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GUIDE SPECIFICATION

DRY-TYPE DISTRIBUTION TRANSFORMERS (≤1,000 kVA, ≤1.2kV Class)

- **General Purpose Transformer**
- **Drive Isolation Transformer**
- **K-Factor Rated Transformer**
- **Harmonic Mitigating Transformer**

Note to User: Sections of the spec written in red font require modification by user. Whenever an * is used in the specification, it is to indicate that one of the following options in square brackets should be selected. The first option listed after the asterisk is the standard option which should be used if there is no preference. When [Other] is listed, the user may specify an unlisted alternative of their preference.

1 GENERAL

1.1 SCOPE

A The Contractor shall furnish and install single-phase and three-phase general purpose individually mounted dry-type transformers of the two-winding (Isolation) type, self-cooled as specified herein, and as shown on the contract drawings.

1.2 RELATED DOCUMENTS

A Drawing and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.3 REFERENCES

A NEMA ST-20 Dry-Type Transformer for General Applications.

B IEEE C57.110 Recommended Practice for establishing transformer capability when feeding non-sinusoidal load currents.

C DOE 10 CFR Part 431 Efficiency Standards; published in the Federal Register on April 18, 2013, CSA C802.2 as referenced in the Canadian Energy Efficiency Act (SOR/94-651).

D UL 1561, CSA C9-02 and C22.2 No.47.

E Natural Resources Canada, Canada Energy Efficiency Act, Energy Efficiency Regulations, SOR/2016 – 311 amendment 14

F Ontario Green Energy Act, revised by ON Reg.404-12 schedule 6 effective January 1st, 2018, last amendment O.Reg.318/17, August 1, 2017

1.4 QUALIFICATIONS

A The manufacturer shall be ISO 9001 certified

B The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years

1.5 SUBMITALS

A The following information shall be submitted to the engineer:

i Outline Dimensions & Weights

ii kVA

iii Primary & Secondary Voltage

iv Voltage taps

v Connection Diagram

vi Basic Impulse Level (BIL) for equipment over 600V

vii Design Impedance Range

viii Insulation Class

ix Temperature Rise

x Sound Level

xi Submit shop drawing and product data for approval and final documentation in the quantities listed according to the Conditions of the contract. Customer name, customer location and customer order number shall identify all transmittals.

1.6 STORAGE AND HANDLING

A Store and handle in strict compliance with manufacturer's instructions and recommendations.

B Protect from potential damage from weather and construction operations. Store where condensation will not form on or in the transformer housing and if necessary, apply temporary heat where required to obtain suitable service conditions.

C Handle transformer using proper equipment for lifting and handling, use when necessary lifting eye and/or brackets provided for that purpose.

1.7 WARRANTY

A The transformer shall carry a 12/18 month limited warranty.

2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A Rex Power Magnetics

The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if pre-approved by the Engineer ten (10) days prior to bid date.

2.2 RATINGS

A kVA Rating: *[3 – 1,000] kVA

B # of Phases: *[1], [3]

C Primary Voltage (Line to Line): Up to 600V

D Secondary Voltage (Line to line): Up to 600V

E Winding Connection:

i Three Phase: *[Dyn1], [Dd0], [Ynd1], [YNyn0], [Dyn11], [Dz0], [Other]

ii Single Phase: *[1ph0], [1ph6], [Other]

F System Frequency: *[50], [60], [Other] Hertz

G Transformers shall be designed for continuous operation at rated kVA, for 24 hours a day, 365 days a year operation, with normal life expectancy as defined in ANSI C57.96

H Typical impedance at 60Hz and rated kVA: 2.5% to 6.5%

I All Transformers shall comply with the following energy efficiency regulations, where applicable:

i DOE 2016 Low Voltage Energy Efficiency levels as per DOE 10 CFR Part 431

ii NRCan 2019 as per SOR/2016-311 amend.14

iii Ontario Green Energy Act, revised by ON Reg.404-12

Energy efficiency levels defined at 35% of full rated load under a linear load (K1) profile.

Efficiencies and load losses will be calculated at temperature reference of 75°C at Unity Power Factor (UPF) and tested as per the DOE test procedures established in CFR title 10 part 431 subpart K.

J In-rush currents not to exceed 15 x RMS.

2.3 GENERAL CONSTRUCTION:

A Transformers shall be designed, built and rated in accordance with applicable UL, CSA, NEMA, and ANSI/IEEE standards. If shipping to Europe, transformer will carry a CE mark.

B Transformers to be used for non-linear load applications shall be de-rated as per ANSI/IEEE C57.110.

C Scott-T designs not acceptable.

D Insulation system

i Transformer shall be insulated with a UL recognized minimum 220 degrees C insulation system with *[150], [130], [115], [80] degree C winding temperature rise, ventilated design.

ii Required performance shall be obtained without exceeding the above indicated temperature rise in a 40 degrees C maximum ambient and a 24-hour average ambient of 30 degrees C

E Primary Voltage Adjustment Taps: *[per NEMA ST 20], [2 x ± 5% (1FCAN, 1FCBN)], [4 x ± 2.5% (2FCAN, 2FCBN)], [2 x +2.5%, 4 x -2.5% (2FCAN, 4FCBN)], [None], [Other].

F Core construction: High grade non-aging, fully processed silicon steel laminations or better.

G Maximum magnetic flux densities shall be substantially below the saturation point.

H Coil conductors: *[Copper], [Aluminum] windings, with terminations brazed, welded or bolted.

I Impregnation:

i < 750 kVA: Core & Coils dipped in polyester resin

ii ≥ 750 kVA: Windings dipped in polyester resin.

J Excitation current: ≤ 3% of full load current rating.

K Sound level: *[As per NEMA ST-20], *[As per CSA C9], [3 dB below NEMA ST-20], [3 dB below CSA C9]

L Transformers shall terminate in mounting pads. Mechanical lugs shall be included on primary, secondary and neutral customer terminations on all aluminum and copper units up to and including 340 amp ratings. Contractors shall provide all necessary lugs not already provided with the transformer.

M BIL: 10 kV BIL for both primary and secondary coils.

N Ground core & coil assembly to enclosure with a flexible copper grounding strap or equivalent.

O Units designed for step-up applications shall be marked accordingly.

P Nameplate Material: *[2 mil White Polyester Film], [Black Anodized Aluminum], [316Stainless Steel]

Q Seismic: Transformers shall be designed and seismically qualified according to the International Building Code (IBC) 2012, and the American Society of Civil Engineers ASCE 7-10 specifications.

i Compliancy must be demonstrated by testing per ICC-ES AC156 Acceptance Criteria for Seismic Qualification by Shake Table Testing. (Applicable to floor mounted units only.)

ii Transformers must be pre-approved by O.S.H.P.D California

2.4 CONSTRUCTION – DRIVE ISOLATION TRANSFORMERS

A Where Drive isolation transformers are indicated on the drawings, the transformers shall be specifically designed to supply circuits with a harmonic profile equal to or more than a K-factor of *[4], [9], [13], [20] without exceeding *[150], [130], [115], [80] degrees C temperature rise.

B Drive isolation transformers shall be designed for use with three-phase ac adjustable frequency drives 600 volts and below to provide isolation between the incoming line and drive circuitry. These drives minimize the line disturbances caused by SCR firing within the drive unit.

C The transformer shall be specifically sized to the drive kVA requirements dictated by the horsepower of the motor and, as such, will be mechanically braced to withstand the stress of current reversals and short-circuit currents associated with the specific drive kVA rating.

D Over Temperature Protection:

i Transformer shall be shall be supplied with a *[N.C.], [N.O.] over-temperature switch(s), wired to an internal terminal strip, specified for use with class 220°C insulation systems for high temperature protection.

ii Configuration: *[one switch: 170°C or 200°C on center coil], [two switches: 170°C and 200°C on center coil], [six switches: one 170°C and one 200°C on each of the 3 coils].

E The neutral bus shall be configured to accommodate 200% of the rated current.

2.5 CONSTRUCTION – K-FACTOR TRANSFORMERS

A Where K-factor transformers are indicated on the drawings, the transformers shall be specifically designed to supply circuits with a harmonic profile equal to or more than a K-factor of *[4], [9], [13], [20] without exceeding *[150], [130], [115], [80] degrees C temperature rise.

B The neutral bus shall be configured to accommodate 200% of the rated current.

2.6 CONSTRUCTION – HARMONIC MITIGATING TRANSFORMERS

A Where Harmonic mitigation transformers are indicated on the drawings, the transformers shall be specifically designed to supply circuits with a harmonic profile equal to or more than a K-factor of *[4], [9], [13], [20] without exceeding *[150], [130], [115], [80] degrees C temperature rise.

B Single output Harmonic Mitigating Isolation Transformers with low zero sequence output impedance are designed to reduce the voltage distortion created by the 3rd and other triplen harmonic currents:

i 3rd, 9th & 15th harmonics and other zero sequence currents shall be treated within the secondary windings through cancellation of the zero sequence fluxes.

ii For 5th, 7th, 17th & 19th harmonics provide the appropriate primary-secondary phase shift in order to cancel these harmonic currents with those of other loads fed from the same primary supply.

iii The Harmonic Mitigation shall be by electromagnetic means only. No capacitors or electronics shall be used.

C Dual output Harmonic Mitigating Transformers are designed to eliminate the harmful effects of all the low frequency, odd order harmonic currents from the 3rd through 21st:

i 3rd, 9th & 15th harmonics and other zero sequence currents shall be treated within the secondary windings through cancellation of the zero sequence fluxes.

ii 5th, 7th, 17th & 19th harmonics will be cancelled in the flux of the secondary winding at low impedance with loads distributed in both outputs.

iii The Harmonic Mitigation shall be by electromagnetic means only. No capacitors or electronics shall be used.

D Primary to secondary phase-shift: *[Single], [Dual]

i Single output units - upstream cancellation of 5th & 7th harmonics: [0°] [30°]. Windings configured to provide primary-to-secondary phase shift of -30° or 0° (as specified on drawing).

ii Dual output units - upstream cancellation of 11th & 13th harmonics: [0°] [15°]. Windings configured to provide primary-to-secondary phase shift of 0° & -30° or -15° & -45° (as specified on drawing).

E The neutral bus shall be configured to accommodate 200% of the rated current.

F Zero sequence impedance/reactance at 60Hz:

i <0.95% and <0.3% respectively for sizes up to 150kVA:

ii <1.0% and <0.5% respectively for 225kVA and 300kVA;

iii <1.5% and <1.0% for 500kVA

G Fundamental current imbalance shall be reduced on the primary when compared to the secondary load measurements.

H Harmonic treatment shall be through electromagnetic means; filters, capacitors, power electronic circuitry or other such devices shall not be used to treat harmonics.

2.7 ENCLOSURE

A The enclosure shall be made of heavy-gauge *[steel], [grade 304 stainless steel], [grade 316 stainless steel].

B All transformers shall be equipped with a wiring compartment suitable for conduit entry and large enough to allow convenient wiring.

C The maximum temperature of the enclosure shall not exceed 90 degrees C per UL requirement.

D The core of the transformer shall be grounded to the enclosure.

E Enclosure Rating:

i < 15 kVA: The enclosure construction shall be ventilated, *[Type 1], [Type 3R], [Type 12] with lifting provisions.

ii ≥ 15 kVA: The enclosure construction shall be ventilated, *[Type 3R], [Type 1], [Type 12] with lifting provisions.

F Mounting:

i Ventilated units up to 750 lbs.: Wall or floor mounting.

ii Ventilated units over 750 lbs.: Suitable for floor mounting only.

G Neoprene anti-vibration pads/isolators shall be used between the transformer core and coil and the enclosure.

2.8 FINISH

A Steel enclosures shall be finished with *[ANSI 61], [Other] color, weather-resistant epoxy powder coat.

2.9 OPTIONAL ACCESSORIES

A External neoprene Anti-Vibration Isolators

B On ventilated outdoor units provide suitable weather shields over ventilation openings.

C Electrostatic Shielding:

i An independent, single, full-width electrostatic shield consisting of a single open turn of Copper placed between each primary and secondary winding and grounded. [Option: double-shielding available]

D Over Temperature Protection:

i Transformer shall be shall be supplied with a *[N.C.], [N.O.] over-temperature switch(s), wired to an internal terminal strip, specified for use with class 220°C insulation systems for high temperature protection.

ii Configuration: *[one switch: 170°C or 200°C on center coil], [two switches: 170°C and 200°C on center coil], [six switches: one 170°C and one 200°C on each of the 3 coils].

E Anti-condensation strip heater.

F Marine Duty (meet ABS requirements)

G SPD (Surge Protection Device)

3 EXECUTION

3.1 FACTORY TESTING

A The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards.

i Ratio tests at the rated voltage connection and at all tap connections

ii Polarity and phase relation tests on the rated voltage connection

iii Applied potential tests

iv Induced potential test

v No-load and excitation current at rated voltage on the rated voltage connection

B Additional type test should be made available on request include:

i BIL – basic impulse insulation level test

ii Partial discharge test

iii Sound level test

iv Temperature rise test

3.2 INSTALLATION

A The installing contractor shall install the transformer per the manufacturer's recommended installation practices as found in the installation, operation, and maintenance manual in compliance with all applicable national and local codes.

B Transformers cannot be back (reverse) fed unless specifically designed for and marked accordingly.

C Make sure that the transformer is levelled.

D Check for damage and loose connections.

E Mount transformer to comply with all applicable codes.

F Install optional vibration isolation pads between transformer enclosure and the mounting surface as needed.

G Install seismic restraint where indicated on the drawing.

H Coordinate all work in this section with all work of other sections.

3.3 FIELD ADJUSTMENTS

A Adjust taps to deliver appropriate secondary voltage.

3.4 FIELD TESTING

A Measure primary and secondary voltages for proper tap settings.