Howard Industries, Inc.
Certified to ISO 9001:2015

Catolog Section
55-10

Open-Wound, Ventilated, Medium-Voltage
Dry-Type Transformers

Introduction
Howard open-wound, ventilated, medium-voltage, dry-type, transformers are designed to meet the demanding requirements of many industrial, commercial, and utility applications. Typical applications include data centers, hospitals, schools, hotels, mining, paper mills, steel mills, shopping centers, manufacturing plants, airport terminals, water treatment plants, and other applications requiring the size, weight, safety, and environmental advantages of a dry-type transformer.

Howard dry-type transformers are manufactured in the United States in an ISO 9001:2015 registered facility. The Howard design team has the expertise to serve its customers with a full range of standard or custom designed transformers that deliver dependable service and long-term reliability.

Safety and Environmental Advantages
Howard dry-type transformers provide many important safety and environmental advantages, when compared to typical oil-filled transformers.

- Lighter and smaller, reduced space requirements
- Can be installed closer to the load, reducing cable losses
- Reduced fire and explosion hazards
- No special waste disposal considerations
- Greater seismic survivability
- Low maintenance

Certifications
- ISO 9001:2015 registered
- Optional UL listed
- Compliant with applicable DOE energy efficiency requirements

Standard Ratings
Howard standard dry-type transformers are suitable for operation in relatively clean environments and under “usual service conditions” as defined by IEEE Standard C57.12.01.

- Power: 225-2,500 kVA three-phase, self-cooled AA-rated
- High-voltage rating: 2.4 kV -34.5 kV
- High-voltage BIL: up to 150 kV (per IEEE standards)
- Low-voltage rating: 120 V -600 V
- Low-voltage BIL: up to 30 kV (per IEEE standards)
- Temperature rise at rated load: 150°C (at 30°c average/40° (Maximum ambient)
- Frequency: 60Hz

Standard Design Features and Accessories
- 220°c insulation system
- Step-lap mitered core
- Core ground strap (insulated core with single ground point)
- Painted core
- High-voltage taps (two 2-1/2% above and below nominal)
- NEMA 1 enclosure
- Lifting eyes
- Provisions for rolling
- Capability for adding cooling fans (above 500 kVA)
- Electrostatically-applied powder exterior finish with urethane top coat (ANSI 61 gray)
- Ground pad
- Diagrammatic nameplate (aluminum)

Document No. 2.4.154
Revision 2
Issued: March, 2018

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Optional Design Features and Accessories

Howard excels at producing custom designs for non-standard applications and can offer numerous optional features and accessories to suit a customer's special requirements.

- Custom designs for special applications
- Loss optimization for lower total owning cost
- Higher efficiency requirement
- 50 Hz. frequency
- Non-standard ambient conditions
- Non-standard BIL level
- Non-standard altitude requirement
- Non-standard sound requirement
- Higher overload capacity
- Low X/R ratios
- K- factor rated (K1, K4, K9)
- Special seismic qualification
- Reduced vibration and vibration isolation
- Retrofit designs
- 80°C or 115°C temperature rise
- Automatic fan cooling package (FA rated)
- Digital temperature monitor
- Copper bus and windings
- Wye-wye connected windings
- Provisions for parallel operation
- Ground bus (copper)
- Medium-voltage interrupter switch
- Lightning arresters
- R/C snubbers
- Current transformers
- Potential transformers (contact factory)
- Power meter
- Control power transformer
- SCADA interface
- Space heaters with thermostat
- Flanged throats or air terminal chambers
- Special taps available
- Dust filters (for non-UL listed transformers)
- Screens for insect and rodent proofing
- Wheels
- IR windows
- ANSI 49 or ANSI 70 external gray finish
- Stainless-steel diagrammatic nameplate
- Stainless-steel enclosure

Standard Tests

The following factory tests are standard and are performed on all transformers before shipment per IEEE C57.12.01 and IEEE C57.12.91.

- Induced potential
- Applied potential
- Resistance
- Ratio
- Polarity and phase relationship
- No-load loss at rated voltage
- Exciting current at rated voltage
- Impedance and load loss
- Quality control impulse (100% full wave)

Optional Tests

The following factory tests can be provided at additional cost.

- Temperature rise
- ANSI impulse
- Sound level
- Power factor
- Partial discharge
- Customer witness test
- 500-Volt insulation resistance test (Megger®)

Applicable Standards

- IEEE C57.12.01—Standard General Requirements for Dry-Type Distribution and Power Transformers Including Those With Solid Cast and/or Resin-Encapsulated Windings
- 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
- 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 20BY/120–4,160 Volts
- ANSI C57.12.55—Conformance Standard for Transformers—Dry-Type Transformers Used in Unit Installations, Including Unit Substations
- IEEE C57.12.56—Standard Test Procedure for Thermal Evaluation of Insulation Systems for Ventilated Dry-Type Power and Distribution Transformers
- IEEE C57.12.58—Guide for Conducting a Transient Voltage Analysis of a Dry-Type Transformer Coil
- IEEE C57.12.59—Guide for Dry-Type Transformer Through-Fault Current Duration
- IEEE C57.12.70—Terminal Markings and Connections for Distribution and Power Transformers
- IEEE C57.12.80—Standard Terminology for Power and Distribution Transformers
- IEEE C57.12.91—Test Code for Dry-Type Distribution and Power Transformers
- IEEE C57.94—Recommended Practice for Installation, Application, Operation, and Maintenance of Dry-Type General Purpose Distribution and Power Transformers
- IEEE C57.96—Guide for Loading Dry-Type Distribution and Power Transformers

Coil Construction
Coils are open-wound, round or rectangular construction.
High-voltage windings are layer or disc style, and secondary windings are sheet or layer style. These parameters are determined based on the application and engineering design considerations. Layer insulation is 220 °C NOMEX®. Coils are vacuum-pressure impregnated (one cycle) with high-temperature epoxy resin. The process includes oven drying to remove moisture, submersion in resin under vacuum and mechanical pressure, and carefully controlled curing using process-controlled equipment to ensure consistency.

Core Construction
Cores are manufactured from high-permeability, cold-rolled, grain-oriented, precision-cut electrical steel. Step-lap mitered core construction and rigid bracing are used to reduce exciting current, no-load loss and sound levels. Cores are mounted on sound-absorbing material to reduce transfer of noise to the enclosure and are electrically grounded by means of a flexible ground strap.

Metal Enclosure
The metal enclosure has removable panels for access to connections and for core and coil inspection. The entire enclosure can be disassembled and removed for ease of installation and maintenance.

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Specification Guide

A. The transformer shall be the unit substation type with side-mounted high-voltage and low-voltage terminations

B. High-voltage terminations shall be designed for close coupling to [a metal enclosed air load-break switch section [a switchgear section] [an air terminal chamber to be provided with the transformer]. Low-voltage terminations shall be designed for close coupling to [a switchgear section] [a switchboard section] [an air terminal chamber to be provided with the transformers].

C. Orientation shall be high-voltage on the _____ [left] [right] when facing the transformer front.

D. The transformer(s) shall be rated [_____kVA AA] [____/_____kVA AA/FFA] [_____/_____kVA AA/FA]. High-voltage _____ volts delta. Low-voltage_____ volts [wye] [delta], [3-wire] [4-wire], 60 Hz, with two 2½% full-capacity taps above nominal and two 2½% full-capacity taps below nominal. Impedance shall be [___%] [manufacturer's standard impedance], ±7½%. All transformers shall have an average temperature rise of _____ [80] [115] [150] °C above a 40 °C maximum, 30 °C average ambient.

E. The basic impulse levels (BIL) shall be a minimum of _____ [60 kV for the15 kV class] [optional 95 kV BIL available] [10 kV for the 1.2 kV class]. High-voltage and low-voltage BIL shall be ___kV and ___kV respectively.

F. Coils shall be oven-dried and then vacuum-pressure impregnated with epoxy varnish. The total VPI process shall apply an epoxy protective shield of varnish to the coils. The varnish shall be cured on the coils following an established temperature-versus-time baking cycle in a hot-air circulating oven. The core and support structure shall be painted to provide them with a protective shield. The VPI process for the windings shall effectively impregnate the coils, and when coupled with the painted core assemble, shall result in a unit that is virtually impermeable to moisture, dust, dirt, salt air, and other industrial contaminants.

G. The coils shall be wound with [aluminum] [copper] [manufacturer's standard] conductors.

H. All insulating materials are to be in accordance with IEEE C57.12.01™ for 220 °C UL insulation system.

I. All cores to be constructed of grain-oriented or domain refined, non-aging silicon steel with high magnetic permeability, and low hysteresis and eddy current losses. Core lamination shall be miter cut at the core corners to reduce hot spots, core loss, excitation current, and sound level. The laminations shall be clamped together and held in place by a suitable steel support structure. Finished cores shall be painted.

J. The transformer enclosures shall be ventilated [indoor] [outdoor] and fabricated of sheet steel construction. Enclosures are to be provided with lifting devices bolted to the base structure. The base is to be constructed of formed steel members to permit skidding or rolling in any direction. Rubber vibration isolation pads shall be installed by the manufacturer between the core and coil and the enclosure. The core shall be visibly grounded to the ground bus or ground pad by means of a flexible grounding conductor sized in accordance with applicable UL and NEC® standards.

K. The enclosure shall be constructed of sheet steel and shall be finished externally with [ANSI 49] [ANSI 61] paint color. The paint shall be applied using an electrostatically deposited dry powder paint system. All ventilating openings shall be in accordance with NEMA and the NEC standards for ventilated enclosures.

L. Transformer sound levels shall be warranted by the manufacturer not to exceed the values specified in IEEE C57.12.01™.

M. Metal-oxide, gapless-type distribution class lightning arresters shall be installed by the manufacturer on the high voltage side of the transformer to provide additional protection against high voltage lightning or switching surges.

N. Fan cooling equipment shall include an electronic-winding temperature monitor controlled automatically by a Type K thermocouple placed in the low voltage air duct. Alarm contacts shall be provided for fans, alarm, and trip function. An audible alarm must sound when the highest phase temperature exceeds a preset point. The fans must be able to operate in either manual or automatic mode. Forced air cooling shall be provided and shall be controlled automatically by the sensor in the low-voltage air duct. The forced air cooling system shall include: fans, control wiring, controller with test switch, current limiting fuses in the power supply to the controller, indication lights, alarm silencing relay, auto/manual switch, and necessary accessories to properly control the system.

O. Testing shall be conducted in accordance with IEEE C57.12.91™ and shall include, at a minimum, the following tests:

1. Ratio
2. Polarity/phase relation
3. No-load loss
4. Excitation current
5. Impedance voltage
6. Load loss
7. Applied potential
8. Induced potential
9. Quality control impulse
10. Temperature (typical data from previous unit is acceptable)

Technical Data

Table 1: Standard Transformer Ratings, High-Voltage Rating 2.4 kV–34.5 kV, 150 °C Rise, 30°C Ambient[1]

Three-Phase kVA		Secondary Voltage	
Self-Cooled	Fan-Cooled Ventilated Dry	208Y/120 V 240 V Delta	480Y/277 V 480 V Delta
225	300	●	●
300	400	●	●
500	667	●	●
750	1,000	●	●
1,000	1,333	●	●
1,500	2,000	●	●
2,000	2,666	[2]	●
2,500	3,333	[2]	●

[1] Other standard temperature rises and low-voltage ratings are possible.

[2] Contact the factory for availability

Table 2: System Voltages and Transformer BIL Ratings

Nominal L-L System Voltage (kV)	Standard and Optional Transformer BIL Ratings									
	10	20	30	45	60	95	110	125	150	200
0.25	None									
0.6	S	1	1							
1.2	S	1	1							
2.5		S	1	1						
5.0			S	1	1					
8.7				S	1	1				
15.0					S	1	1			
18.0						S	1	1		
25.0						2	S	1	1	
34.5								2	S	1

S = Standard value.

1 = Optional higher levels where exposure to overvoltage occurs and improved protective margins are required.

2 = Optional lower levels where protective characteristics of applied surge arresters have been evaluated and found to provide appropriate surge protection.

Loading

Howard dry-type transformers may be loaded above rated kilovolt-amperes with no sacrifice of life expectancy, if operated in “usual service” conditions as specified in IEEE C57.12.01 and with loading as specified in IEEE C57.96.

Table 3: Typical Weights and Dimensions

kVA	High-Voltage Rating (Volts)	Enclosure Dimensions (Inches)			Weight (Pounds)		
		Length	Width	Height	Core & Coil Assembly	Enclosure	Total
500	13,800 (60 kV BIL)	78	54	90	3,546	1,512	5,058
750		84	54	90	4,445	1,576	6,021
1,000		84	54	90	5,693	1,576	7,269
1,500		102	60	96	7,677	1,934	9,611
2,000		114	60	102	10,721	2,160	12,881
2,500		120	60	108	14,022	2,324	16,346
500	24,940 (110 kV BIL)	96	60	96	5,345	1,866	7,211
750		108	60	102	6,859	2,090	8,949
1,000		114	66	108	8,515	2,342	10,857
1,500		120	66	114	10,151	2,513	12,664
2,000		126	66	114	13,214	2,591	15,805
2,500		132	66	114	16,327	2,668	18,995
500	34,500 (150 kV BIL)	126	66	108	8,545	2,492	11,037
750		126	66	114	10,099	2,591	12,690
1,000		126	72	120	12,276	2,789	15,065
1,500		126	78	120	16,399	2,889	19,288
2,000		144	78	132	20,108	3,364	23,472
2,500		150	78	132	25,070	3,452	28,522

Note: Weights and dimensions are approximate.

Table 4: Impedance and Loss Data

kVA	High-Voltage Rating (Volts)	IZ (Percent)	Losses (Watts)	
			No-Load	Total
500	13,800 (60 kV BIL)	5.75	1,391	6,130
750		5.75	1,629	8,627
1,000		5.75	1,983	10,333
1,500		5.75	2,814	13,015
2,000		5.75	3,683	15,299
2,500		5.75	4,391	17,231
500	24,940 (110 kV BIL)	5.75	1,730	6,021
750		5.75	2,213	8,228
1,000		5.75	2,635	10,194
1,500		5.75	3,582	13,262
2,000		5.75	4,806	14,781
2,500		5.75	5,198	18,832
500	34,500 (150 kV BIL)	5.75	1,928	5,361
750		5.75	2,349	7,774
1,000		5.75	2,568	9,960
1,500		5.75	3,910	12,106
2,000		5.75	5,005	13,867
2,500		5.75	5,852	16,246

Notes: Impedance is subject to IEEE tolerance. Loss data is typical and not guaranteed.

All designs meet DOE efficiency requirements.

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NOTES

Medium-Voltage Dry-Type Transformers

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Certified to ISO 9001:2015
10002179

Catalog Section 55-10
Document 2.4.154, Revision 2, March, 2018

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