Question 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 thermically

Response: Yes, it would be great that GIC simulation models be verified by measurements. However, such measurements should be under conditions representative of real operation. Typical test room generators or electronic power supplies provide far too little power to avoid voltage collapse at the transformer terminals and severe harmonic distortion of the voltage when the transformer core approaches saturation, as is made obvious in the paper 10842. The verification of the computational method remains questionable, as can be seen by the big difference between simulated and test room temperature rises of tie plates (Measured temperature rise is about 60% of the calculated value). Extrapolating the validity to significantly higher DC/GIC currents that may occur in operation introduces significant uncertainty.
Measurements with the transformer connected to a strong network, i.e. on site, provide results that require no re-calculations and assumptions to compensate for shortcomings of the test room's power supply. In a cooperation of Hitachi Energy and Statnett of Norway, an on-site DC testing of two 3-Phase Hitachi Energy large Power Transformers, equipped with a significant number of temperature measurement probes, as well as current and stray flux measuring probes, is scheduled to be performed on the Statnett grid in Norway for the last week of August.

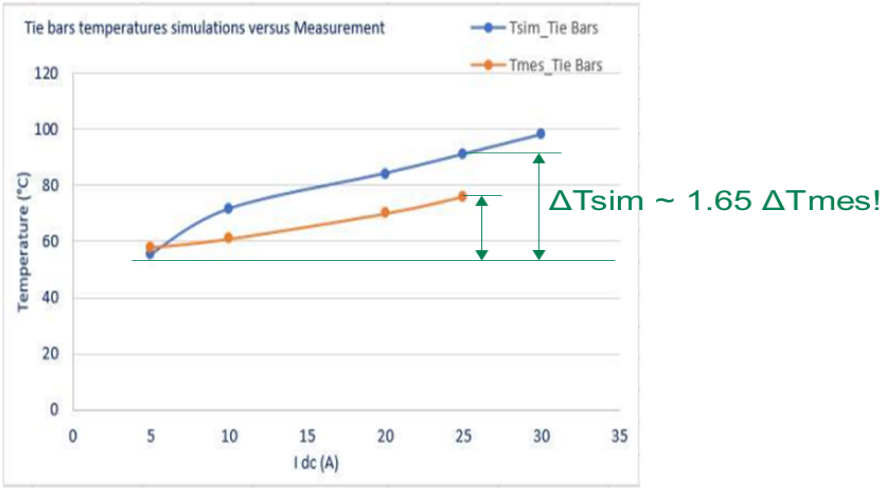

Figure 15 of paper 10842 with comment.

Power transformer designs (5 different core types for core form transformers and 3 different core types for shell form transformers) differ significantly in the way load dependent stray flux and off-core flux, during core magnetic saturation caused by GIC, are handled. Such design details are proprietary information to the manufacturer. Reactive power consumption and harmonics in the magnetizing current, i.e. electrical effects, may be estimated with some accuracy from "black box" simulation models, typically involving or derived from some circuit simulation with saturating elements. For proper simulation of thermal and mechanical effects, however, one needs design details that can only be included in more complex white box models.