IEEE PES Transformers Committee
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Tutorial on CIGRE WG D1.29: Partial Discharges in Transformers

— Technical Presentation —

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1. Abstract

The goal of the work of WG D1.29 was to summarize the progress in partial discharge (PD) measurements and evaluation of transformers taking a wide view.

PD measurements are among the most important diagnostic tool made for the reliable assessment of the condition of new or service aged HV components. The interpretation of PD results is still based upon the recorded amplitude of the apparent charge in pC or µV. A critical review confirms that the conventional measurement of this apparent charge at the bushings of a transformer, in particular, for PD sources hidden inside the insulation system (which are considered to be dangerous) and the measured value of this apparent charge do not sufficiently reflect the real risk of detected PD activity. Therefore, any detectable PD activity in a transformer during the factory acceptance test, especially at the nominal level of rated voltage, should be investigated and localized.

Transformer PD measurements can be used for multiple purposes. Off-line testing in a laboratory can be completed to determine a basis for quality assurance and acceptance testing (factory acceptance tests, or FAT) to reveal contamination, manufacturing errors or incorrect design. On-site PD diagnostic measurements (off-line or on-line site acceptance tests, or SAT) or on-line monitoring on new or service-aged transformers can serve as a condition assessment tool. For the purpose of this tutorial, the discussed interpretation and localization methods, as well as the suggested procedure for solution of PD problems in transformers, are valid for both FAT and SAT. The content of the tutorial is based on experience with PD measurements on transformers filled with mineral oil. The same procedures are expected to be applicable to transformers filled with alternative insulating fluids.

A number of practical case studies will be reviewed, where the testers had to go beyond IEC and IEEE requirements to arrive at a successful solution. Additionally, possible criteria for distinguishing between dangerous and less dangerous PD sources in power transformer oil-impregnated electrical insulation will be defined. Finally, despite the large number of practical examples of identified and localized PD defects, the unambiguous identification of dangerous PD sources in the electrical insulation system of power transformers remains a topic for further research.

2. Learning Objectives

This tutorial provides the following learning opportunities:

- Overview of PD measuring systems commercially available today
- Overview of the common PD source in the insulation system of transformers
- Overview of interpretation methods to distinguish between dangerous and less dangerous PD sources
- Overview of localization methods (electrical PD signals, acoustic and UHF signals)
- Recommended procedure for successful solution of PD problems

3. Learning Outcomes

By attending this tutorial, attendees will gain an understanding of the following:

- Benefits and limits of advanced PD measuring systems
- Basic knowledge about alternative PD measurements and evaluation methods
- Reliable analysis of PD results
- Efficient methods for localization of PD sources
- Procedure for solving the PD problem in the most efficient way

4. Presenters' Biographies

Jitka Fuhr has been an independent consultant since 2012 for her own company, AF Engineers + Consultants (AFEC) GmbH, based in Iseltwald, Switzerland. AFEC focuses on the areas of electrical power generation, e.g. generators, and high voltage (HV) power transmission and distribution equipment such as transformers and substations. As an expert in the solution of PD problems, she supports transformer factories worldwide. She published more than 50 publications in technical journals and presented at various international conferences. She is a co-author of the ABB book, Testing of Power Transformers. Jitka is a member of IEEE (M'04) and CIGRE. She contributed as the convenor of the CIGRE working group WG D1.29 "PD measurement on transformers," which published its results in the CIGRE Technical Brochure TB 676 in February 2017. Jitka received her master's degree in electrical engineering at Technical University Fridericana Karlsruhe (Germany) and her PhD at Technical University Darmstadt (Germany) in 1974 and 1985, respectively.

Janusz Szczechowski has worked for ABB's Transformers Group since 2007 and is currently located in the ABB Technology Center in Raleigh, North Carolina USA. From 2003 until 2007, he was working as a member of the research staff at the Schering Institute (Leibniz University Hannover/Germany). He authored and co-authored several international papers and ABB internal technical instructions and standards with a focus on high voltage testing and PD measurements as well as the implementation of the new acquisition Ultra High Frequency (UHF) method. He worked on the design, project execution and manufacturing of the first ABB high voltage mobile test system based on a frequency converter with Insulated Gate Bipolar Transistor (IGBT) technology. Janusz received his master's degree in electrical engineering in 2002 from the Poznan University of Technology (Poland) with a focus on high voltage technology.