

GIC Capability Tests?

SC A2 – PS3 – Q3.9

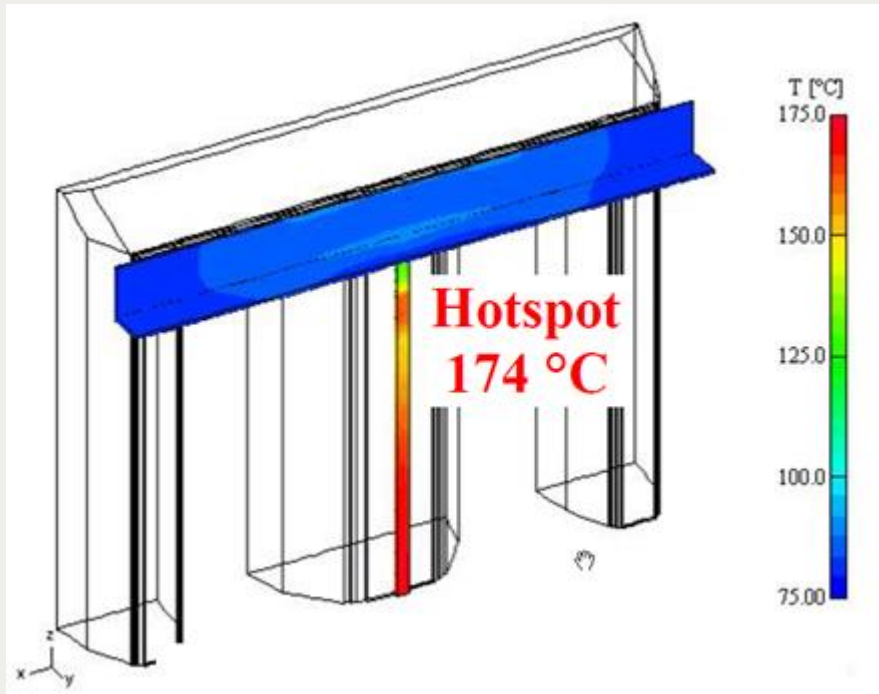
Is it relevant to realize GIC capability tests? Could white-box or black-box models be applied to evaluate the GIC capability of transformer electrically, mechanically and thermally?

Gerald LEBER - AT

SIEMENS
ENERGY

GIC capability tests

The electrically and thermally behaviour of transformers under GIC is design-dependent



Thermal FEM3D simulation for tie bar and clamping plate hotspot with additional DC excitation

The electro-magnetic behaviour (current harmonics, reactive power, etc.) depends on the core type and winding design („air core induction“)

In delta-connected windings flows an additional circulating current ¹⁾

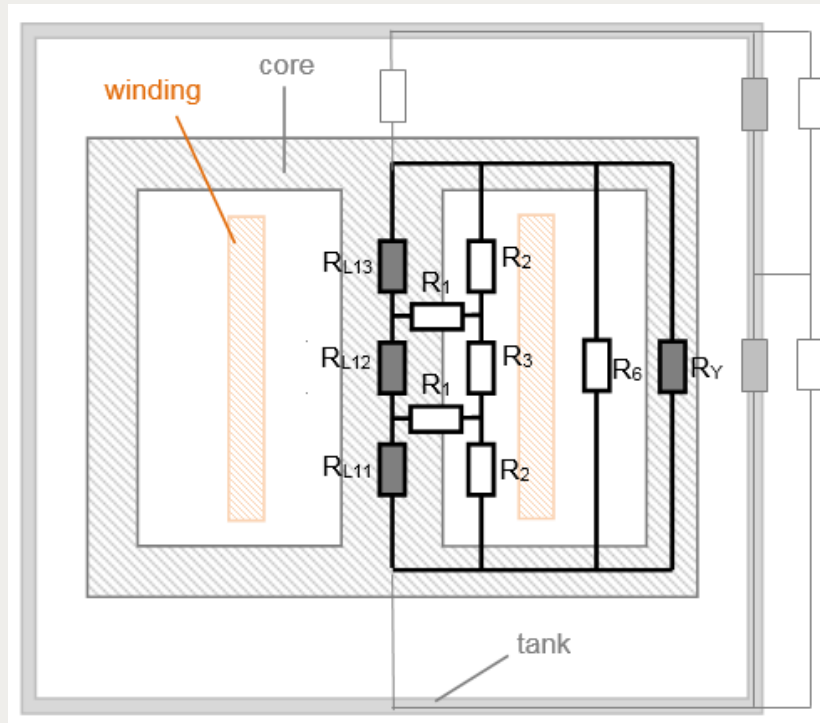
Hotspots are caused by additional stray flux due to core saturation. They depend on geometry, used material and general transformer design parameter

Also eddy losses in windings increase due to additional stray flux. The used conductor type influences the loss increase in the windings ¹⁾

¹⁾ C. Müller, J. Raith, R. Arritt, L. van der Zel and E. Schweiger: “The influence of GIC on the thermal behavior of tie bars and tertiary windings in large power transformers”, CIGRE Symposium, Paper 1133, Ljubljana, 2021.

GIC capability tests

White and Black-Box models are available to simulate the effects of GIC in a transformer



Longitudinal section view of a single-phase transformer modelled with magnetic resistances

Electro-magnetic network models are used to simulate the electrical behaviour. In such models relevant areas can be modelled with different magnetic resistances

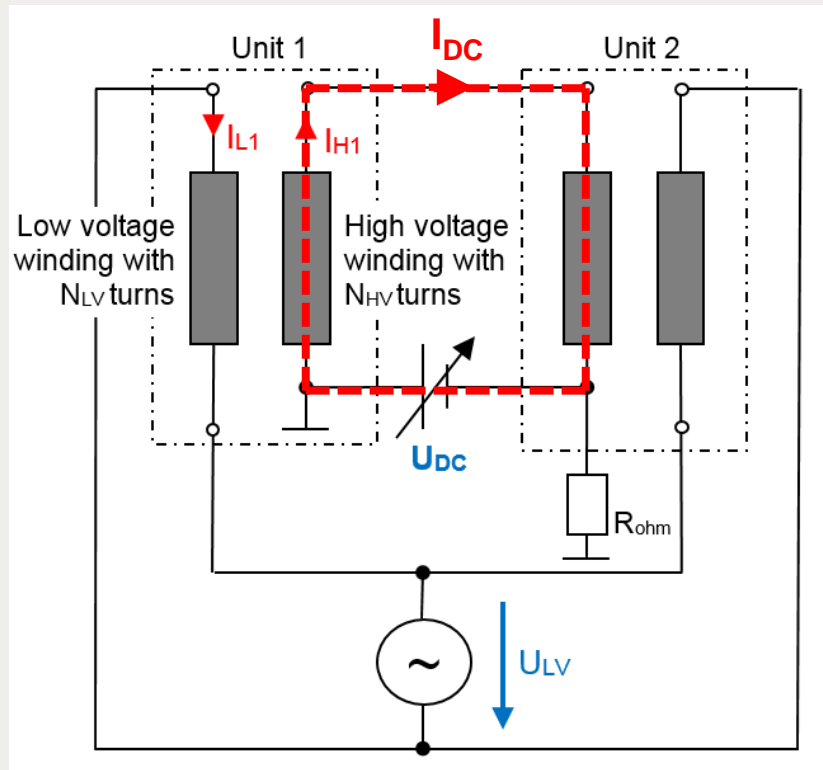
Hotspots of different steel parts can be simulated with detailed 3d FEM models

For components with a simple magnetic field orientation under GIC (tie bars near the core) also simplified layer models are possible for loss determination. They are easy to implement and can be combined with electro-magnetic network simulations. Also simplified thermal models are available. ²⁾

²⁾ J. Raith and U. Schichler: "Risk Assessment of Electrical Equipment under the Influence of GIC", CMD conference, Xi'An, 2016.

GIC capability tests

GIC tests are essential to verify and improve used calculation models and their parameter



Back-to-Back test circuit (no-load) to measure additional DC effects

DC sources can be used to inject DC currents in addition to the AC voltage excitation during FAT

Effects like additional harmonics and rising temperatures can be measured for the transformer under no-load

Costly and difficult tests in the grid can be avoided

Important is a suitable laboratory equipment (reactive power supply of generator)

Potential voltage fluctuations must be considered during model verification ³⁾

³⁾ J. Raith: "Risk Assessment of Power Transformers under the Influence of GIC", Doctoral thesis at Graz University of Technology, Graz, 2019.