

GIC Capability Test & Models

A2

PS3 Question Number 3.9

Is it relevant to realize GIC capability tests? Could white-box or black box models be applied to evaluate the GIC capability of transformer electrically, mechanically and thermally?

Pradeep Ramaswamy, USA

GIC Capability Test

- Relevance
 - Generally, transformers with return limbs and independent magnetic circuit may be considered for GIC testing
 - For transformers with high total GIC susceptibility like Category IV & Category III, assessed using section 8.3 of IEEE standard C57.163
- Test Challenges
 - Adjustable DC source with AC bypass, Adequate Reactive power supplies, Harmonic isolation from grid and compatible instrumentation
 - However, few site testing have been reported which were subsequently used to validate white box models
- Recommended Test
 - No Load Loss & Excitation
 - Load Loss
 - Heat Run with DGA

GIC Models

- Black box vs White box models

- Black box models may be sufficient for system level studies (stability, load flow etc.)
- Detailed white box models are needed if effects on equipments needs to be assessed
- For both system and equipment level studies, co-simulation of equipment FEA and system network models can be done.
- The computation time of white box models can be reduced by using High Performance Computing (HPC) tools available through cloud infrastructure

Advantages of White Box Models

- 2D / 3D Non linear Transient Circuit Field Thermal Coupled FEA
 - The tank and its non-linear permeability can be accurately modeled
 - Unequal limb saturation resulting in zero sequence currents that can circulate in tertiary along with third harmonic currents can be modeled
 - Three phase interconnected magnetic circuit effect on saturations currents (Helping effect as described by Price) resulting in AT balance of phases not undergoing saturation at a given time can be modeled.
 - GIC transient effects and condition for steady state (Walling) can be modeled
 - Tank circulating currents due to zero sequence / 3rd harmonic flux can be calculated
 - Loss densities in structural components with the actual 3 phase GIC winding currents (rather than superposition of harmonics) and nonlinear permeability can be accurately calculated