Knowledge Is Power℠

Apparatus Maintenance and Power Management for Energy Delivery

Understanding Transformer Nameplates

Connection Diagrams

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Connection Diagrams

Serial Numbers

- Identifies a specific transformer
- Key to locating differences between one transformer and others of the same type and rating
- Provides access to pertinent factory information such as test reports, etc.

Connection Diagrams

Class

- Refers to the type of insulating medium and the method by which the transformer is cooled.
- Indicated by a group of letters (i.e. OA/FA/FOA)
- Same nomenclature is used for askarel-immersed transformers as is for oil-filled units.

Connection Diagrams

Cooling Method	CSA	ANSI	BESA	Temp Rise
Oil Immersed, Natural Circulation, Self-Cooled	ONAN	OA	ON	55/65
Oil Immersed, Natural Circulation, Water-Cooled	ONWF	OW	OW	55/65
Oil Immersed, Natural Circulation, Forced Air Cooled	ONAF	OA/FA	OB	55/65
Oil Immersed, Forced Oil, Water Cooled	OFWF	FOW	OFA	55/65
Oil Immersed, Forced Oil, Forced Air Cooled	OFAF	OA/FA/FOA	ORB	55/65
Oil Immersed, Natural Circulation, Forced Air Cooled, Second Stage of Forced Air Cooling	ONAN/ONAF	OA/FA/FA	-	55/65

Connection Diagrams

Load Capacity

Type of Cooling	Loading Capacity %
ONAN	100
ONAN/ONAF	100/133
ONAN/ONAF/ONAF	100/133/167
ONAN/ONAF/OFAF	100/133/167
ONWF	125
OFWF	167

Connection Diagrams

Temperature Rise

- KVA/MVA and temperature rise are associated with each set of letters in the class designation that is separated by diagonals (/). (i.e. 30000/40000/50000 KVA or 30/40/50 MVA)

Connection Diagrams

Temperature Rise

- Example:
  - Transformer Class OA/FA/FOA may be rated:
    - 30MVA continuous at 55° C Rise, Self-Cooled (OA rating)
    - 40 MVA continuous at 55° C Rise, Forced Air-Cooled (FA rating)
    - 50 MVA continuous at 55° C Rise, Forced Oil and Forced Air-cooled (FOA rating)

Connection Diagrams

Temperature Rise

- Temperature Rise given is the average winding rise by resistance over maximum ambient temperature.
- The hottest spot temperature rises corresponding to various winding rises are shown below:

Transformer Type	Winding Rise (by Resistance)	Hottest Spot Rise
55 °C Rise Oil-Immersed	55 °C	65 °C
65 °C Rise Oil-Immersed	65 °C	80 °C
55 °C Rise Dry-Type	55 °C	65 °C
80 °C Rise Dry-Type	80 °C	110 °C
150 °C Rise Dry-Type	150 °C	180 °C

Connection Diagrams

Temperature Rise

- Temperature Rise is based on a maximum ambient of 40° C, with an average ambient cooling air for any 24 hr. period of 30° C for air-cooled units
- For water-cooled, the temperature of the cooling water must not exceed 30° C, within a 24 hr. average not over 25° C.
- Based on altitude no greater than 1000m (3300 ft).

Connection Diagrams

Temperature Rise

- The temperature indicator on a transformer indicates the operating temperature, not temperature rise.
- To determine temperature rise in an operating transformer, use the following equation:
- Temp rise = Operating temp - ambient temp.
- Example: Transformer rated for 55° C rise, operating at 30° C ambient should not exceed 85° C operating temperature.

Connection Diagrams

Voltage

- Each winding voltage rating is separated from other winding ratings by a dash (-)
- The nominal rating of the highest voltage winding will be the first in a series of numbers.
- A winding that may be connected delta or wye has the delta first, separated from the wye voltage with a diagonal (/).
- A transformer permanently connected in wye with the neutral brought out, has the line-to-line voltage first, separated from the line-to-neutral voltage by a diagonal (/).

Connection Diagrams

Voltage

- Two winding ratings separated by an “X” indicates that either a series or a multiple connection is possible.

Connection Diagrams

Basic Insulation Level (BIL)

- Indication that the transformer can withstand the crest value of a specified voltage wave during testing.
- Often called the Basic Impulse Insulation Level or BIL.
- It is also an indication of the ability of the insulation system to withstand transient system overvoltages.

Connection Diagrams

Bushing Designations

- Rectangle represents the top view of the transformer or enclosure
- Cover bushings are indicated as a circle with a dot
- Tank wall bushings are indicated with a triangle
- Capacitance tap bushing is shown with a capacitor symbol within the circle

Connection Diagrams

Bushing Designations

- All bushings (winding terminations) available for connection are labeled
- Highest voltage winding terminals are designated by H
- Lower voltage winding terminations designated as X, Y and Z in order of decreasing voltage
- Subscripts are used with the letters to designate bushing position (usually from right to left…H1, H2, H3)

Connection Diagrams

- Bushing marked with a subscript “o” is usually labeled as the neutral bushing

Connection Diagrams

Tap Changer Connections

- Taps are indicated on the diagram in the winding in which they are located
- Numeral 1 or letter A is assigned to the tap which provides the maximum ration of transformation (DETC). 1-5 or A-E
- For LTC's, the normal or neutral position is designated with the letter N and raise or lower positions to change voltage taps with L or R in ascending order.

Connection Diagrams

Tap Changer Connections

- All taps in any winding are tabulated on the nameplate by tap changer letter, dial position number and tap connection.
- The line current equivalent to the max transformer rating is given for each tap.
- Assuming xfmr is excited from HV side, moving a DETC to a higher voltage (lower number tap), lowers the secondary voltage.

Connection Diagrams

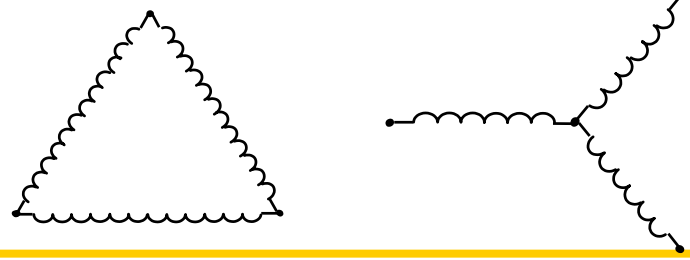
Current Transformers/Arresters

- CT's on bushings or internally are indicated on diagram. If they are multi-ratio, each tap is labeled following the X1-X2, etc. convention plus the CT number and polarity
- Lightning arresters or fuses mounted on a transformer are also typically shown.

Connection Diagrams

Vector Diagram

- Gives an indication of phase relationship between voltages of various windings.
- Vector diagram on a 3-phase xfmr displays the angular displacement between the high and low voltages.
- Follow phase angles when performing TTR and Leakage Reactance Tests.



Connection Diagrams

Impedance

- Quantity given on nameplate is usually “impedance volts” in percent
- Usually indicated for the self-cooled (OA) KVA/MVA rating and nominal voltage
- Classical definition of impedance is the percent of rated high-voltage impressed on the high-voltage winding to produce rated full-load current in the short-ciruited low-voltage winding. (i.e. short-circuit impedance test)

Connection Diagrams

Impedance

- Same holds true for low-voltage winding
- On 3-winding transformers, three impedance values are given (one for each combination of 2 windings…H-X, H-Y, X-Y)

Connection Diagrams

Pressure Range

- Liquid and gas-filled transformers usually operate with positive pressure in sealed tanks.
- A statement of the range of operating pressures is typically on the nameplate
- A statement of whether a tank is rated for “full vacuum” may be indicated. If so, the unit should be vacuum filled. If not, the unit should not be placed under vacuum.

Connection Diagrams

Weights

- Broken down so that maximum weights for untanking as well as total weights are known.
- Shipping weights can be estimated from these by adding packaging weight.

Connection Diagrams

Miscellaneous Information

- Oil volume is given to indicate storage capacity required if oil must be drained or replaced.
- If windings are other than copper, a statement of the material typically appears on the nameplate.
- Instruction book numbers will appear also.
- Date of Mfr. and Mfr. Location may be listed.