Version: 10/10/2019

WG on Revision of Low Frequency Tests

Proposal for additions in IEEE C57.12.00 and C57.12.90 to address the core gassing issue of wound cores.

Background information.

Proposed wording to insert into IEEE C57.12.00

6.7.2.1 Grounding of Wound Cores

In transformers with wound cores, five-legged three phase and three-legged single phase, Low Voltage-High voltage winding construction and a high voltage winding greater than or equal to 25 kV (15 kV to ground), the transformer core shall be properly grounded to the tank. Said grounding may be from the inside or outside of the core as long as there are not two ground locations in the same core. In order to validate that the core will not be susceptible to partial discharges during normal operation, a design test, specific for this type of wound core transformer, is specified in Table 17, and the procedure is described in C57.12.90-2015 Clause 10.7.7.

Note: Partial Discharge (PD) generation in transformers can possibly occur due to various other factors which may be internal and/or external to the transformer and the capacitive coupling of the core is one of these factors.

Table 17 Revision inserted under Dielectric beneath core insulation:

Partial discharge test for core gassing		*****			*****					**Test only applies to wound cores see Clause 6.7.2.1**

Proposed wording to insert into IEEE C57.12.90

10.7.7 Special Induced-Voltage Test for distribution and class I power transformers with a wound core, Low-High winding construction and having a high voltage winding voltage of 25 kV, (15 kV to ground) or greater to detect improper core grounding. Note that this test is intended only for detection of inadequate core grounding issues and not for accessories like dead front bushings, tap changers, current limiting fuses or dual voltage switches, which may have difficulty passing the test at 100 pc. The transformer may or may not contain such components. If the transformer fails the

test with such components, the components may be removed or bypassed and the test re-run. The Design Test shall be conducted on a transformer with functionally similar core grounding.

10.7.7.1 Minimum test duration and application of voltage

1. Voltage shall be raised to 100% of rated volts for 30 seconds and PD shall be measured and recorded.
2. Voltage shall be raised to 110% of rated volts for 30 seconds and PD shall be measured and recorded.
3. Voltage shall be raised to 150% of rated volts, held for 1 minute and PD shall be measured and recorded.
4. Voltage shall be lowered to 140% of rated volts, held for 1 minute and PD shall be measured and recorded.
5. Voltage shall be lowered to 130% of rated volts, held for 1 minute and PD shall be measured and recorded.
6. Voltage shall be lowered to 120% of rated volts, held for 1 minute and PD shall be measured and recorded.
7. Voltage shall be lowered to 110% of rated volts, held for 10 minutes and PD shall be measured and recorded

PD is to be measured as apparent charge in pico-coulombs (pC). One reading shall be made at the end of each interval.

10.7.7.2 Test Frequency

As an induced-voltage test applies greater-than-rated volts per turn to the transformer, the frequency of the impressed voltage shall be high enough to limit the flux density in the core to that permitted by 4.1.6.1 of IEEE Std.C57.12.00-2010. The minimum test frequency to meet this condition is given in Equation (27):

$$Minimum\ test\ frequency = \frac{E_t}{1.1\ x\ E_r}\ x\ rated\ frequency \quad (27)$$

where

E_t is the induced voltage across winding (V)
E_r is the rated voltage across winding (V)

10.7.7.3 Grounding of Windings

When a transformer has one end of the high-voltage winding grounded, the other windings should be grounded during the induced-voltage test. This ground on each winding may be made at a selected point

of the winding itself or of the winding of a step-up transformer that is used to supply the voltage or that is connected for the purpose of furnishing the ground.

10.7.7.4Failure detection

The test is considered passed if PD recorded in step 7 of 10.7.7.1 does not exceed partial discharge level of 100 pC. Judgment shall be used in test intervals such that momentary excursions beyond 100 pC may be acceptable, however at the end of step 7 of 10.7.7.1 PD must not exceed 100 pC.

Note —Normally, transformers will pass the test if they are equipped with outside core grounds and with shielded and grounded inside outer core loops. In cases where pass-fail is marginal at the 110% voltage level, it is useful to continue reducing voltage until partial discharge is extinguished. Core gassing results in bubbles between core laminations that push liquid out and leave only gas that ionizes at much lower voltages than the insulating liquid. Hence, core gassing usually results in partial discharge (pd) extinction well below rated voltage. Most other components in the transformer behave more linearly and do not persist with partial discharge at or below rated voltage.