

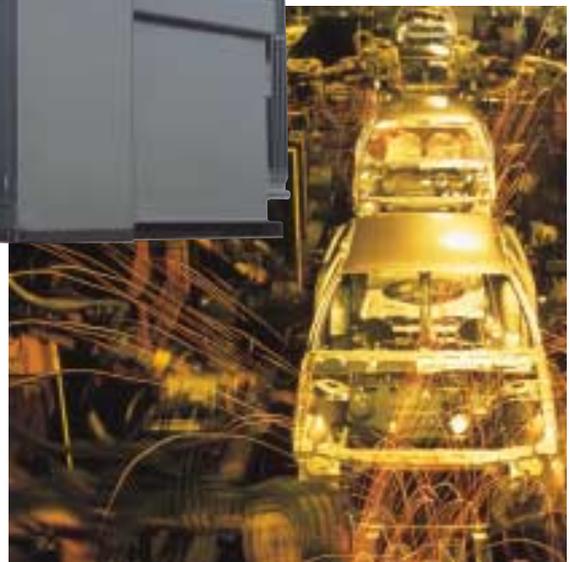
# Padmount

Small Power Transformers

2500 kVA Through 20,000 kVA

5 kV Through 46 kV Primary Voltage

120V Through 25 kV Secondary Voltage



## ABB's Padmounted Transformers provide tamper-resistant protection in a compact package for underground power distribution systems.

Padmounted Transformers feature tamper-resistant construction which prevents entry by unauthorized personnel. The bolts, hinges, screws, and fasteners are not accessible in this safe, self-contained unit.

Padmounted Transformers utilize a rectangular core and coil design that is a distinguishing characteristic of ABB small power liquid filled transformers. This proven design provides excellent mechanical strength, dependability, and space-saving economy needed for underground power distribution.

With most ratings, a choice of fluids including mineral oil, silicone, R-Temp®, and BIOTEMP® is offered. Mineral oil is typically specified for outdoor applications. When flammability is a concern, Silicone or R-Temp are generally used. BIOTEMP is used anywhere any insulating fluid spill could require expensive clean-up procedures.

### Product Scope:

- 2500 kVA-20,000 kVA
- Primary Voltages: 5 kV Through 46 kV
- Secondary Voltages: 120V Through 25 kV
- Three Phase

### Available Fluids:

- Mineral Oil
- Silicone
- R-Temp®
- BIOTEMP®

### Padmounted Benefits/Advantages:

- Rectangular core/coil design
  - Minimal size: space saving
  - Minimal weight: energy saving
- Captive and recessed tamper-proof hardware in LV compartment door
- Tamper resistant
- Insuldur® layer insulation system for thermal upgrade and mechanical strength
- DuraBIL® turn insulation superior adhesion, abrasion resistance, and thermal stability
- High efficiency with best combination of initial cost and low operating cost.



ABB Padmounted Transformers are completely factory assembled and are shipped as one-piece.

## 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 cost, 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 evolution of ABB's rectangular core and coil design

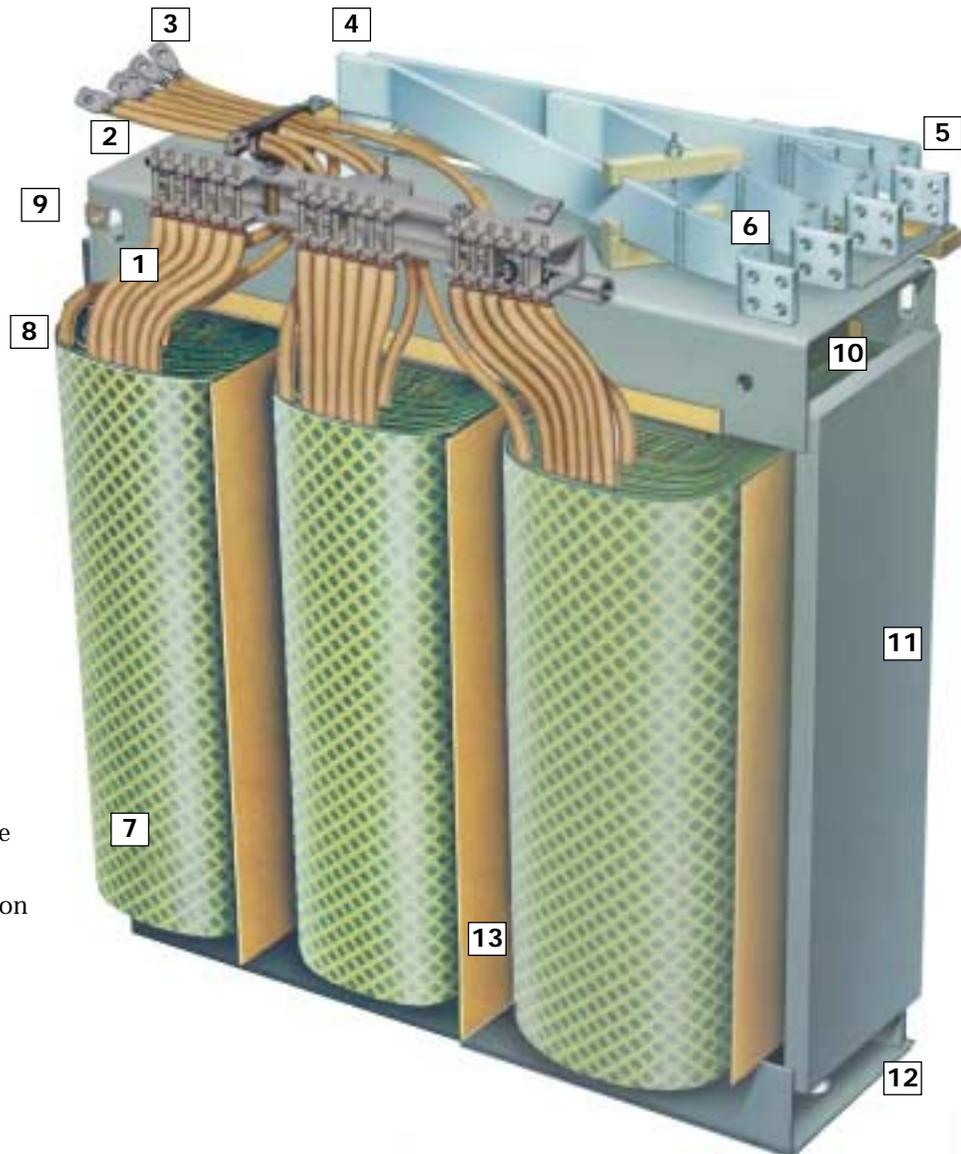
The basic configuration of a transformer core was originally circular, due to the natural shape suggested by a coil. As space and material considerations became more critical, engineers explored more efficient methods for transformer design. The greatest incentive for change came from the excessive cost of vault space in larger cities.

In 1954, after more than a decade of

research and development, the first rectangular core and coil was placed into commercial service. Service records starting then and up through today have shown the overall superiority of the rectangular core and coil design for conserving space and materials. Just as importantly, the rectangular core and coil has an outstanding record for reliability, strength, and efficiency. This has been demonstrated

through successful short circuit tests, as defined by ANSI standards, in addition to thousands of service years in the field.

ABB has continued development and testing of the rectangular core and coil design. Advanced materials and state-of-the-art manufacturing techniques currently allow ABB to offer ratings through 20,000 kVA and 69 kV.



## The rectangular core and coil process

ABB's rectangular design offers excellent mechanical strength that has been proven through years of service and in special testing.

The mechanical strength is achieved through the use of a unique six-piece supporting structure. This supporting structure is assembled in a pressure jig around the core and coils and arc welded to form a rigid structure.

The top and bottom pieces exert a clamping action on the yokes of the core to hold the laminations firmly in place and more importantly, to achieve optimum sound attenuation by using a precalculated pressure. Welding holds this preload for a permanently quiet core.

Steel end plates are pressed into position and welded to the top and bottom pieces to form a permanent framing. The thickness of the end plate is calculated for each design. The end plate's calculated thickness provides the beam strength required to minimize the tendency of the wide, flat part of the outside coils to "round out" during fault conditions.

### The Core

The rectangular core is a series of laminations made from high-quality, grain-oriented silicon steel.

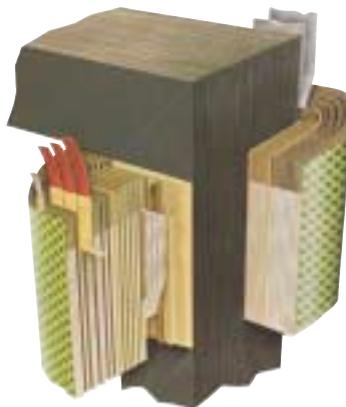
The stacked core provides a superior flux path by utilizing a step-lap mitered core joint. The effective way in which the core is supported, as well as the efficient step-lap joint, have resulted in: decreases in exciting current up to 40%; reductions in sound levels up to 3 db; and reductions in no load loss up to 10%.

The rectangular-shaped core efficiently



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

fills the corresponding shaped opening in the coil with a minimum of unused space. The short yoke between the core legs reduces the external path of the flux between active core leg material, resulting in an increase in efficiency. The rectangular shape of the core allows for more uniform and rigid support which prevents the shift of laminations and improves sound level characteristics.



The core efficiently fills the similar shape opening in the coil to minimize unused space.

### The Coil

ABB coils feature aluminum or copper conductors in both high and low voltage windings. The low voltage winding is accomplished on a constant tension machine and consists of a full-width or part-coil sheet conductor extending the full height of the coil.

The advantage of the low voltage sheet is a continuous cross section of conductor that allow the electrical centers of high and low voltage windings to easily align themselves, virtually eliminating the vertical component of short circuit force.

The high voltage windings use wire conductors and are wound directly over the low voltage winding on a constant tension traversing machine. The high voltage conductors are typically insulated with ABB's exclusive DuraBIL® turn insulation.



DuraBIL turn insulation

### Turn Insulation

Traditional crepe paper or NOMEX tape is used in some design considerations. However, DuraBIL, which is a tough, flexible and inert turn insulation, is used in most designs. It

reduces the most prevalent cause of transformer failure: deterioration of turn insulation.

DuraBIL is a single layer of epoxy powder deposited electrostatically and baked on the wire conductor. The process is closely controlled and monitored to insure a continuous, uniform coating. The result is a compact turn insulation with superior characteristics, including: adhesion; flexibility; abrasion resistance; and thermal and chemical stability.

DuraBIL will not degrade and contaminate the transformer fluid with moisture. Beyond the chemical attributes, DuraBIL maintains dimensional stability and the coil's structural integrity.

### **Insuldur® Insulation**

Insuldur insulation thermally upgraded kraft paper is typically used for layer and high to low insulation.

The Insuldur system of chemical stabilizers thermally upgrades cellulose insulating materials to permit a 12% higher load capacity. Insuldur can be used with all fluids offered with ABB small power transformers.

Chemical stabilizers retard insulation breakdown under elevated temperature conditions. Additionally, dimensional changes in the insulating materials are minimized to insure a tighter structure. The result is greater strength and coil integrity throughout the life of the transformer.

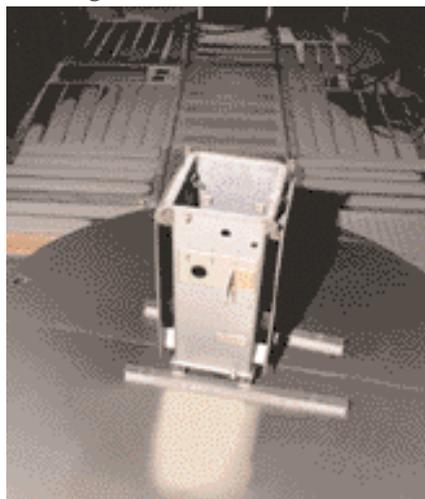
The Insuldur system allows a unit rated at 55°C rise to be operated at a 10°C higher temperature, with a 12% increase

in kVA capacity. Generous oil ducts extend the height of the coil to provide cooling in the winding. The staggered, diamond epoxy bonds help assure free oil flow through the winding.

### **Coil Construction**

The Insuldur layer insulation is coated with a diamond pattern of B-stage epoxy adhesive, which cures during processing to form a high-strength bond. This bond restrains the windings from shifting during operation or under short circuit stresses. The high-to-low insulation is placed over the low voltage winding and the wire-wound high voltage is wound directly over the low voltage, forming a high-strength coil assembly.

Accurately-located taps and a large winding cross section keep unbalanced ampere turns to a minimum. Unbalanced ampere turns create forces during short circuit that drive the high voltage and low voltage coils apart vertically. By minimizing this imbalance, vertical forces are correspondingly reduced and the design is stronger under short circuit stresses.



Tank surface preparation is accomplished using a state-of-the-art shot blast facility.

The large areas presented by the layer-type winding result in a low ground capacitance, which gives a nearly straight line surge distribution throughout the winding. A compact, high-impulse-strength coil is the result.

### **Tank Construction**

The transformer tank is designed to withstand a pressure 25% greater than the maximum operating pressure.

The carbon-steel plate used to form the tank is reinforced with external side wall braces, and tank seams are continuously welded.

Each cooler assembly is individually welded and receives a pressurized check for leaks prior to assembly on the tank. After the coolers are attached to the tank, the completed tank assembly is leak-tested before shipment.



High voltage and low voltage compartments

### **Terminating Compartments**

Tamper-resistant, weather-resistant HV and LV terminating compartments are side-by-side, separated by a metal barrier.

## MicaFil low frequency heating chamber

Effectively removing the moisture from the cellulose insulation is a key process in transformer manufacturing. The quality of the drying of the insulating material is critical in meeting dielectric requirements and assuring trouble-free service for users. MicaFil low frequency heating is a state-of-the-art process for drying transformers.

## MicaFil low frequency heating insulation drying process

- The insulation is dried in its own tank and is never exposed to the atmosphere once it dries.
- The windings are heated uniformly, so the insulation deep in the coils reaches a temperature that promotes moisture removal during the vacuum cycle.
- The moisture level of the air in the vacuum exhaust is monitored constantly to ensure that the insulation is dry when the process is completed.
- The drying process cycle time is reduced by up to 60% less than the oven and vacuum methods.

## Fluid Preservation Systems

### Sealed Tank

The Sealed Tank system is basic to all ABB network transformers. The tank is filled under vacuum and sealed so that throughout a top-oil temperature range of -5°C to +105°C, the gas-plus-oil volume will remain constant within limits defined by standards.



MicaFil low frequency heating is a state-of-the-art process for drying transformers.

## Transformer Fluids

### Mineral Oil

Mineral oil is primarily used in outdoor applications.

ABB offers transformers designed with less flammable fluids—silicone, R-Temp®, and BIOTEMP®—that can be used to meet National Electric Code 450-23 for indoor applications.

### Silicone

Silicone is a less flammable dielectric coolant for transformer applications and features heat stability, material compatibility, low flammability, and low toxicity. Silicone's high fire point of 340°C qualifies it as a less flammable fluid, which is U.L. Listed and factory mutual approved for indoor and outdoor use. It's a good choice in areas where potential fire hazards

exist and special fire-suppressant systems are installed.

### R-Temp®

R-Temp fluid is classified as less flammable and is available when flammability is a concern. R-Temp fluid is Factory Mutual Approved and U.L. Listed for indoor and outdoor use.

### BIOTEMP®

BIOTEMP is a fully biodegradable, environmentally-friendly dielectric fluid. In a 21-day period, BIOTEMP has been tested to be 97% biodegradable. BIOTEMP is Factory Mutual Approved and U.L. Listed. BIOTEMP is suitable for application indoors and in areas of heightened environmental sensitivity where any insulating fluid spill could require expensive clean-up procedures.

## 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 C57.12.90 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. Induced Potential Test
9. Mechanical Leak Test.

### Optional tests

The following additional tests can be made on any substation transformer. All tests are made in accordance with the latest revision of ANSI Standard Test Code C57.12.90.

1. ANSI Impulse Test
2. Quality Control Impulse Test
3. ANSI Front-of-Wave Impulse Test
4. Temperature Test
5. Sound Test
6. Octave Band Sound Test



Padmounted transformers have successfully passed ANSI Short Circuit Tests.

7. Insulation Resistance (Meggar) Test
8. Corona (Partial Discharge) or Radio Influence Voltage (RIV) Tests
9. Short Circuit Test
10. Short Circuit Capability Calculations in lieu of Short Circuit Test
11. Insulation Power Factor Test
12. Zero-Phase Sequence Impedance Test
13. Seismic Test
14. Quality Assurance Documentation
15. Witness or Inspection.

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.



Padmounted transformers are manufactured in an ISO 9001 Certified factory.

### Standards Compliance

- ANSI C57.12.00
- ANSI C57.12.90
- ISO 9001
- CSA - C88
- Factory Mutual Labeling Available
- UL Labeling Available

# Specifications

Self-Cooled Power Rating (kVA)	Primary Voltage (kV)	Secondary Voltage (kV)	Available Fluids
2500-20,000	5 through 46	120V through 25 kV	Oil, Silicone, R-Temp®, BIOTEMP®

## Standard Electrical Features

- 2 Windings, without reconnectable windings
- Four high voltage winding full-capacity taps with a total tap range of 10%
- Frequency of 60 Hertz
- Standard impedance shown in Standard Impedances Chart
- Sound levels shown in Standard Sound Levels Chart
- Standard BIL levels shown in Standard BIL Levels Chart
- Excitation limits defined by ANSI C57.12.00-1980:
  - Unit will deliver rated kVA at 5% above rated secondary voltage without exceeding the limiting temperature rise provided the load power factor is 80% or higher and the frequency is at least 95% of rated value
  - Unit can be energized at 10% above rated secondary voltage at no-load without exceeding the limiting temperature rise
- 65°C average temperature rise

## Standard Electro-Mechanical Features

- Aluminum windings
- Tap changer for de-energized operation with the handle brought out through the tank wall in the LV compartment
- Core ground strap

## Standard Tank Features

- Lifting hooks for complete unit
- Lifting loops for tank cover
- Welded main tank cover with welded handhole cover
- Bolted handhole for wye-wye units when HV and LV neutrals are tied together internally
- Ground pad
- Transformer base which permits rolling in directions parallel to the base center line
- Provisions for jacking
- Weather-resistant cabinet bolted to the front of the transformer including HV and LV compartments with interlocked padlockable doors
- HV/LV compartment barrier, bolted in place
- Three-point terminal compartment latching
- Removable front sill under the HV and LV compartment doors
- Bolted safety catch between HV/LV compartment barrier and HV door
- Hinged cabinet doors with stop in open position (hinges are corrosion resistant hardware)

## Optional Electrical Features

- Series multiple windings
- Delta-wye connection—changing the internal connections on the HV or LV windings
- Special HV taps and tap range
- Tap range exceeding 10%
- Special high and low voltage rating
- Special phase relationship
- Low-loss, high efficiency designs
- Frequency other than 60 Hertz
- Special impedances
- Special sound level
- Special BIL level
- Over excitation
- 55°/65°C average temperature rise
- Special ambient temperatures
- Operation at altitudes above 3300 feet

## Optional Electro-Mechanical Features

- Copper windings
- Tap changer located on HV compartment
- Tap changer mechanical key interlock
- Core ground lead brought to test point located inside tank adjacent to bolted handhole
- Electrostatic shields
- Internally or externally mounted bushing current transformer
- Potential transformers (includes primary fuses)

## Optional Tank Features

- Bolted handhole with locked cover accessible from LV compartment only
- Ground connector and pad
- Export packing
- Tamper-resistant design that meets Western Underground Guide 2.13, Rev. 4 requirements when pentahead bolt is specified
- Tamper-resistant design that meets the State of California requirements

# Specifications

## Standard Gauges and Fittings

- Pressure-relief valve (standard with oil and silicone)
- Drain valve with sampling device

## Optional Gauges and Fittings

- Magnetic liquid-level gauge (no alarm contacts)
- Magnetic liquid-level gauge with alarm contacts
- Dial-type thermometer (no alarm contacts)
- Dial-type thermometer with alarm contacts
- Pressure-vacuum gauge (no alarm contacts)
- Pressure-vacuum gauge with alarm contacts
- Pressure-relief device (no alarm contacts):
  - Silicone filled
  - Oil filled
- Pressure-relief device with alarm contacts
- Rapid pressure rise relay
- Dial hot-spot indicator
- Shock indicator for shipment

## Standard Low Voltage Components

- Captive and recessed pentahead or hex-head locking bolt in LV compartment door (bolt is corrosion-resistant)
- Six-hole aluminum NEMA spades, cast-resin bushings, welded in horizontal line

## Optional Low Voltage Components

- Bolted-in bushings
- Staggered bushing arrangement
- Bus duct connection
- Molded-case circuit breaker

## Standard Cooling System

- Tank Design Pressure:
  - Per ANSI C57.12.26
- Sealed Tank Fluid Preservation System
- Flat tubular coolers welded to tank
- Self-cooled (OA)

## Optional Cooling System

- Tank Design Pressure
  - 15 psig
- Sheet metal guard for tubular coolers
- Complete forced-air cooling system (FA) (available only when tamper-resistant requirements are waived)
- Control power transformers for fan power source or auxiliary service

## Standard Tank Finish

- Paint color:
  - Bell telephone green, Munsell no. 7GY/3.29/1.5
- Paint system process:
  - Paint system process: waterborne alkyd primer and intermediate coat, oven cure, air dry alkyd enamel spray finish coat, ambient cure, 3 mils minimum
- Tank undercoating
  - One inch on sides

## Optional Tank Finish

- Paint color:
  - ANSI 24, dark grey
  - ANSI 61, light grey
  - ANSI 70, sky grey
- Special paint color
- Tank undercoating
  - Up to 12 inches on sides

## Specifications

### Standard High Voltage Components

#### Live-Front Primary Entrance Equipment:

- Live-front cast resin bushings with clamp-type terminals for radial feed

#### Dead-Front Primary Entrance Equipment

- Universal bushing wells for radial feed
- Six universal bushing wells and loadbreak inserts for loop feed

#### Provisions for distribution class arresters

#### Space for stress cones, (live-front only)

#### Interlocked door which can be opened only after the low voltage compartment door is opened

### Optional High Voltage Components

#### Live-Front Primary Entrance Equipment:

- Six cast-resin bushings for loop feed
- Potheads
- Phase barriers for live-front entrance equipment
- Overcurrent protection
- HV Switches

#### Dead-Front Primary Entrance Equipment (for Oil and Silicone Filled Units Only):

- Six universal bushing wells for loop feed
- Three universal bushing wells and loadbreak inserts for radial feed
- Three non-loadbreak bushings for radial feed
- Six non-loadbreak bushings for loop feed
- Three integral loadbreak bushings for radial feed
- Six integral loadbreak bushings for loop feed
- Overcurrent protection

#### HV Switches

#### Live-front surge arresters

#### Dead-front surge arresters

## Standard Sound Levels

Self-Cooled (OA) Equivalent Two-Winding (kVA)	NEMA Average DB-OA
112.5-300	55
301-500	56
501-700	57
701-1000	58
1001-1500	60
1501-2000	61
2001-2500	62
2501-3000	63
3001-4000	64
4001-5000	65
5001-6000	66
6001-7500	67
7501-10000	68
10001-12000	69
12001-15000	70
15001-20000	71

## Standard Basic Impulse Levels

kV Class	Introduced Test 180 Hz-7200 cyc.	kV BIL	Applied Test 60 Hz-kV
1.2		30	10
2.5		45	15
5.0	Twice	60	19
8.7	Normal	75	26
15.0	Voltage	95	34
25.0 Grd Y Only		125	40
25.0		150	50
34.5 Grd Y Only		150	50
34.5		200	70
46.0		250	95

## Standard Impedances (Percent)

kVA	15 kV Class 95 kV BIL and Below	25 kV Class 125/150 kV BIL	34.5 kV Class 150/200 kV BIL
500-2500	5.75%	5.75%	5.75%
3000	6.50	6.50	7.00
3750	6.50	6.50	7.00
5000	6.50	6.50	7.00

Note: The standard tolerance is +/- 7.5% of the design tolerance.

### Special Options

Receptacle or light LV compartment

Space heaters

Special dimensions

# Specification Guide

## Quality Assurance

The manufacturer shall have specialized in the design, manufacture and assembly of liquid filled padmounted transformers for a minimum of (25) years. The transformer manufacturer and location of manufacture and test are to be supplied at the time of quotation.

The test facility used to perform loss tests in accordance with ANSI C57.12.90 must be certified by an approved 3rd party to meet standard levels for accuracy. Calibration of the equipment used for these loss measurements must be traceable to NIST or an approved equal 3rd party laboratory. Records of all equipment calibration shall be made available to the Buyer upon request.

The transformers 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 manufacturing, and servicing of liquid filled small power transformers. A certificate of Compliance to this requirement shall be provided with the proposal.

## Core

The core shall be constructed of high-grade, grain oriented, silicon steel laminations, with high magnetic permeability. Magnetic flux density is to be kept well below the saturation point. The core construction shall include step-lap mitered joints to keep core losses, excitation current and noise level to a minimum.

## Windings

All windings and internal connections shall be (copper) (aluminum). The windings shall be tightly wound utilizing tension devices to place the conductor into the coils. For optimum dielectric and mechanical strength, a minimum of two sheets of epoxy coated thermally upgraded Insuldur® insulation shall be placed between each layer in the winding.

Sheet conductor shall be used in secondary winding to minimize vertical short circuit forces.

## De-Energized Tap Changer

Four full capacity taps, 2 +/- 2.5%, shall be located in the high voltage windings. A manually operated de-energized tap changer shall be provided for changing the off circuit taps. The tap changer shall be capable of carrying the full transformer short-circuit current without damage or contact separation. The tap changer shall be gang operated from a single operating point and shall have an easily visible position indicator. The tap changer operating mechanism shall include provisions for pad locking in each tap position.

## HV Compartment

The transformer shall be furnished with a high voltage compartment located on the left of the unit. The high voltage compartment shall be furnished with live front cast resin bushings or universal bushing wells for dead front. The HV compartment shall be provided with an interlocked door which can only be opened after the LV compartment door has been opened.

## LV Compartment

The transformer shall be furnished with a low voltage compartment located on the right of the unit. The low voltage compartment shall be provided with a three-point latch with provisions for padlocking. The low voltage compartment shall be provided with a pressure relief device and liquid level gauge and provisions for a dial-type thermometer and vacuum-pressure gauge. A

stainless steel diagrammatic nameplate shall be located inside the LV compartment.

## Gaskets

The gaskets shall be compatible for the insulating fluid in the transformer tank. Gasket in contact with Silicone fluid or vapors shall be Viton material.

## Insulating Fluid And Preservation System

The fluid preservation system shall be sealed air. The insulating fluid shall be (mineral oil) (BIO-TEMP®) (Silicone fluid) (R-TEMP®). The transformer insulating fluid shall be certified PCB free at the time of shipment and the tank shall be so labeled. The transformer insulating fluid shall meet or exceed the requirements of the appropriate ANSI and ASTM fluid Standards. The transformer fluid shall be tested for dielectric breakdown and moisture content just prior to the time of shipment.

## Grounding Provisions

All non-energized metallic components of the transformer shall be grounded. Tank grounding provisions shall consist of two ground pads, welded to the base or to the tank wall near the base on diagonal corners. The ground pads shall be copper-faced or stainless steel with two holes spaced horizontally at 1.75-inch centers and tapped for 0.5 inch 13-UNC thread.

## Sound Level

The padmounted transformer shall be designed and constructed to minimize the audible noise generated with the transformer energized at rated voltage. The acceptable noise level shall be in accordance with NEMA TR 1. The measurement procedure shall be as specified in ANSI C57.12.90.

## Nameplates

Transformer shall be furnished with a non-corrosive diagrammatic nameplate, permanently attached with non-corrosive hardware. The diagrammatic nameplate shall include the name of the manufacturer of the equipment as well as the location where the transformer was manufactured and tested.

## Exterior Finish

The transformer exterior painting system shall be the manufacturers standard, which complies with ANSI C57.12.28. However, as a minimum, the transformer shall be thoroughly cleaned, painted with at least one corrosion inhibiting primer and one finish coat to provide a minimum total dry-film thickness of not less than 3 mils. The finish shall be Bell Telephone green, Munsell no. 7GY/3.2/1.5

## Testing

Each transformer shall receive all standard routine tests as required by ANSI C57.12.00 and performed as specified by ANSI C57.12.90.

A certified test report shall be submitted and shall contain the test data for each transformer serial number manufactured. The certified test report shall as a minimum contain the data as specified in ANSI C57.12.90.

Short Circuit withstand capability shall be verified by full short circuit tests on similar or larger units in accordance with the latest revision of ANSI C57.12.00 and ANSI C57.12.90. Certified test reports from applicable short circuit tests shall be submitted to the purchaser, upon request, prior to shipment of the transformers.



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