CIGRE Study Committee A2

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

WG N° A2.61	Name of Convenor: Axel Kraemer(Germany)
Strategic Directions #[2]: 1, 2	**Technical Issues #[3]: 8, 10**
The WG applies to distribution networks[4]: Yes	
Potential Benefit of WG work #[6]: 1, 2, 4	
Title of the Group: On-load tap-changer best practices	

Scope, deliverables and proposed time schedule of the Group:

Background:

On-load tap-changers (OLTCs) are one of the most critical components used in power transformers.

In the late 19th century the first regulating schemes (close to the today's reactor type principle) were used to regulate the output voltage of transformers. A different switching principle (high-speed resistor type) was introduced in the 20's of the last century. Over the years the basic principles have not changed by much, but the step voltage and step capacity has been increased significantly over time and the vacuum technology was introduced.

The most common application is the OLTC used in step-up /step-down transformers, but they are also used in shunt reactors, phase-shifting transformers, arc-furnace and HVDC applications. Each application needs special attention with respect to the OLTC.

Performance requirements and test methods as well as principal design aspects and standard applications are well described in the relevant tap-changer standards (e.g. IEC 60214-1:2014, IEC 60214-2:201x (Draft 14/950/CDV:2018), IEEE C57.131:2012). Also some basic information on special applications can be found in the aforementioned standards as well as in the respective international device standards or CIGRÉ brochures (e.g. CIGRÉ TB 655:2016, IEEE PC57.21:201x, IEC/IEEE 60076-57-1202:2017, IEC 62032:2012/IEEE C57.135:2011, IEC 61378-:2011 and -3:2015, IEC/IEEE 60076-57-129:2017).

Detailed descriptions of specification and selection of tap-changers to meet the special challenges of those applications are not explained in detail by the standards already existing or under revision, because they cannot be comprehensive in dealing with every detail. Today this information is available at the tap-changer manufacturers and can be asked for.

In IEC 60214-2 a list of information to be provided by the transformer manufacturer at the enquiry or order stage for on-load tap-changers is given. However, an explanation on the correct determination of the required values is not given in every case. The specification sheets of the tap-changer manufacturers are based on this required information and might be similar for standard transformer applications, but differs from manufacturer to manufacturer when considering special applications. Additionally, also for standard transformers some special situations or duties may arise, which could be missed during specifying the OLTC.

OLTCs have to be maintained regularly. The tap-changer manufacturer documentation usually describes actions to be taken for maintenance on their devices, which is common practice since many years. Today, more and more OLTC shall be refurbished or replaced. Both actions are new challenges, because often it is not only the exchange of a device but

also a change to a new technology.

DGA analysis of tap-changers became more and more importance within the last decade. CIGRE, IEC and IEEE took this task already into their working programs and currently there is no need for further investigation within CIGRÉ in this topic. The following documents are/will be available:

- IEC 60599 Ed.3:2015 “Mineral oil-filled electrical equipment in service – Guidance on the interpretation of dissolved and free gases analysis” (OLTC related information can be found in the annex of this standard)
- IEEE C57.139 – 2015 “IEEE Guide for Dissolved Gas Analysis in Transformer Load Tap Changers” (Contrary to the previous version the new edition covers all types of OLTCs)
- CIGRÉ JWG D1/A2.47 “New frontiers of Dissolved Gas Analysis (DGA) interpretation for Power Transformers and their Accessories” (TB is scheduled for 2019)

Another topic with increasing importance is the use of alternative fluids in transformers and OLTCs. IEEE already taken care of this and established a working group; PC57.166 “Guide for Acceptance and Maintenance of Insulating Liquids in Transformers and Related Equipment”. This WG consists of 6 task forces. TF5 is dealing with requirements also for OLTCs. The scope of this new standard is very comprehensive. This new guide will provide acceptance and maintenance criteria for insulating liquids used in transformers, tap changers, regulators and reactors. This guide is intended to complement the existing standards. Dealing with those issues in CIGRÉ would imply a parallel work in two organizations and is currently out of scope.

Scope:

The scope of this working group is to provide information on open topics related to the recommended practice of using non-vacuum type as well as vacuum type OLTCs in power transformers and address new input for related standards and guides. Finally, the Technical Brochure shall give advice and guidance to transformer manufacturers and end users of OLTCs.

In particular, the following topics shall be covered:

- Special applications of OLTCs not covered completely by existing standards (OLTCs applied to e.g. shunt reactors, phase-shifting transformers, HVDC transformers, arc furnace transformers). Additionally, paralleling of regulated transformers is an issue to be considered.
- Guidelines for the proper selection of OLTCs
    - Transformer design consideration (including restrictions when using alternative liquids)
    - Life cycle cost consideration
    - Specification and design review
- Actions on OLTCs during lifetime of regulated transformers
    - Commissioning
    - Maintenance (recommended maintenance, scope of work, quality of work, frequency of work, testing practices after maintenance …)
    - Field testing (IEEE is also working on this topic) (e.g. DRM, VAM, DGA, fluid quality, thermography)
    - End of life decision making

- Refurbishment
- Replacement

- Failure modes, i.e. what can go wrong with an OLTC and what are the possible consequences for the transformer (not included will be health index issues of transformers and accessories, because they are handled in CIGRÉ WG A2.49. A practice to gain failure rates for OLTCs is discussed in CIGRÉ TB 642 (WG A2.37, published in December 2015)

De-energized tap-changers (DETC) are excluded from the scope of this working group.

Deliverables:

☒ Technical Brochure and Executive summary in Electra

☒ Electra report

☒ Tutorial[5]

Time Schedule: start: March 2019 **Final Report**: March 2022

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