Small Power Transformers

112.5 kVA Through 10,000 kVA

600V Through 35 kV Primary Voltage

120V Through 15 kV Secondary Voltage

# VPI

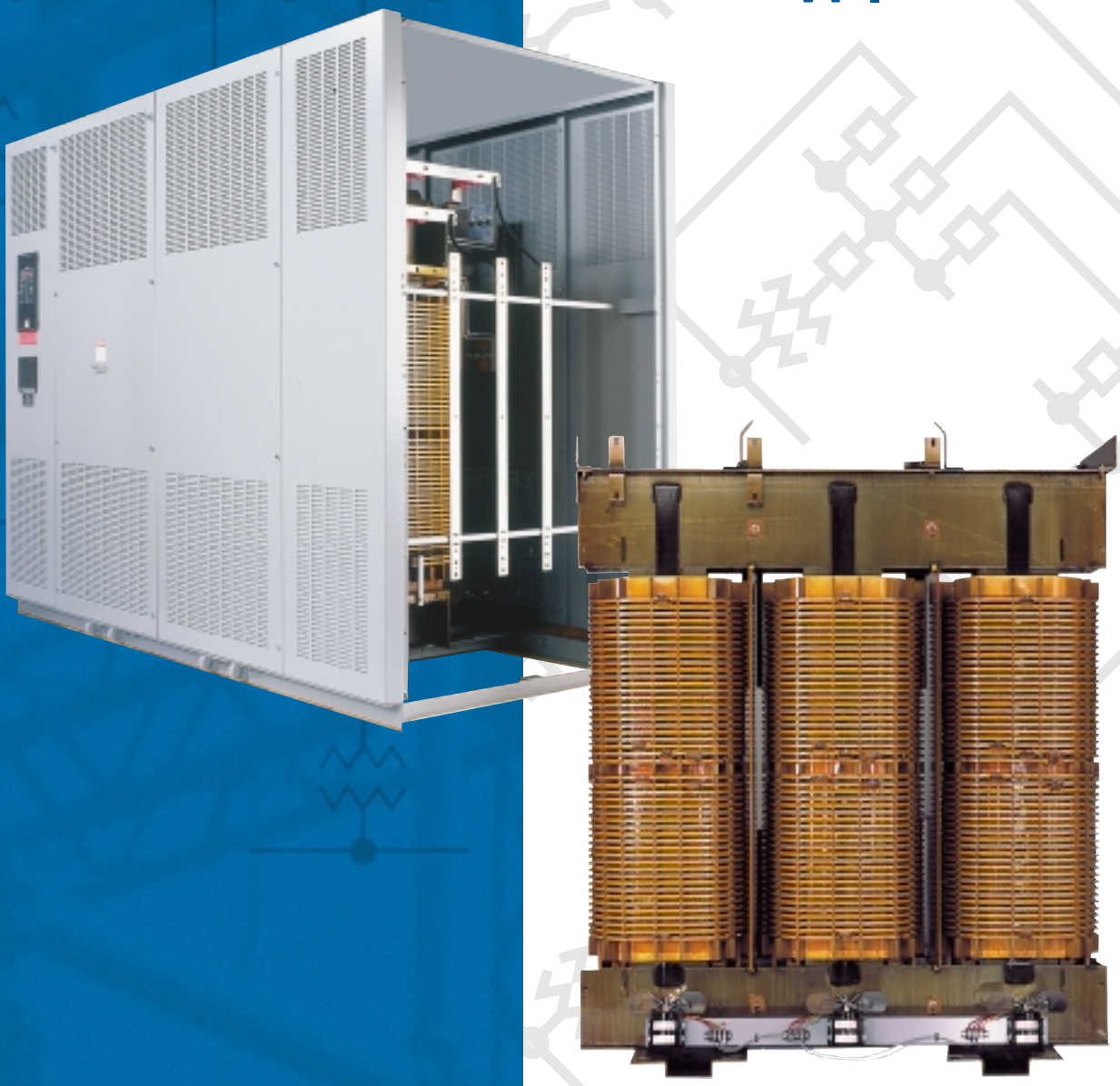


ABB Power T&D Company, Inc.

# VPI (Vacuum Pressure Impregnation) transformers are ideal for universal applications.

ABB's VPI ventilated, dry type transformers are ideal for most industrial and commercial applications. These transformers provide excellent mechanical and short-circuit strength, no danger of fire or explosion, no liquids to leak, less weight than comparable cast coil units, step-lap mitered cores, low total ownership costs and low initial costs. They use a UL listed 220˚C insulation system, regardless of temperature rating. Installation, maintenance and operation costs are making ABB's VPI transformers a solid investment.

VPI transformers are non-explosive with high resistance to flame and do not require vaults, containment dikes, or expensive fire suppression systems.

Product Scope:
- 112.5 kVA-10,000 kVA
- Primary Voltages: 600V-35 kV
- Primary BIL: Up to 150 kV
- Secondary Voltages: 120V-15 kV
- Secondary BIL: Up to 75 kV

Temperature Rise 80/115/150˚C

VPI Benefits/Advantages
- No danger of fire or explosion
- No liquid to leak
- 220˚C Insulation Class
- ISO 9001 Registered
- Emergency Support:
  Quick Ship Option (5 days)
- Custom Coordination
- On Site Service
- Technical Support
- Optional UL and CSA Certification
- Optional Nuclear 1E Certification
  -IEEE 323 - Qualified Life
  -IEEE 344 - Seismic Certification

VPI transformers are vacuum pressure impregnated with a high temperature varnish to assure environmental protection in most commercial and industrial applications.

## Quality Products...Built With Pride

As a single-source supplier, ABB is the largest and most complete manufacturer of power transmission and distribution equipment in the world. We make certain that our world renowned quality is exemplified by every product that bears our name. An experienced and dedicated work force ensures the quality of our work and your satisfaction with our products. We strive for operational excellence, lowest manufacturing costs, and short cycle times.

ABB's mission is to be the leader in delivering quality products and services for power generation, transmission and distribution, industrial processes, mass transit, and environmental control that meet the needs and requirements of our customers and contribute to their success.

To ensure customer satisfaction ABB will provide value-added, integrated solutions that are driven by superior technology and performance.

ABB's employees are committed to leadership standards in applying the Company's unique combination of experience and global resources to meet societal goals for sustainable growth and clean energy.

# The VPI Process

ABB's VPI Transformers are used in every imaginable application.

ABB's VPI transformer coils are vacuum pressure impregnated in high temperature polyester varnish. The process includes oven drying to remove moisture, complete submersion in varnish under vacuum and pressure, and regulated curing using statistically process controlled equipment to ensure consistency.

The finished coils are effectively protected against moisture, dirt, and most industrial contaminants. ABB's VPI transformers are generally suitable for use indoors or outdoors where people work and breathe.

A 220˚C Class UL Listed insulation system is used on ABB's VPI transformers regardless of specified temperature rating. This gives the 80/150˚C VPI transformer an optional reserve overload capacity of approximately 35% above the 80˚C ambient air (AA) nameplate rating.

The overload capacity is achieved with optimal conductors, BIL levels, and temperature rises.

Operational efficiency is achieved in VPI's standard transformer design from its low installation cost, low maintenance cost, and low energy costs.

VPI transformers offer design flexibility and are constantly used for power upgrades and retrofit designs.

Custom designs available

Core and coil with low voltage stub bus

Special design options:

- Seismic Qualifications
- Special Sound Requirements
- Low X/R Ratios
- Higher Overload Capacity
- Special Altitude Requirements
- Retrofit Designs
- Higher Efficiency Requirements
- Special Ambient Conditions
- Rectifier Transformer Design
- Nuclear 1E Applications
- UL Listing

# Core and Coil Construction

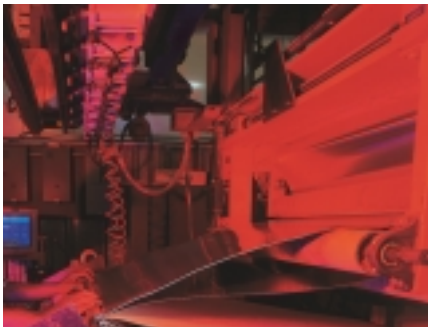
## Core Construction

ABB's VPI transformers utilize a step-lap mitered core construction to ensure optimum performance and minimal sound levels. The mitered core joints allow efficient flux transfer along natural grain lines between the core legs and yoke. The step-lap construction further enhances the efficiency of the joint by reducing joint fringing, which reduces core losses and exciting current.

The core is manufactured from high permeability, cold-rolled, grain oriented silicon steel. Magnetic flux densities are kept well below the saturation point. The steel is precision cut to assure that it will be smooth and burr-free. For rigidity and support, the upper and lower yokes are solidly clamped with steel support members. Tie plates connect the top and bottom clamps and provide a rigid structure for lifting.

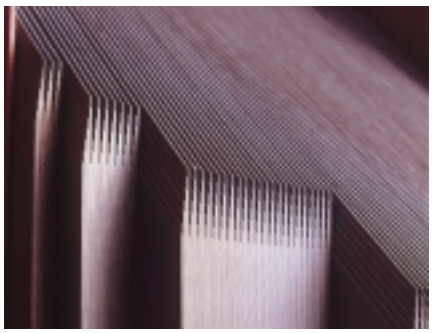
The core is designed and built to provide the lowest possible losses from the effects of magnetic hysteresis and eddy currents. All possible steps are taken to prevent local circulating currents and to avoid built-in bending stresses.

The finished core is coated with a corrosion resistant sealant which provides lamination cohesion and protection for moderate to harsh environments.



Sheet wound for short circuit integrity.

Computer controlled high voltage disk winding.



Step-lap mitered core joints are utilized for efficiency and noise reduction.

Bus connections made using bolted connections.

## Coil Construction

Winding design need not be specified unless there is a customer preference. ABB optimizes winding construction for operating voltage, basic impulse level, and current capacity of the individual winding.

Whenever possible, rectangular construction is used with sheet wound secondary windings and wire wound primary windings.

Winding construction may be either round or rectangular through 2500 kVA for VPI coils. Windings on VPI transformers with ratings greater than 2500 kVA are typically round.

ABB's low voltage VPI windings, insulation class 1.2 kV (600V) and below, are typically wound using sheet conductors. This construction allows free current distribution within the axial width of the coil which eliminates the axial forces developed in other types of windings under short circuit conditions.

The primary coil is wound directly over the secondary coil and is separated by an insulating barrier.

Aluminum conductors are standard with copper as an option.

# Indoor/Outdoor Application

VPI transformers are utilized in some of the harshest indoor and outdoor environments imaginable. While core and coil technologies have been enhanced to combat caustic and humid environments, VPI transformers still require the protection of a properly designed enclosure.

An enclosure which flexes or bends under high wind loading can compromise electrical clearances from the transformer to the enclosure, which can lead to transformer failures as well as electrical safety hazards. An enclosure that allows excess water entry into the enclosure also poses undue risk. ABB designs have been tested for extreme weather requirements and the mechanical stresses associated with seismic criteria. ABB's enclosure designs have been used along coastal areas and frigid northern slopes where high winds and driving rain are common.

ABB enclosures are custom fabricated using heavy gauge sheet steel as standard. Aluminum and stainless are also available.

Electrostatically deposited dry powder paint, baked onto a phosphated surface, provides added protection against harsh outdoor or indoor environments.

A variety of options ranging from NEMA 2 drip-proof roofs to filters, screens, hinged panels, and special hardware can be added. Modifications can be made to extend the enclosure, add bottom plates, add end sheets, and special cut-outs for specific applications.

NEMA1
Indoor Enclosure

NEMA 3R
Outdoor Enclosure

Special colors such as ANSI 24 are available.

ABB's dry powder state-of-the art paint system keeps enclosures looking new for years.

# Forced Air Cooling Increases kVA Capacity

## Provisions for future fan cooling (FFA)

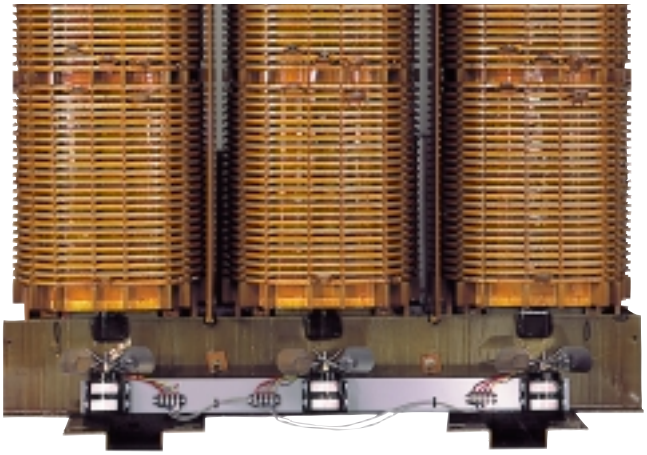
VPI transformers, when specified, can be supplied with provisions for future forced air cooling. This option includes bus work rated for increased current capacity and provisions for future installation of fans and fan control equipment.

## Forced air cooling (AA/FA)

VPI transformers, when specified, can be supplied with forced air cooling. Forced air cooling equipment includes fans, control wiring, thermal sensors, and a three phase electronic temperature monitor. The temperature sensors are located in the low voltage windings and are factory connected to the three phase winding temperature monitor which controls the forced air cooling automatically.

The three phase electronic temperature monitor tracks the transformer temperature with automatic displays and functions.

Typical location of low voltage thermocouple.



Typical forced air cooling increases the rated capacity of VPI transformers 33 1/3% on units up to 3750 kVA and 25% for units 3751 kVA and larger.

## Electronic Temperature Monitor (ETM)

The ETM combines temperature indication and fan control functions for the transformer and accepts input from three thermal sensors.

Features:

- Digital temperature display
- Hottest winding temperature is automatically displayed
- Temperature of any single winding can be displayed
- Maximum temperature can be recalled even if the supply power has been interrupted
- Fan, alarm, and trip functions are controlled by the hottest winding temperature
- DPDT contacts are provided for fan, alarm, and trip functions
- Contacts are dry
- Alarm relay is fail-safe
- Fans can be manually operated
- Includes internal sonic alarm, which can be temporarily silenced without canceling the alarm circuit
- Isolation box to separate gauge from energized components
- Alarm reset can be automatic or manual with auto condition start-up
- State-of-the-art solid state construction
- UL component recognized
- Non-magnetic Type E thermocouple standard
- Easy retrofit with existing panels
- Open thermocouple circuits are detected and indicated, but do not affect instrument operation
- Accepts 115 or 230 VAC supply power
- Form C relays.

## Optional Features

- Fan exerciser (programmable) will energize fans once per week
- Remote communication available through RS-232 port.

# Standard Enclosure Design Dimension & Weights

| 15 kV 95 kV BIL Aluminum 150˚ | | | | |
|---|---|---|---|---|
| kVA | Height Inches (mm) | Width Inches (mm) | Depth Inches (mm) | Weight Lbs. (kg) |
| 113 | 90 (2286) | 78 (1981) | 60 (1524) | 2250 (1022) |
| 225 | 90 (2286) | 78 (1981) | 60 (1524) | 2850 (1294) |
| 300 | 90 (2286) | 78 (1981) | 60 (1524) | 3200 (1453) |
| 500 | 90 (2286) | 78 (1981) | 60 (1524) | 4350 (1975) |
| 750 | 90 (2286) | 84 (2134) | 60 (1524) | 5450 (2474) |
| 1000 | 90 (2286) | 84 (2134) | 66 (1676) | 6250 (2838) |
| 1500 | 90 (2286) | 84 (2134) | 66 (1676) | 8150 (3700) |
| 2000 | 90 (2286) | 96 (2438) | 66 (1676) | 9350 (4245) |
| 2500 | 90 (2286) | 102 (2591) | 66 (1676) | 11,050 (5017) |
| 3000 | 102 (2591) | 108 (2743) | 66 (1676) | 14,750 (6697) |

| 15 kV 95 kV BIL Copper 80˚ | | | | |
|---|---|---|---|---|
| kVA | Height Inches (mm) | Width Inches (mm) | Depth Inches (mm) | Weight Lbs. (kg) |
| 113 | 90 (2286) | 78 (1981) | 60 (1524) | 2950 (1339) |
| 225 | 90 (2286) | 90 (2286) | 60 (1524) | 4250 (1930) |
| 300 | 90 (2286) | 90 (2286) | 60 (1524) | 4650 (2111) |
| 500 | 90 (2286) | 96 (2438) | 66 (1676) | 6350 (2883) |
| 750 | 90 (2286) | 102 (2591) | 66 (1676) | 8150 (3700) |
| 1000 | 90 (2286) | 102 (2591) | 66 (1676) | 9200 (4177) |
| 1500 | 102 (2591) | 108 (2743) | 66 (1676) | 12,050 (5471) |
| 2000 | 102 (2591) | 114 (2896) | 66 (1676) | 14,850 (6742) |
| 2500 | 112 (2845) | 126 (3200) | 66 (1676) | 18,550 (8422) |
| 3000 | 112 (2845) | 144 (3658) | 66 (1676) | 20,850 (9466) |

Values listed are typical and should not be used for construction purposes.

## ANSI/IEEE Loading Guide

| Times Rated kVA 150˚ Insulation System Following and followed by a constant load of | | | | | | |
|---|---|---|---|---|---|---|
| Peak Load in Hours | 90% | (1) | 70% | (1) | 50% | (1) |
| 1/2 | 1.56 | (210) | 1.64 | (217) | 1.71 | (220) |
| 1 | 1.37 | (196) | 1.42 | (203) | 1.45 | (206) |
| 2 | 1.27 | (181) | 1.29 | (185) | 1.30 | (186) |
| 3 | 1.19 | (165) | 1.21 | (169) | 1.21 | (169) |
| 4 | 1.14 | (155) | 1.14 | (156) | 1.15 | (158) |

Daily loads above rating to give normal life expectancy.
(1) Maximum Hottest—spot temperature reached during load cycle.

Winding Temperature Indicator and typical nameplates

Winding Temperature Indicator provided with isolation barrier for added safety.

Coordinated low voltage bus termination with flexible connectors.

# Quality Assurance

The following tests are made on all transformers unless noted as an exception. The numbers shown do not necessarily indicate the sequence in which the tests will be made. All tests will be made in accordance with the latest revision of ANSI C57.12.91 Test Code for Transformers.

1. Resistance measurements of all windings on the rated tap and on the tap extremes on one unit of a given rating on a multiple unit order
2. Ratio Tests on the rated voltage connection and all tap connections
3. Polarity and Phase-relation Tests
4. No-load loss at rated voltage
5. Excitation current at rated voltage
6. Impedance and load loss at rated current on the rated voltage connection of each unit and on the tap extremes on one unit of a given rating on a multiple unit order
7. Applied Potential Tests
8. Double Induced Potential Test.

## Optional tests which are routinely performed:

Temperature Tests will be made when a record of a Temperature Test that has been made in accordance with ANSI standards is not available on a duplicate or essentially duplicate unit.

Temperature Test or tests will be made on one unit only of an order covering one or more units of a given rating.


VPI transformers have successfully passed ANSI Short Circuit Tests.


VPI transformers are manufactured in an ISO 9001 Certified factory.

## Optional Tests:

1. Impulse Tests-full and chopped-wave Tests per ANSI and NEMA standards
2. Quality Control Impulse Test (100% full wave)
3. Audible Sound Level Test
4. Induced Partial Discharge
5. Temperature Test
6. Insulation Power-factor Test
7. Switch and Soak Test
8. Short Circuit Test
9. Seismic Qualification.

ABB's quality assurance begins with contract negotiations and continues through design, control of purchased materials, manufacturing and test, and is not complete until the transformer is installed and operating successfully in the customer's application for many years.

LISTED 93DO DISTRIBUTION TRANSFORMER

LISTED 93DO DISTRIBUTION TRANSFORMER

NUCLEAR 1E CERTIFICATION
IEEE 323—QUALIFIED LIFE
IEEE 344—SEISMIC CERTIFICATION

# Specifications

| Self-Cooled Power Rating kVA | Primary Voltage kV | Primary BIL kV | Secondary Voltage kV | Secondary BIL kV | Temperature Rise C |
|---|---|---|---|---|---|
| 112.5-10,000 | Up through 35 | Up to 150 | Up through 15 | Up to 75 | 80/115/150˚ |

## Standard VPI Features

1. Aluminum windings—copper optional
2. Step-lap mitered core
3. 220˚C insulation system-150˚C average temperature rise
4. Vacuum pressure encapsulated in silicone varnish
5. Four (4) full-capacity taps on HV winding rated 2 1/2% 2-FCAN—2-FCBN on units with voltage above 601V
6. NEMA 1 heavy-gauge ventilated enclosure with removable panels front and rear
7. ANSI 61 gray paint electrostatically applied using dry powder
8. Vibration isolation pads between core and coil and enclosure
9. Base equipped with jacking pads and designed for rolling or skidding enclosure in any direction
10. Provisions for lifting core and coil assembly
11. Diagrammatic aluminum nameplate
12. Short Circuit Design Verification

## Options & Accessories

____ UL listing

____ CSA certification

Nuclear 1E certification:

____ IEEE 323—qualified life

____ IEEE 344—seismic certification

____ NEMA 3R enclosure

____ 80˚C or 115˚C average temperature rise

____ Copper windings

____ Provisions for future fan fooling (FFA)

____ Three-phase electronic temperature monitor

____ Forced cooling package with three-phase electronic temperature monitor

____ Increased basic impulse levels

____ Loss optimized designs

____ Air-filled terminal chambers

____ Special paint colors

____ Retrofit designs

## Temperature Rise

| Temperature Rise | Base Rated kVA | 150˚C Rise kVA | Fan Cooled kVA |
|---|---|---|---|
| 150˚C | 1000 | 1000 | 1333 |
| 115˚C | 1000 | 1150 | 1530 |
| 80˚C | 1000 | 1350 | 1800 |

VPI transformers are constructed with 220˚C class insulation and have a maximum temperature rise of 150˚C.

When ordered with 115˚C rise, the VPI transformer (if specified) will have a 115% continuous overload capability (153% with fans). AA/FA/FA

VPI transformers, when ordered with a 80˚C rise (if specified), will have a 135% continuous overload capability (180% with fans). AA/FA/FA

## Standards and Certifications

ANSI C57.12.01

ANSI C57.12.91

ANSI N45.2-1977

UL

NRC 10CFR50 Appendix B

ISO 9001

NEMA ST20

CSA Z 299.3

MIL-I-45208A

Qualified for manufacture of Nuclear Class 1-E, Safety Related Transformers including IEEE 344 Certification.

## Standard Transformer Ratings

Primary Voltage Class 600V through 34.5 kV 150˚C rise 30˚C average ambient

| kVA 3-Phase | | | Secondary Voltage | | |
|---|---|---|---|---|---|
| Self-Cooled | Fan-Cooled Ventilated Dry | Fan-Cooled Weather Resistant Ventilated | 208Y/120 240 Delta | 480Y/277 480 Delta | 2400 Delta 4160Y / 2400 4160 Delta |
| 112 1/2 | — | — | X | X | — |
| 150 | — | — | X | X | — |
| 225 | — | — | X | X | — |
| 300 | 400 | 400 | X | X | — |
| 500 | 667 | 667 | X | X | X |
| 750 | 1000 | 1000 | X | X | X |
| 1000 | 1333 | 1333 | X | X | X |
| 1000 | 1333 | 1333 | X | X | X |
| 1500 | 2000 | 2000 | X | X | X |
| 2000 | 2666 | 2666 | — | X | X |
| 2500 | 3333 | 3333 | — | X | X |
| 3750 | 4687 | 4687 | — | — | X |
| 5000 | 6250 | 6250 | — | — | X |
| 7500 | 9375 | 9375 | — | — | X |
| 10,000 | 12,500 | 12,500 | — | — | X |

"X" denotes standard or available.

## Altitude Derating Factor

| Altitude (FT) | kVA Correction | | BIL Correction |
|---|---|---|---|
| | VPI (AA) | Forced Air (FA) | |
| 3300 | 1.00 | 1.00 | 1.00 |
| 4000 | .994 | .989 | .98 |
| 5000 | .985 | .974 | .95 |
| 6000 | .975 | .959 | .92 |
| 7000 | .966 | .944 | .89 |
| 8000 | .957 | .929 | .86 |
| 9000 | .948 | .914 | .83 |
| 10,000 | .939 | .898 | .80 |
| 11,000 | .930 | .883 | .77 |
| 12,000 | .921 | .868 | .75 |
| 13,000 | .912 | .853 | .72 |
| 14,000 | .903 | .838 | .70 |
| 15,000 | .894 | .823 | .67 |

NOTE: 3.28 FT = 1 Meter

## Audible Sound Levels

| Equivalent Two-Winding (kVA) | Self-Cooled | Ventilated Forced Air Cooled | |
|---|---|---|---|
| | Ventilated (Class AA Rating) | kVA | Class FA and AFA Rating |
| 0-9 | 40 | 0-1167 | 67 |
| 10-50 | 45 | 1168-1667 | 68 |
| 51-150 | 50 | 1668-2000 | 69 |
| 151-300 | 55 | 2001-3333 | 71 |
| 301-500 | 60 | 3334-5000 | 73 |
| 501-700 | 62 | 5001-6667 | 74 |
| 701-1000 | 64 | 6668-8333 | 75 |
| 1001-1500 | 65 | | |
| 1501-2000 | 66 | | |
| 2001-3000 | 68 | | |
| 3001-4000 | 70 | | |
| 4001-5000 | 71 | | |
| 5001-6000 | 72 | | |
| 6001-7500 | 75 | | |

## BIL's Associated Voltages

| Nominal System Voltage (kV) | BIL's in common use (kV crest) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10 | 20 | 30 | 45 | 60 | 95 | 110 | 125 | 150 | 200 |
| 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 | | | |
| 25.0 | | | | | | 2 | S | 1 | 1 | |
| 34.5 | | | | | | | | 2 | S | 1 |

NOTES:
S = Standard value.
1 = Optional higher levels where exposure to overvoltage occurs and improved protective margins are required.
2 = Lower levels where protective characteristics of applied surge arresters have been evaluated and found to provide appropriate surge protection.

## Impedance Chart

| kVA | ANSI Std. | ABB |
|---|---|---|
| 112.5-500 | None Specified | 5.75% |
| 501 & Larger * | 5.75% | 5.75% |

* For Units with 60 kV Primaries and below.

# Specification Guide

The transformer shall be of Vacuum Pressure Impregnated construction (VPI) and shall be mounted in a suitably ventilated (indoor, outdoor) enclosure.

The transformer shall be manufactured by a company which is certified to ISO 9001:1994, EN ISO 9001:1994; BS EN ISO 9001:1994; ANSI/ASQC Q9001: 1994 for design and manufacture of Power, Distribution and Specialty Dry Type Transformers. A certificate of Compliance to this requirement shall be provided with the proposal.

The transformer shall be rated _____ kVA with a primary voltage of _____kV (delta,wye) connected and have a BIL rating of _____ kV and a secondary voltage of _____V (delta,wye) connected and have a BIL rating of _____ kV.

The transformer is to have an impedance (per manufactures standard, _____ %IZ.)

The average temperature rise of the transformer windings shall be rated at (80˚C, 115˚C, 150˚C) and shall be built utilizing Class 220˚C insulations, regardless of the temperature rise specified. The transformer shall not exceed the specified temperature rise when the unit is operated continuously at full nameplate rating. The transformer shall be capable of carrying 100% of the nameplate rating in a 30˚C average, not to exceed 40˚C maximum ambient in any 24 hour period.

The high voltage and low voltage windings shall be constructed using (copper, aluminum) conductors. The conductors shall be insulated with a 220˚C insulation. Transformer windings, insulation class 1.2 kV (600V) and below, shall be wound using foil or sheet conductors.

Transformer windings, insulation class 2.5 kV (2400V) and above, shall be wound using wire conductors. The high voltage winding shall be wound over the low voltage winding with sufficient mechanical bracing to prevent movement during fault conditions and sufficient solid Class 220˚C insulation to isolate the high voltage winding dielectric potential from the low voltage windings.

The transformer core shall be constructed of high grade non-aging silicon steel laminations with high magnetic permeability and low hysteresis and eddy current losses. Magnetic flux densities are to be kept well below the saturation point. A step-lap mitered core joint shall be used to minimize losses, exciting currents and sound levels. The core laminations shall be clamped together with heavy steel members.

After installation of windings on core and stacking of the top yoke core steel, core and coil assembly is to be secured with a welded frame. Primary and secondary coordination bus assemblies, as required for connection to associated switchgears are to be of (welded, bolted) construction.

The coils and all clamping structure and buswork shall be assembled on the core, and then dried at atmospheric pressure in an oven through which hot air is continuously circulated. The totally assembled core and coil assembly shall be vacuum pressure impregnated in polyester varnish. The total VPI process shall apply a one (1) cycle polyester protective shield of varnish to the coils and a protective shield to the bus, core and support structure. The varnish shall be cured on the core and coil assembly following an established temperature vs. time baking cycle in a hot air circulating oven. The VPI process shall effectively impregnate the entire core and coil assembly which results in a unit which is virtually impermeable to moisture, dust, dirt, salt air and other industrial contaminants.

The transformer shall have vibration isolation pads installed between core and coil assembly and enclosure base structures to prevent the transmission of structure borne vibration.

The impulse rating of the transformer must equal or exceed the basic impulse level specified by ANSI for the applicable voltage class. The basic impulse level shall be inherent to the winding design and is to be obtained without the use of supplemental surge arresters.

The enclosure shall be constructed of heavy gauge sheet steel and shall be finished in 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. The base of the enclosure shall be furnished with ground pads located on opposite diagonal corners. The base shall have jacking pads and shall be constructed of heavy steel members to permit skidding or rolling in any direction. The core shall be visibly grounded to the frame by means of a flexible grounding strap.

Forced air cooling, when required, shall increase the continuous self cooled rating of the transformer by 33 1/3% on units through 3750 kVA and by 25% on units greater than 3750 kVA. The FA increase shall be possible with forced cooling without exceeding the specified maximum temperature rise. The forced air cooling shall be regulated automatically by sensors placed in the low voltage winding's air ducts. Forced air cooling shall include: three phase electronic digital temperature monitor, fans, control wiring, control panel with test switch, indicator lights, alarm and alarm silencing switch.

When 80˚C and 115˚C winding temperature rise are specified, they can be designed with inherent overload capabilities. An 80˚C rise unit shall be capable of continuous operation at 35% above nameplate rating and a 115˚C rise unit shall be capable of continuous operation at 17% above nameplate rating when specified. This overload capability would be achieved on the AA and FA rating and shall be accomplished by allowing the transformers ultimate rise to be 150˚C. Customer specification must define the high capacity overloads.

After completion, each transformer shall undergo the following routine tests per ANSI C57.12.01 and ANSI C57.12.91. Testing shall be accomplished using calibrated test equipment which have recorded accuracy traceable to National Institute of Standards Technologies (NIST). Certification of Calibration shall be provided with test reports, if requested.

In addition to routine testing a 100% QC Impulse Test shall be performed on each transformer furnished.

<u>Routine Tests</u>

- Megger
- Ratio
- Resistance
- Phase relation
- Load Loss, Impedance and Regulation
- No Load Loss and Excitation Current
- 100% QC Impulse Test
- Applied Potential Test
- Induced Potential Test


Descriptive Bulletin 47-650

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**Small Power Transformers**

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