted together in proper manner.

3.2. INSTALLATION

3.2.1. Install transformers as shown on Contract Drawings and in accordance with all applicable codes, standards and Manufacturer's instructions.

3.2.2. If it is required that any part of the transformer must be filled with liquid at the jobsite the transformer Vendor shall furnish the liquid and jobsite supervision, and shall also make available, at the jobsite, a suitable filter press and vacuum pump equipment.

3.2.3. Install transformers in level upright position.

3.2.4. Install floor mounted transformers on pad as described in Section 26 05 00.

3.2.5. Provide a minimum of four (4) fasteners for each transformer.

3.2.6. Ensure adequate clearance around transformer for ventilation.

3.2.7. Remove shipping supports only after transformer is installed and just before putting into service.

3.2.8. Mount floor mounted distribution transformers on isolation pads to minimize noise and vibration transmission and provide flexible connections online and load sides to prevent vibration transmission to other equipment. Loosen isolation pad bolts until no compression is visible.

3.2.9. Remove shipping supports in accordance with manufacturer's instructions after installation and just before putting transformer into service.

3.2.10. Ground transformers as required by CSA and ESA.

3.2.11. Make primary and secondary connections and control connections as shown on Contract Documents. Make primary and secondary connections in accordance with Accepted shop drawings and tighten connections to Manufacturer's standard torques.

3.2.12. Energize transformers immediately after installation is completed, where practicable.

3.3. TESTING AND COMMISSIONING.

3.3.1. Each transformer shall be completely tested. Certified test reports shall be furnished to Metrolinx.

END OF SECTION