Network

Small Power Transformers
300 kVA Through 2500 kVA
5 kV Through 34.5 kV Primary Voltage
Through 600 Volt Secondary Voltage
ABB’s Part I Network Transformers provide the dependability, ruggedness, and space-saving economy needed for secondary network distribution systems.

ABB liquid filled Network Transformers deliver unrivaled reliability and high efficiency throughout the long life of the transformer.

Networks are commonly used in a grid-type secondary system in areas of high load density required for large cities. Network Transformers are designed for either subway or vault applications. Network transformers are designed for frequent or continuous submerged operation. A vault-type Network is designed for occasional submerged operation.

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:
- 300 kVA-2500 kVA
- Primary Voltages: 5 kV Through 34.5 kV
- Secondary Voltages: Through 600V
- Three Phase

Available Fluids:
- Mineral Oil • Silicone
- R-Temp® • BIOTEMP®

Network Benefits/Advantages:
- Rectangular core/coil design
  - Minimal size: space saving
  - Minimal weight: energy saving
- 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
- High voltage network switch

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 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.
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 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 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.

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 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.

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 Switch**

The high voltage switch on ABB network transformers is designed for reliable service and safety. It is rotary type with the three operating positions clearly indicated on the switch handle.

The switch cannot be moved from “OPEN” to “GROUND” or from “GROUND” to “OPEN” until a mechanical stop is disengaged when the handle is in the “CLOSED” position. This feature allows an electrical interlock to engage if the transformer is energized. In any position, the switch handle is held against accidental movement by a spring-loaded latch which must be released before the handle can be moved. This latch also makes it possible to padlock the switch in any position.

The use of a one-piece rotary insulating drum with sliding contacts babbitted accurately into place eliminates alignment problems. A stainless steel operating shaft with a spring-loaded silicone rubber packing gland assembly eliminates leakage problems.

High conductivity copper blades and contacts carry 400 amperes continuously without exceeding a 55°C temperature rise. In the ground position, the switch can withstand 15000 amperes for five seconds without damage.

Insulating fluid is used to fill the switch chamber. The chamber is furnished with a filling plug, magnetic liquid-level gauge, and combination drain valve and sampling plug.

The standard switch assembly is welded to the transformer tank with the terminal chamber compartment located above the switch compartment.
MicaFil low frequency heating and fluid systems

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.

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.

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.

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.
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
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.

Standards Compliance

Network transformers have successfully passed ANSI Short Circuit Tests.
Network transformers are manufactured in an ISO 9001 Certified factory.

Standards Compliance

- ANSI C57.12.40
- ANSI C57.12.00
- ANSI C57.12.90
- ISO 9001
- CSA - C88

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.
### Specifications

<table>
<thead>
<tr>
<th>Self-Cooled Power Rating (kVA)</th>
<th>Primary Voltage (kV)</th>
<th>Secondary Voltage (kV)</th>
<th>Available Fluids</th>
</tr>
</thead>
<tbody>
<tr>
<td>300-2500</td>
<td>Up through 34.5</td>
<td>Through 600V</td>
<td>Oil, Silicone, R-Temp®, BIOTEMP®</td>
</tr>
</tbody>
</table>

### 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 as shown in chart
- Sound levels as shown in chart
- Standard BIL levels as shown in 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
  - 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 an externally operated mechanism located under a pipe cap

### Standard Tank Features
- Corrosion-resistant tank with minimum copper content of .20% and minimum thickness of .313 inches
- Corrosion-resistant welded cover and bottom, minimum thickness of .50 inches
- Sub-base of steel bars parallel to long axis of transformer to provide 1.50 inches clearance from floor and with four jacking areas under corners
- Corrosion-resistant steel hardware
- Lifting hooks for complete unit
- Lifting loops for tank cover
- Two (2) handholes on cover:
  - One welded on for access to LV neutral for testing (bolted for wye-wye connected units when HV and LV neutrals are tied together internally)
  - One welded on for access to HV terminal chamber and switch chamber
- Network protector support brackets on LV termination side of tank
- Panel-type coolers, .313 inches thick for subway design (.125-inch thick for vault design)
- Tank Design Pressure:
  - 15 psig:
    - Ground connector and pad

### 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 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 mechanical key interlock
- Core ground lead brought to test point located inside tank adjacent to bolted handhole
- Electrostatic shields

### Optional Tank Features
- Special height sub-base, up to 8 inches maximum
- Special hardware
- Additional bolted handhole
- Tank Design Pressure:
  - Per ANSI C57.12.40

### Special Options
- Special dimensions

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Specifications

<table>
<thead>
<tr>
<th>Standard Gauges and Fittings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnetic liquid-level gauge (no alarm contacts)</td>
</tr>
<tr>
<td>Dial-type thermometer (no alarm contacts)</td>
</tr>
<tr>
<td>Drain valve and bottom filter valve combination</td>
</tr>
<tr>
<td>Liquid filling plug and upper filter press connection</td>
</tr>
<tr>
<td>Top liquid sampler:</td>
</tr>
<tr>
<td>— 1/2 inch pipe plug</td>
</tr>
<tr>
<td>Air-test fitting</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Optional Gauges and Fittings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnetic liquid-level gauge with alarm contacts</td>
</tr>
<tr>
<td>Dial-type thermometer with alarm contacts</td>
</tr>
<tr>
<td>Pressure-vacuum gauge (no alarm contacts)</td>
</tr>
<tr>
<td>Pressure-vacuum gauge with alarm contacts</td>
</tr>
<tr>
<td>Pressure-relief device (no alarm contacts):</td>
</tr>
<tr>
<td>— Silicone filled</td>
</tr>
<tr>
<td>— Oil filled</td>
</tr>
<tr>
<td>Pressure-relief device with alarm contacts</td>
</tr>
<tr>
<td>Pressure-relief valve</td>
</tr>
<tr>
<td>Pressure temperature device (auto-call) for oil and silicone-filled units only</td>
</tr>
<tr>
<td>Filter press valve piping to rear of tank (for filtering fluid in diagonal position)</td>
</tr>
<tr>
<td>Drain valve with liquid sampling valve</td>
</tr>
<tr>
<td>Additional drain valve on tank or switch chamber</td>
</tr>
<tr>
<td>Top liquid sampler:</td>
</tr>
<tr>
<td>— Rotary skimmer device</td>
</tr>
<tr>
<td>— Sampling valve</td>
</tr>
<tr>
<td>Spare gaskets for LV throat, handholes, HV terminal chamber, and switch compartments</td>
</tr>
<tr>
<td>Sight gauge for HV terminal chamber</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Standard Tank Finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paint system process: black zinc chromate epoxy, oven cure and air dry, 3 mils minimum</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Optional Tank Finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Premium paint system: zinc-rich primer, epoxy coat, oven cure and air dry, 7 mils minimum</td>
</tr>
<tr>
<td>Tank undercoating</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Standard High Voltage Terminal Chamber, for Oil or Compound Filling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drain plug</td>
</tr>
<tr>
<td>Bolted cover with gasket and guide pins</td>
</tr>
<tr>
<td>Two (2) lifting loops for removing terminal chamber cover</td>
</tr>
<tr>
<td>One (1) single conductor, wiping sleeve for cable entrance, copper brazed or removable</td>
</tr>
<tr>
<td>Three (3) bushings between switch chamber and terminal chamber, with terminals</td>
</tr>
<tr>
<td>Air vent and liquid level plug (0.25-inch)</td>
</tr>
<tr>
<td>Liquid filling plug</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Standard High Voltage Switch</th>
</tr>
</thead>
<tbody>
<tr>
<td>The standard network switch is 3-pole, 3-position, non-interrupting capacity</td>
</tr>
<tr>
<td>One electrical interlock on switch</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Standard High Voltage Liquid-Immersed Switch Chamber (Welded to Transformer Tank)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disconnect and grounding switch, non-interrupting, three-position, externally operated mechanism</td>
</tr>
<tr>
<td>Liquid level gauge, magnetic type</td>
</tr>
<tr>
<td>Liquid filling plug</td>
</tr>
<tr>
<td>Two (2) lifting loops, for removing switch chamber cover</td>
</tr>
<tr>
<td>Air test fitting</td>
</tr>
<tr>
<td>Liquid sampler</td>
</tr>
<tr>
<td>Drain valve</td>
</tr>
<tr>
<td>Three (3) HV bushings between the main tank and the switch chamber, replaceable from switch chamber</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>High Voltage Switch Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mag-Break switch</td>
</tr>
<tr>
<td>Provisions for phase sequence identification (phasing out plugs)</td>
</tr>
<tr>
<td>Phase sequence indication (sequential grounding), including 3 internal grounding contacts, 5-position switch to indicate phase when switch is moved from transformer positions to ground position</td>
</tr>
<tr>
<td>Additional electrical interlock on switch</td>
</tr>
</tbody>
</table>
Specifications

Standard Low Voltage Termination Facilities
(Passions for mounting a network protector)
- Flanged throat with drillings, pins, jack screws, and gasket necessary for mechanical connection to network protector
- Three (3) replaceable LV line bushings welded to tank
- Flexible connectors on LV line bushings for electrical connection to network protector
- Bushing guard for protection during shipment
- Low voltage neutral welded to tank wall and opposite an internally welded boss for neutral winding connection

Optional High Voltage Equipment
- Three 1/C wiping sleeves in lieu of standard 1-3/C sleeve
- Loop feed wiping sleeves (only when switch is omitted)
- Three (3) universal bushing wells, 200A and 150 kV BIL maximum rating, in lieu of standard wiping sleeves
- Six universal bushing wells, 200A and 150 kV BIL maximum rating, for loop feed (available only when HV switch is omitted)
- Three universal bushing wells, 200A, 150 kV BIL, and loadbreak inserts for radial feed
- Six universal bushing wells, 200A, 150 kV BIL, and loadbreak inserts for loop feed
- Three non-loadbreak bushings, 600A, 150 kV BIL, for radial feed
- Six non-loadbreak bushings, 600A, 150 kV BIL, for loop feed
- Three integral loadbreak bushings, 200A, 150 kV BIL, for radial feed
- Six integral loadbreak bushings, 200A, 150 kV BIL, for loop feed
- Three molded bushings, 600A, 150 kV BIL, mounted on front of terminal chamber in lieu of the standard wiping sleeve
- Potheads, one 3-conductor or three 1-conductor, in lieu of the standard terminal chamber
- Bottom entrance of HV cable, including wiping sleeves
- Packing gland or stuffing box for termination rubber coerable cable (15 kV maximum rating)
- Phase separation barriers in compartment when switch is omitted
- Two adjacent windows for viewing switch blades (windows protected by bolted cover)
- Filling compound or cable oil for HV terminal chamber

Standard Sound Levels

<table>
<thead>
<tr>
<th>Equivalent Two-Winding (kVA)</th>
<th>Average Sound Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>300</td>
<td>55</td>
</tr>
<tr>
<td>500</td>
<td>56</td>
</tr>
<tr>
<td>501-750</td>
<td>57</td>
</tr>
<tr>
<td>751-1000</td>
<td>58</td>
</tr>
<tr>
<td>1001-1500</td>
<td>60</td>
</tr>
<tr>
<td>1501-2000</td>
<td>61</td>
</tr>
<tr>
<td>2001-2500</td>
<td>62</td>
</tr>
</tbody>
</table>

Standard Impedances (Percent)

<table>
<thead>
<tr>
<th>HV kVA</th>
<th>Percent Impedance</th>
</tr>
</thead>
<tbody>
<tr>
<td>300-1000</td>
<td>5.00</td>
</tr>
<tr>
<td>1500-2500</td>
<td>7.00</td>
</tr>
</tbody>
</table>

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

Standard Basic Impulse Levels

<table>
<thead>
<tr>
<th>kV Class</th>
<th>Introduced Test 180 Hz-7200 cyc.</th>
<th>kV BIL</th>
<th>Applied Test 60 Hz-kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.2</td>
<td>Twice</td>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td>2.5</td>
<td>Normal</td>
<td>45</td>
<td>15</td>
</tr>
<tr>
<td>5.0</td>
<td>Voltage</td>
<td>60</td>
<td>19</td>
</tr>
<tr>
<td>8.7</td>
<td></td>
<td>75</td>
<td>26</td>
</tr>
<tr>
<td>15.0</td>
<td></td>
<td>95</td>
<td>34</td>
</tr>
<tr>
<td>25.0 Grd Y Only</td>
<td></td>
<td>125</td>
<td>40</td>
</tr>
<tr>
<td>25.0</td>
<td></td>
<td>150</td>
<td>50</td>
</tr>
<tr>
<td>34.5 Grd Y Only</td>
<td></td>
<td>150</td>
<td>50</td>
</tr>
<tr>
<td>34.5</td>
<td></td>
<td>200</td>
<td>70</td>
</tr>
</tbody>
</table>

Optional Network Protector Provisions
- Oversized throat with 11-inch LV bushing spacing
- Externally removable low voltage neutral bushing

Optional Low Voltage Air Terminal Chamber
- Terminal chamber mounted on throat
- Clamp-type terminals in addition to flexible connectors
- Stud or spade bushings in lieu of wiping sleeves (no terminals)
- Stud or spade bushings in lieu of wiping sleeves with clamp-type terminals
- Stud bushings in lieu of wiping sleeves with stud moles mounted on bushings
- Moles in lieu of wiping sleeves
Specification Guide

Quality Assurance
The manufacturer shall have specialized in the design, manufacture and assembly of liquid filled network 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, 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.

High Voltage Switch
The transformer shall be furnished with a high voltage liquid immersed three position switch with a high voltage terminal chamber. The switch shall be a rotary type with three operating positions; Open, Ground, Closed. The three operating positions must be clearly marked on the switch handle.

Low Voltage Flange
The low voltage side of the transformer is to be provided with a flange connection and support brackets for connection to a LV network protector.

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.

Bushings
High voltage and low voltage bushings shall be furnished. Bushings above 45 kV BIL rating shall be gray wet-process porcelain.

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 network 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 ANSI C57.12.40. 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 finish shall be in accordance with ANSI C57.12.40.

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.