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***HPS Millennium*™ E / C**

**1.2kV thru 44kV Class**

**Vacuum Pressure Impregnation (VPI)**

**Dry-Type Medium Voltage (Power) Distribution Transformer**

**United States Canada**

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1. **GENERAL**
	1. SCOPE
		1. This section defines dry-type, enclosed and ventilated medium voltage (power) transformers as indicated.
		2. Transformers shall be designed, constructed and rated in accordance with UL, NEMA and IEEE/ANSI standards.
		3. Transformers shall be designed, constructed and rated (where applicable) in accordance with U.S. Department of Energy, Energy Conservation Program for Commercial Equipment; Distribution Transformers Energy Conservation Standards.
			1. DOE 2016 – DOE 10 CFR Part 431 Efficiency Standards; published in the Federal Register on April 18, 2013.
			2. NRCan (Natural Resources Canada), Energy Efficiency Act SOR/2018-201, amendment 14 effective April 30th, 2019.
			3. Ontario Green Energy Act, revised by ON Reg.404-12 effective January 1st, 2018.
	2. RELATED DOCUMENTS
		1. Drawing and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section
	3. REFERENCES
		1. IEEE C57.12.01 - General Requirements for Distribution, Power and Regulating Transformers
		2. ANSI C57.12.28 - Switchgear and Transformers, Pad-Mounted Equipment - Enclosure Integrity
		3. ANSI C57.12.50 - Requirements for Ventilated Dry-Type Distribution Transformers, 1-500 kVA Single-Phase and 15-500 kVA Three-Phase, with High Voltage 601-34,500 Volts, Low Voltage 120-600 Volts
		4. ANSI C57.12.51 - Requirements for Ventilated Dry-Type Power Transformers, 501 kVA and
		5. Larger Three-Phase, with High Voltage 601-34,500 Volts, Low Voltage 208Y/120-4160 Volts
		6. ANSI C57.12.55 - Conformance Standard for Transformers - Dry-Type Transformers Used in Unit
		7. Installations, Including Unit Substations
		8. IEEE C57.12.56 - Standard Test Procedure for Thermal Evaluation of Insulation Systems for
		9. Ventilated Dry-Type Power and Distribution Transformers
		10. IEEE C57.12.58 - Guide for Conducting a Transient Voltage Analysis of a Dry-Type Transformer
		11. Coil
		12. IEEE C57.12.59 - Guide for Dry-Type Transformer Through-Fault Current Duration
		13. IEEE C57.12.70 - Terminal Markings and Connections for Distribution and Power Transformers
		14. IEEE C57.12.80 - Standard Terminology for Power and Distribution Transformers
		15. IEEE C57.12.91 Standard Test Code for Dry-Type Distribution and Power Transformers,
		16. IEEE C57.94 - Recommended Practice for Installation, Application, Operation, and Maintenance of Dry-Type General Purpose Distribution and Power Transformers
		17. IEEE C57.96 - Guide for Loading Dry-Type Distribution and Power Transformers (ANSI).
		18. IEEE C57.105 - Guide for Application of Transformer Connections in Three-Phase Distribution Systems
		19. C57.110 for non-linear loads and C57.18.10 for rectifier duty if specified
		20. IEEE C57.124 - Recommended Practice for the Detection of Partial Discharges and the Measurement of Apparent Charge in Dry-Type Transformers
		21. CSA-C88 - Power Transformers and Reactors
		22. UL 1562 Transformers, Distribution, Dry-Type - Over 600 Volts
		23. DOE 2016 – DOE 10 CFR Part 431 Efficiency Standards; published in the Federal Register on April 18, 2013
		24. Natural Resources Canada, Canada Energy Efficiency Act, Energy Efficiency Regulations, SOR/2018-201 amendment 14 effective April 30th, 2019
		25. Ontario Green Energy Act revised by ON Reg.404-12 schedule 6 effective January 1st, 2018.
		26. NEMA 210 - Secondary Unit Substations
		27. NEMA TR-27 - Commercial, Institutional and Industrial Dry-Type Transformers
	4. TESTING & QUALITY CONTROL

A Production tests: each unit according to:

* CSA C9 & C22.2 No. 47
* UL 1562
* DOE 10 CFR Part 431 sub part K

B Test each model design and submit report on request

C Standard production tests to include:

* Applied potential test
* Induced voltage test
* Impedance voltage and load loss test
* Voltage ratio test
* No load and excitation current test

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

* Short circuit test
* BIL – basic impulse insulation level test
* Partial discharge test
* Sound level test
* Temperature rise test
	1. SUBMITALS
		1. Submit shop drawing and product data for approval and final documentation in the quantities listed according to the conditions of the contract.
			1. Customer name. Customer location and customer order number shall identify all transmittals.
		2. Product Data including KVA rating, Temperature Rise, Detailed enclosure dimensions, Primary & Secondary nominal voltages, primary voltage taps, no load & full load losses, impedances, unit weight, warranty; Efficiency (where applicable) per DOE 10 CFR Part 431 Efficiency Standards; published in the Federal Register on April 18, 2013 and/or NRCan 2019 and/or Ontario 404/12 (2018).
			1. Submit manufacturer's installation instructions.
			2. Units destined for the US built after January 1st, 2016, must meet the new DOE 10 CFR Part 431 Efficiency Standards; published in the Federal Register on April 18, 2013 effective as of January 1st, 2016.
			3. Units destined for Ontario and built after January 1st, 2018, must meet new ON 404/12 efficiency levels.
			4. Units destined for rest of Canada and built after April 30th, 2019, must meet new NRCan 2019 efficiency levels.
	2. STORAGE AND HANDLING
		1. Store and handle in strict compliance with manufacturer’s instructions and recommendations. Protect from potential damage from weather and construction operations. Store so condensation will not form on or in the transformer housing and if necessary, apply temporary heat where required to obtain suitable service conditions.
		2. Handle transformer using proper equipment for lifting and handling, use when necessary lifting eye and/or brackets provided for that purpose.
	3. WARRANTY
		1. The transformer shall carry a 1 year limited warranty.

(For details, refer to the manufacturers published warranty)

1. **PRODUCTS**
	1. General construction:
		1. Transformer core shall be manufactured from quality non-aging, cold rolled, fully processed silicon steel laminations. Cores are to be precisely cut to close tolerances to eliminate burrs and improve performance. Cores are to be carefully assembled and rigidly held secure with structural steel clamps to minimize gaps. Glass resin I beams shall be used as blocking coil supports for superior resistance to axial short circuit forces. Primary and secondary terminations to be mounted on separate insulated supports.
		2. Coils shall be designed for proper ventilation using [aluminum] [copper] conductors with insulated coil supports. Coils shall be disc wound above 5 kV.
		3. 220oC insulation systems based on Nomex® paper (or equivalent) shall provide long operating life and quiet operation. The complete core and coil assembly shall be vacuum pressure impregnated with a polyester varnish and oven cured to make the assembly highly resistant to moisture, dust, and other industrial contaminants. Insulation system shall be fire resistant and self extinguishing.
	2. VOLTAGE AND KVA REQUIREMENTS:
		1. Primary Voltage: [44000][34500][25000][13800][12470][6900][4160][2400][1200][other]
		2. Primary Voltage Basic Impulse Level (BIL) Rating: [10][20][30][45][60][95][110] [125][150][175][other]
		3. Secondary Voltage: [208Y/120][480Y/277][600Y/347][2400][4160][other]
		4. Secondary Voltage Basic Impulse Level (BIL) Rating: [10][20][30][45][other]
		5. kVA rating: [225] [300] [500] [750] [1000] [1250] [1500] [2000] [2500] [3000] [4000] [5000] [7500] [other]
		6. System Frequency: 60 [50] [other] Hertz
	3. Key Requirements:
		1. Standard impedance at 60Hz:
			1. 225 to 300 kVA [4% - 5%][3% - 6%][other]
			2. 500 kVA [4% - 7%][other]
			3. 750 – 5000 kVA [5.75%][4.5% - 8%][other]
		2. Name Plate Rating: Linear load [Non-Linear] 60Hz
		3. Efficiencies: (where applicable)
			1. Efficiencies will meet levels defined (where applicable) in DOE 10 CFR Part 431 in effect on January 1st, 2016.
			2. NRCan (Natural Resources Canada), Energy Efficiency Act SOR/2018-201, amendment 14 effective April 30th, 2019.
			3. Ontario Green Energy Act, revised by ON Reg.404-12 effective January 1st, 2018
			4. Efficiencies at 50% of rated load on units having a primary voltage BIL rating greater than 20kV.
			5. Efficiencies are calculated under a linear load profile.
			6. Efficiencies, no-load losses, load losses and impedance values will be calculated at temperature reference of 75°C at Unity Power Factor (UPF).
			7. Refer to the DOE 10 CFR Part 431 Energy Efficiency Standards and/or NRCan 2019 for product exemption criteria.
	4. Basic Requirements:
		1. Insulation Class: 220°C system [200][other]
		2. Temperature Rise: Average winding rise by resistance shall not exceed 150 °C [115°C] [80°C] [other] in an average 30°C and a maximum 40°C ambient.
		3. Taps: [2 x 2.5% FCAN and 2 x 2.5% FCBN)][none][other]
		4. Three-phase, common core construction. Convection air cooled [Fan Cooled]
		5. Impregnation: Vacuum pressure impregnated (VPI) polyester resin.
		6. Excitation current: 3% of full load current rating (max.)
		7. Sound level to meet IEEE C57.12.01
		8. Enclosure: Ventilated NEMA 1 [NEMA 2][NEMA 3R][NEMA 3R Enhanced c/w filters][Totally Enclosed Type 12] [Totally Enclosed Type 4][Core and Coil][other].
		9. Enclosure Finish: [ANSI 61 Grey] [ANSI 61 Grey suitable for UL50 outdoor applications] [ANSI 49][other].
		10. Anti-vibration pads/isolators shall be used between the transformer core and coil and the enclosure.
		11. UL Listed [CSA Certified][IEC Type Testing]
		12. Seismic: Transformers shall be designed and seismically qualified according to the  International Building Code (IBC) 2018, and the American Society of Civil Engineers  ASCE 7-16 specifications, with the following seismic design parameters defined:

- Spectral acceleration:         Sds

- Importance Factor:              Ip

- Attachment/height ratio:      z/h

 (Applicable to floor mounted units only.)

Transformers must be approved for O.S.H.P.D in California.

* + 1. Primary terminations shall be: [Stubs up][Designed for close coupling] to a:
			1. [metal enclosed air load break switch section]
			2. [a switchgear section]
			3. [an air terminal chamber to be provided with the transformer]
		2. Secondary terminations shall be: [Stubs up] [Designed for close coupling] to a:
			1. [metal enclosed air load break switch section]
			2. [a switchgear section]
			3. [an air terminal chamber to be provided with the transformer]

Options:

* Fan mounting provisions only for future forced air-cooling.
* Forced air-cooling. 120V Power will be supplied/ not supplied.
* Forced air cooling with 33 1/3% overload capacity without exceeding natural cool kVA rating.
* Forced air cooling shall be controlled by a digital temperature monitor that will monitor and display winding temperature fan position test switch, power “On”, fan operation “On” and excessive temperature.
* Forced air cooling system shall include: fans, control wiring, controller with test switch, current limiting fused in the power supply to the controller, indications lights, alarm silencing relay, auto/manual switch, and necessary accessories to properly control the system.
* Primary Air Terminal Compartment (ATC) shall be bolted directly to the high voltage end of the transformer section at the full height and depth of the section. ATC shall be 18” wide.
* For side entry air termination cabinet add 20 inches to the width. [required if primary disconnect switch is provided]
* Primary Air Terminal Compartment (ATC) shall provide [Clamp Type],[Pothead] terminations
* Primary Air Terminal Compartment (ATC) shall be bolted directly to the high voltage end of the transformer section at the full height and depth of the section. ATC shall be [18”][24”][36”][48”][other] wide.
* Secondary Air Terminal Compartment (ATC) shall be bolted directly to the high voltage end of the transformer section at the full height and depth of the section. ATC shall be [18”][24”][36”][48”][other] wide.
* Taps shall be FCAN 2 @ 2.5%., FCBN 2@ 2.5%. Specify if other tap arrangement is needed.
* Termination shall be [cable to coil taps][Buss to Ends – Uncoordinated][Buss to Ends Coordinated][Top Entry: Uncoordinated][Top Entry: Coordinated] [Bottom Entry: Uncoordinated][Bottom Entry: Coordinated]
* Primary: Metal-oxide, gapless-type lightning arrestors: [Station class][ Intermediate class][Distribution class]
* Secondary: Metal-oxide, gapless-type Lightning arrestors: [Station class][ Intermediate class][Distribution class]
* A grounding resistor shall be provided. (Rating to be specified by customer.)
* A Neutral Ground Monitor shall be provided.
* Thermometers: [dial 2 contacts][dial 3 contacts][4-20mA o/p thermocouple input][other]
* Trip Thermostat (1 per phase): [N.O. 200°C][N.C. 200°C][other]
* Alarm Thermostat (1 per phase): [N.O. 180°C][N.C. 180°C][other]
* Nameplate shall be [Aluminium][Stainless Steel].
* Lamacoid tag shall be [Aluminium][Stainless Steel]. Provide description of what is on Lamacoid.
* A Kirk key interlock to prevent unauthorized access shall be provided. (Option: Kirk key interlock with indicating signal light that indicates doors are open shall be provided).
* A current transformer on the HV windings shall be provided to the specification in job-specific data sheet. (customer to provide ratio and accuracy requirement)
* A current transformer on the LV windings shall be provided to the specification in job-specific data sheet. (customer to provide ratio and accuracy requirement)
* An electrostatic shield shall be provided.
* Transformer shall be designed to handle the current harmonics provided in job-specific data sheet.
* Duty Cycle shall be to attached job-specific data sheet.
* Potential transformer shall be provided to the specification provided in job-specific data sheet. (customer to provide ratio and accuracy requirement)
* A strip heater powered from separate source shall be provided**.** Strip heater power supplied by other.
* Provide 16” braided flexible leads for each Buss to End connection.
* Altitude above 3300 feet (1000 meters)[specify height]
* Rodent [Insect] screens on ventilation openings.
* Solid metal base.
* Anti-vibration pads between transformer and floor: [Anti-vibration Pads][Spring Isolators][Springs & Snubbers]
* Low Sound Level: [-3 dB][ -5 dB][-8 dB][other]
* Rolling and Skidding Base: [2 directions] [4 directions].
* Provision for Lifting and Jacking.
	1. Acceptable Product and Manufacturer:
		1. Hammond Power Solutions Inc. (U.S.: 1-800-537-0500).
		2. Hammond Power Solutions Inc. (Canada: 1-888-798-8882).
		3. Substitutions are permitted, subject to meeting all requirements of this specification and also having written approval by engineering 10 days prior to bid closing.

# ECUTION

* 1. Installation
		1. The installing contractor shall install the Dry-Type Medium Voltage (Power) Transformer per the manufacturer's recommended installation practices as found in the installation, operation, and maintenance manual and comply with all applicable codes.
		2. Make sure that the transformer is level.
		3. The transformer shall be mounted on a concrete pad unless otherwise indicated.
		4. Check for damage and loose connections.
		5. Mount transformer on suitable isolation pad to minimize vibrations.
		6. Install seismic restraint where indicated on the drawing.
		7. Coordinate all work in this section with all work of other sections.
		8. Take Infrared Picture to verify connections accuracy or deficiencies.
		9. Prior to energizing transformer, verify secondary voltages and if necessary adjust secondary taps.
		10. Report on the Commissioning of the transformer shall include:
			1. Primary & Secondary Voltages
			2. Primary & secondary THDi & THDv