CIGRE Study Committee A2

PROPOSAL FOR THE CREATION OF A NEW WORKING GROUP[1]

WG N° A2.60	**Name of Convenor:** Tim Gradnik (Slovenia)	
Strategic Directions #[2]: 1	**Technical Issues #[3]: 9**	
The WG applies to distribution networks[4]: Yes		
Potential Benefit of WG work #[6]: 3		
Title of the Group: Dynamic Thermal Behaviour of Power Transformers		

Scope, deliverables and proposed time schedule of the Group:

Background:

The worldwide electrical networks are challenged by frequent changes due to the energy transition to low-carbon distributed generation, the investment limitations in developed networks and the intense investments in emerging networks. These circumstances are stimulating development of new approaches in the design and operation of both existing and new power transformers. Knowing the power transformer condition is essential to meet the goals of maximizing the return on investment, increasing transformer operational efficiency and minimizing the probability of an unexpected transformer outage. As the winding hot-spot temperature is one of the most critical parameters defining transformer thermal condition and its overloading capabilities, accurate prediction of transformer dynamic thermal behaviour by application of Dynamic Thermal Modelling (DTM) is of vital importance for reaching the fore mentioned goals.

There have been a considerable number of publications dealing with power transformer dynamic thermal modelling. Moreover, IEC and IEEE loading guides have been recently revised and published. However, both loading guides did not manage to address appropriately the viscous effect of the new transformer insulating liquids as well as the effect of transformer operation at sub-zero ambient temperature. The availability of fiber optics measurements on windings of transformers in service condition (various load and ambient temperature) have clearly shown the limitations of these models. In addition, the recently published CIGRE Brochure 659 describes the evolution of thermal modelling approaches such as Thermal Hydraulic Network (THN) and Computer Fluid Dynamics (CFD) models, providing new tools for a more comprehensive assessment of transformer thermal behaviour.

Therefore, it is considered that now is a good time to consolidate this information, to identify and validate possible improvements of dynamic thermal models in order to support development of the international power transformer loading guides and temperature rise standards.

Scope:

The scope of this working group is to review the state-of-the-art tools and approaches to power transformers dynamic thermal modelling with aim of proposing suggestions for improvement of the existing standard models, taking into account the effects of using new insulating liquids and sub-zero ambient temperature operational conditions.

Particular areas of focus, for both mineral oil and new insulating liquid applications, will be:

1. Literature review in DTM development: historical background, dynamic heat transfer processes, methodologies (thermal-electrical analogy, THN, CFD, machine learning), advantages and limitations of different models, seasonal model accuracy, application examples, etc.
2. Improvement of DTM accuracy considering cooling system state, transformer design (core, shell type), winding arrangement, type of fluid, viscosity, load profile (e.g. cold start, step load) with explanation of the DTM input parameters.
3. On-line DTM applications for new and existing transformers: dynamic overload capability evaluation, cooling system performance monitoring, ageing assessment, etc.
4. Provide guidelines for Heat Run test specification and the methodology to extract the required DTM input parameters (exponents, time constants, thermal overshoot, temperature rises, etc.).

When applicable, the WG will make recommendations for standards improvement.

Deliverables:

☒ Technical Brochure and Executive summary in Electra

☒ Electra report

☒ Tutorial[5]

Time Schedule: start: January 2019 **Final Report**: 2023

Approval by Technical Committee Chairman:

Date: November 5th, 2018

Notes: [1] or Joint Working Group (JWG), [2] See attached Table 2, [3] See attached Table 1, [4] Delete as appropriate, [5] Presentation of the work done by the WG, [6] See attached table 3

Table 1: Technical Issues of the TC project "Network of the Future" (cf. Electra 256 June 2011)

1	Active Distribution Networks resulting in bidirectional flows
2	The application of advanced metering and resulting massive need for exchange of information.
3	The growth in the application of HVDC and power electronics at all voltage levels and its impact on power quality, system control, and system security, and standardisation.
4	The need for the development and massive installation of energy storage systems, and the impact this can have on the power system development and operation.
5	New concepts for system operation and control to take account of active customer interactions and different generation types.
6	New concepts for protection to respond to the developing grid and different characteristics of generation.
7	New concepts in planning to take into account increasing environmental constraints, and new technology solutions for active and reactive power flow control.
8	New tools for system technical performance assessment, because of new Customer, Generator and Network characteristics.
9	Increase of right of way capacity and use of overhead, underground and subsea infrastructure, and its consequence on the technical performance and reliability of the network.
10	An increasing need for keeping Stakeholders aware of the technical and commercial consequences and keeping them engaged during the development of the network of the future.

Table 2: Strategic directions of the TC (ref. Electra 249 April 2010)

1	The electrical power system of the future
2	Making the best use of the existing system
3	Focus on the environment and sustainability
4	Preparation of material readable for non-technical audience

Table 3: Potential benefit of work

1	Commercial, business or economic benefit for industry or the community can be identified as a direct result of this work
2	Existing or future high interest in the work from a wide range of stakeholders
3	Work is likely to contribute to new or revised industry standards or with other long term interest for the Electric Power Industry
4	State-of-the-art or innovative solutions or new technical direction
5	Guide or survey related to existing techniques. Or an update on past work or previous Technical Brochures
6	Work likely to have a safety or environmental benefit