CONSIDERATIONS WHEN SPECIFYING A TRANSFORMER

- Application
- Configuration
- Internal Construction
- Dielectric Fluid
- Accessories
APPLICATION

- Distribution – Running lights, HVAC, Office
- Motor Control Center
- Dedicated Load – Pump, Crusher
- Extreme Duty – Drag-line
Available Configurations

- Padmount
- Station
- Secondary Unit Substation
- Specialty
  - Grounding, Rectifier, Mine Duty
INTERNAL CONSTRUCTION

Shell vs. Core Form Transformers

Rectangular vs. Round Coil Construction

Disk Wound
Shell form & core form transformer construction

- 5 legged wound core-
  Each phase has a magnetic flux return path independent from the other phases.

- 3 legged stacked core-
  Each phase shares a core bar. Harmonic content can lead to tank heating if wye/wye connected.

IEEE Std C57.12.80-2002 definitions:

Shell form: A transformer in which the laminations constituting the iron core surround the windings and usually enclose the greater part of them.

Core form: A transformer in which those parts of the Magnetic circuit surrounded by the windings have the Form of legs with 2 common yokes.
Shell & core transformers
Rectangular coil & 5 legged core assembly
Distributed gap core construction

Core after shear operation

“Distributed” gaps
Distributed gap core construction

Raw stock core material
Distributed gap core construction

Pressed cores queued for annealing

Loading the annealing oven
Distributed gap core construction

Annealed cores
Rectangular coils

HV finish
HV taps
HV start
LV winding
Cooling ducts
Core windows
LV leads
Rectangular coils w/ distributed gap cores
Rectangular coils w/ distributed gap cores

Stacking the distributed gap cores

Annealed Laminations
Rectangular coils w/ distributed gap cores

Application of core frame
Rectangular coils w/ distributed gap cores

Assembled 5 legged distributed gap core and coil assembly
Rectangular coils w/ distributed gap cores

Outer core legs and core frame
Shell & core transformers
Round core and coil assembly

Top view, single core/coil
Cruciform core shear
Cruciform stacked core construction
Cruciform core construction

Yoke - leg interface

Top view
Cruciform stacked core construction
Cruciform core
Round Coils
Round Coils

360 degree cooling ducts

Radial forces are equalized during short circuits & overloads
Core – Coil Assembly

Improved cooling
Core – Coil Assembly

core frame insulation
Round coils with cruciform core

Top yoke

LV leads

HV leads & taps
Round coils with cruciform core

Tanking assembled core & coil assembly
Disk-Type Coil Winding
Disk Coil Construction

Continuous Disk

Helical Disk
Stages of Disk Windings Assembly
Construction comparisons

Core form VS. Shell form
Rectangular coil - 5 legged core advantages

With strip conductor secondaries:

• **HV electrically centered on the LV winding**
• **Significant gain in mechanical strength**
• **Suitable for high volume production**
• **No tank heating from stray flux induction in tank wall when connected wye-wye**
Round coil - cruciform core uses

With wire / wire windings:

- Means of providing increased hoop strength
- Enables solid construction of higher kVA units
- Suitable for small power designs & dedicated loads
- Reduction in width dimension for retrofit applications
Round Coil/Cruciform Core Advantages

• 360 degree cooling
  • Increased insulation life
  • More efficient cooling during heavy duty cycles
• Top & bottom pressure plates
  • Containment of axial forces during short circuits
• Round coil construction
  • Maximum containment of radial forces during short circuits
  • Improved clearances between phases
Dielectric Fluids

- Mineral Oil (Type II)
- Vegetable-Based Oil (Envirotemp FR3)
  - High Fire Point (300 degrees C)
  - Biodegradable
- Silicone
- Voltesso
  - Lower Temperature Pour Point
Standard Accessories

- Oil Temperature Gauge
- Liquid Level Gauge
- Pressure/Vacuum Gauge
- Pressure Relief Valve
- Drain Valve w/ Sample Port
- Upper Fill Port
- Air Space filled with Dry Nitrogen
Optional Accessories Part 1

- Dry Contacts on Gauges
- Pressure Relief Device
- Forced Air Cooling
  - 15% increased capacity 2499 kVA and smaller
  - 25% increased capacity 2500 kVA and larger
- Winding Temperature Gauge
- Sudden Pressure Rise Relay
  - Seal-In Relay
Optional Accessories Part 2

- Removable Radiators
- Positive Pressure System
- Stainless Steel
  - Auxiliary Wiring Cabinet – NEMA 4X
  - Hardware
  - Base
  - Tank
  - Radiators
  - Transitions
### SUBSTATION SPECIFICATION SUMMARY SHEET

<table>
<thead>
<tr>
<th>Customer</th>
<th>CATALOG #</th>
<th>KVA</th>
<th>Customer PO#</th>
<th>QTY</th>
<th>SO#</th>
<th>PART#</th>
<th>SE</th>
</tr>
</thead>
</table>

#### PHASE
- THREE
- SINGLE
- TYPE II OIL
- VOLT ESSO
- ENVIROTEMP (FR3)
- BIOTEMP
- OTHER

#### FLUID
- LTC
- GROUNDING
- RECTIFIER: PULSE

#### TEMP
- 65°C
- 55°C
- 55/65°C
- OTHER

#### COOLING
- ONAN
- ONAN / ONAF-FFA
- ONAN / ONAF-less fans
- ONAN / ONAF

#### HERTZ
- 60 Hz
- 50 Hz

#### CONDUCTOR
- # ALUMINUM
- # COPPER
- OTHER

#### AMBIENT
- 30°C avg.
- 40°C avg.

#### HIGH VOLTAGE
- HV: _____________ BIL: ________ kV
- CONNECTION: DELTA
- WYE
- HO Bushing w/full BIL
- HO Ground Strap
- Neutral internal & isolated
- Neutral internally grounded
- GROUNDED WYE (HO-XO Comm.)
- DELTA-WYE
- ZIG ZAG

#### TAPS
- 2-2 1/2% FCAN & BN
- 4-2 1/2% FCBN
- 2-2 1/2% FCAN & 4-2 1/2% FCBN

#### LOW VOLTAGE
- LV: _____________ BIL: ________ kV
- CONNECTION: DELTA
- With single Phase Mid-Tap Coil
- WYE
- XO bushing
- XO bushing w/ground strap
- GROUNDED WYE (XO-HO Comm.)
- DELTA-WYE
- ZIG ZAG

#### IMPEDANCE
- % MIN NOM MAX

#### VECTOR CONNECTION
- HV LOCATION: [ ] Left [ ] Right [ ] Tank face Seg ________ [ ] Top Seg ________
- LV LOCATION: [ ] Left [ ] Right [ ] Tank face Seg ________ [ ] Top Seg ________

#### HV BUSHINGS: [ ] LV CONNECTION: [ ] LV BUSHINGS: [ ]

---

Note: If less flammable fluid is used, rating is KNAN or KNAF respectively.

- 5 LEGGED CORE
- TERTIARY
- TRIPLEX CORE/COIL