METROLINX

Liquid Filled Transformer Specification

Specification 26 12 13

Revision 01
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an Agency of the Government of Ontario

Amendment Record Sheet

Amendment in Clause No.	Date of Amendment	Description of Changes
Cover page	March 2023	Removed 'Capital Projects Group'
2.14	March 2023	Updated nomenclature specification number

LIST OF CONTENT

1. GENERAL

1.1. SCOPE OF WORK

1.1.1. Design, labour, products, equipment and services necessary for liquid-filled 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 theGO 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. This type of transformer shall be used in Metrolinx owned outdoor power distribution systems design.

1.2.7. 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.

1.2.8. Equipment ratings shall be selected from industry standard ratings only.

1.2.9. Oil Natural Air Natural (ONAN) cooling is the standard configuration and all ratings shall be based on ONAN operation. Oil Natural Air Forced ONAF shall be provided when indicated on Contract Documents. Other configurations shall not be permitted without Metrolinx approval. In the case of ONAF operation the continuous transformer kVA rating shall be at least 133% of ONAN rating while still maintaining the specified temperature-rise. ONAF shall be accomplished using transformer mounted electrical powered cooling fan(s). Note that the 133% allowance is over and above the spare capacity specified in paragraph 1.2.7 of this Specification.

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

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

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

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

1.2.12. Unless otherwise mentioned in the Contract Documents the values and tolerances of sound level, impedance, losses and insulation level must follow CSA-C88 standards.

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

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

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 16 Dry Type 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 C22.1 06, Canadian Electrical Code, Part I (20th Edition), Electrical Installations.

1.4.12. CSA C227.4 06, Three Phase, Pad Mounted Distribution Transformers with Separable Insulated High Voltage Connectors.

1.4.13. NEMA (National Electrical Manufacturers Association).

1.4.14. CAN/CSA-C88-M, Power Transformers and Reactors.

1.4.15. ANSI/IEEE C57.13, Standard Requirements for Instrument Transformers.

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

1.4.17. ANSI/IEEE C57.12.80, Terminology for Power and Distribution Transformers.

1.4.18. ANSI/IEEE C57.12.90, Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers and Guide for Short-Circuit Testing of Distribution and Power Transformers.

1.4.19. ANSI/IEEE C57.92, Guide for Loading Mineral-Oil-Immersed Power Transformers Up to and Including 100 MVA with 55°C or 65°C Winding Rise.

1.4.20. ANSI/IEEEC57.98, Guide for Transformer Impulse Tests.

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

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

1.4.23. IEEE C57.106, Guide for Acceptance and Maintenance of Insulating Oil in Equipment.

1.4.24. IEEE C57.111, Guide for Acceptance of Silicone Insulating Fluid and Its Maintenance in Transformers.

1.4.25. IEEE C57.121, Guide for Acceptance and Maintenance of Less Flammable Hydrocarbon Fluid in Transformers.

1.4.26. IEEE 386, Separable Insulated Connector Systems for Power Distribution Systems Above 600 V.

1.4.27. NETA (International Electrical Testing Association) ATS, Acceptance Testing Specifications for Electrical Power Distribution Equipment

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 five 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 Package

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.

1.9.3. Certificates

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

1) Voltage ratio;

2) Polarity or angular displacement;

3) No-load losses;

4) Load loss;

5) Impedance;

6) Exciting current;

7) Temperature rise;

8) Sound level;

9) Radio influence voltage;

10) Partial discharges (corona);

11) Basic insulation impulse level;

12) Insulation resistance test;

13) Winding resistance test;

14) Short circuit test; and

15) Dielectric withstand, applied and induced.

1.9.4. 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; and

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

1.9.5. Testing and Commissioning Documentation

a) Submit testing and commissioning documentation.

1.9.6. 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 ANSI/IEEE standards and CAN/CSA-C88-M.

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.

2.1.2. Insulating Liquid shall be oil conforming to IEEE C57.106.

2.1.3. Certified sound levels, shall be accordance with CSA.

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

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

2.2. MATERIALS

2.2.1. Busbars: Copper silver-plated.

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

2.2.3. Terminal, winding, ground bus and conductor material: Copper.

2.2.4. Fasteners: Galvanized expansion bolt type.

2.3. FINISH

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

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

2.3.3. 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.

2.3.4. Provide touch-up paint.

2.4. TANK

2.4.1. Tank shall be sealed type.

2.4.2. Tanks shall be designed to withstand pressure 25% greater than maximum operating pressure.

2.4.3. Tanks shall be designed for vacuum filling in the field. Auxiliary compartments not designed for vacuum filling, shall be so designated and isolating valves shall be provided.

2.4.4. The maximum operating pressure (positive and negative) which the transformer tank is designed to withstand shall be indicated on the nameplate.

2.4.5. A sealed liquid preservation system shall be supplied for each transformer.

2.4.6. Access points shall be provided in the tank for access to transformer key internal components including primary and secondary bushings. Access through this shall required the use of tools. Where possible locate access on top of transformer.

2.4.7. Tank 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.

2.5. WINDINGS

2.5.1. All transformers shall be copper wound core type.

2.5.2. Insulation temperature Class

a) For 0.25 to 0.5 kVA, Class B.

b) For 0.75 to 10 kVA, Class F.

c) For 15 to 2000 kVA, Class H.

2.6. HIGH VOLTAGE TERMINATIONS

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

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

2.6.3. Allow for safe maintenance access.

2.6.4. Manufacture shall use reusable insulated boots designed for cable terminations.

2.7. LOW VOLTAGE TERMINATIONS

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

a) Cablebus

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

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

2.7.3. Allow for safe maintenance access.

2.7.4. 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.

2.8. TAP CHANGER

2.8.1. 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.

2.8.2. Unless otherwise noted, the tap changer shall have full capacity taps at -5%, -2.5%, 0%, +2.5% and 5% of rated primary voltage.

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

2.9. ENCLOSURES

2.9.1. All electrical equipment including auxiliary cooling fan starters and accessories, and any relays, etc., shall be installed in enclosures mounted on the transformer.

2.9.2. Enclosures shall be NEMA 4x, constructed of stainless steel, weatherproof, and shall contain a breather/drain at the bottom.

2.9.3. Enclosures shall include hinged doors with facilities for padlocking.

2.9.4. Enclosures used for thermostats and fan control equipment shall be located on one side of the transformer.

2.9.5. The number of enclosures shall be kept to a minimum.

2.9.6. Mounting height shall allow a minimum of 1 m clearance below the enclosure to ground level.

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

2.9.8. Terminal strips shall be clearly identified.

2.10. WIRING

2.10.1. 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.

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

2.11. ACCESSORIES

2.11.1. Each liquid filled transformer shall be supplied with the following accessories:

a) Magnetic liquid-level indicator;

b) The dial-type thermometer:

1) Mounted at tank top to measure top oil temperature;

2) Equipped with two pointers, one to indicate top liquid temperature at the time of reading, and the other to indicate the maximum temperature reached since the last reading;

3) Equipped with auxiliary contacts (1 trip and 1 alarm). Temperature settings for auxiliary contact operation shall be adjustable. Contacts shall be wired to the transformer control enclosure; and

4) Additional ONAF requirement: The dial-type thermometer shall include addition auxiliary contacts for fan control. Temperature settings for auxiliary contact operation shall be adjustable. Contacts shall be wired to the transformer control enclosure.

c) A pressure/vacuum gauge, mounted on the transformer tank;

d) A mechanical pressure relief device completed with one electrical alarm contact and mechanical target. Relief device shall have protective shields to prevent oil from spraying directly into personnel; and

e) A sudden pressure or fault pressure relay mounted on tank top with contacts wired to the control enclosure.

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

2.12. VALVES

a) A single globe valve shall serve as an oil drain valve, bottom filter press connection and liquid sampling valve. Valve shall be constructed of non-corroding material.

b) Globe valve shall serve as the top filter press connection and vacuum pump connection. Valve shall be constructed of non-corroding material.

c) Radiator valves are required when detachable cooling radiators are supplied.

2.13. COOLING - ONAF

2.13.1. Where indicated on the Contract Documents the transformers shall be furnished with cooling fans for ONAF operation. Fans shall be connected for both manual and automatic operation. All switches shall be operable without opening any enclosures.

2.13.2. Power supply for transformer cooling fans shall be 208 V, 3 phases provided from an external source.

2.13.3. Separate fan motor starters shall be provided for each fan where multiple fans are used.

2.14. IDENTIFICATION

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

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

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

2.14.4. 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:

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

b) kVA ratings at cooling class ratings and temperature rises.;

c) Transformer impedance for ONAN rating;

d) Tap change positions and voltage and full load currents at each tap setting;

e) Low voltage rating and full load current;

f) Fault withstand rating;

g) Maximum operating pressure;

h) Gallons or litres of liquid in tank and radiators;

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

j) Serial number.

2.14.5. Transformer shall have a permanently attached nameplate stating that the unit is free of PCB.

3. EXECUTION

3.1. INSTALLATION

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

3.1.2. 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.

3.1.3. Install transformers in level upright position.

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

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

3.1.6. Ensure adequate clearance around transformer for ventilation.

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

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

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

3.1.10. Ground transformers as required by CSA and ESA.

3.1.11. 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.

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

3.2. TESTING AND COMMISSIONING.

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

END OF SECTION