IEEE PES Transformers Committee
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Online/Virtual

Tutorial on IEEE C57.104-2019 "Guide for the Interpretation of Gases Generated in Mineral Oil-Immersed Transformers"

— Technical Presentation —
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1. Abstract

IEEE C57.104 "Guide for the Interpretation of Gases Generated in Mineral Oil-Immersed Transformers," originally introduced in 1978, is widely used worldwide. The original guide was updated in 1991 but had remained virtually unchanged since. Recently, the industry recognized that an extensive revision was needed, especially in regards to the various numerical values used to evaluate transformer condition. That revision, based on the analysis of a large DGA database, was completed in 2019 and resulted in a major reorganization of the guide.

The guide now has six sections: Overview; Reference; Definition; The Nature, Purpose, and Application of Dissolved Gas Analysis; DGA Data Interpretation and Suggested Interpretation Procedures. Section 4 describes the nature of dissolved gas analysis, the purpose and application of DGA, DGA use context and precautions for sampling. Section 5 addresses DGA data interpretation, data quality review, reliability of DGA, context of DGA application and selection of norm values. Section 6 suggests interpretation procedures for DGA results, including flow charts and four norms tables, to generate a DGA status (1, 2 or 3) with fault identification using Rogers ratios and the Duval Triangle and Pentagons methods.

In addition, the guide has eight annexes. Annex A presents the DGA database's main characteristics and resumes the data analysis method used to generate the norms tables. Annex B describes how to compute rates and gives examples of Section 6 procedure. Annex C describes typical faults, and Annex D offers supplemental fault interpretation methods. Annex E presents five case studies, Annex F describes an alternate interpretation method and Annex G contains material from the previous version that could be of historical interest. Annex H is a complete bibliography.

2. Learning Objectives

This tutorial provides the following learning opportunities:

- Provide an overview of the guide's history
- Introduce the basics of a gas generation mechanism in mineral oil and its significance
- Review dissolved gas analysis process and pitfalls
- Provide a procedure to evaluate DGA results in terms of anomaly detection
- Identify faults from DGA results
- Provide an example of the procedure

3. Learning Outcomes

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

- History of the guide
- Significance of DGA
- Methodology changes
- How to use DGA results

4. Presenters' Biographies

Claude Beauchemin has been the director of technical development and director of quality assurance at TJ|H2b Analytical Services since 2011 and has been working 30 years for Syprotec (acquired by GE Canada) on the development and application of on-line gas-in-oil monitors for power transformers (Hydran systems). He is member of the IEEE Standards Association and of the IEEE Transformers Committee, where he has been Chair of the working group for the revision of the C57.104 DGA interpretation guide as well as being a member of several other working groups. Claude is also active in CIGRE A2.44, A2.47, A2.49, A2D1.46, D1.52 and D1.53; ASTM as Chair of D27.03; IEC TC10 and SCC. He is member of the Ordre Des Chimistes du Québec and graduated from Université de Montréal in chemistry in 1976.

Dr. Luiz Cheim works for ABB Power Grids as a senior principal R&D engineer with over 30 years of experience in the power transformer industry. His major activities as a member of the global ABB R&D team are in the development of power transformer condition assessment methods, performance models and algorithms as well as in the development of new sensors and monitoring technologies, such as the transformer inspection robot. In August 2018, Luiz was granted the Best Paper Award by CIGRE Study Committee A2/PS2 in Paris for the paper, "Machine Learning in Support of Transformer Diagnostics." He has been granted or filed for over 20 patents over the last 10 years. ABB selected him to give an interview to *Public Utilities Magazine* as top innovator for its November 2019 issue. Luiz has been a member of CIGRE since the late 1980s and IEEE since the early 2000s and has taken several active roles in both organizations.

Norman Field has been the supervising engineer for transformer and asset management projects at Teshmont Consultants LP since 2015. He has accumulated a variety of experience in the power transmission industry, including 13 years in large power transformer design with Pauwels Canada Ltd and Ferranti-Packard Transformers Ltd. followed by 17 years in asset management of electric power apparatus with Teshmont Consultants LP and Weidmann Diagnostic Solutions. Norman has published many papers and presented at several conferences. He is member of IEEE PES, the IEEE SA and of the IEEE Transformers Committee, where he has been Vice Chair of the C57.104 DGA interpretation guide revision working group. Norman graduated in electrical engineering at the University of Manitoba in 1989 and is a member of the Association of Professional Engineers and Geoscientists of the Province of Manitoba (APEGM).

Tom Prevost is the vice president of innovation for transformer insulation products in the Americas region at Weidmann Electrical Technology. He has worked at Weidmann for 27 years. He was Chairman of the IEEE PES Transformers Committee from 2008 to 2009 and is the Chair of several IEEE working groups, including PC57.162 to develop a guide for moisture in insulating systems, PC57.166 to develop a guide for acceptance and maintenance of insulating fluids and PC57.124 to revise a guide for partial discharge measurement in dry-type transformers. Tom is also active on ASTM Committee D27 on Insulating Fluids. He is a member of the U.S. National Committee of CIGRE and has written many technical papers on the subject of electrical insulation materials, transformer diagnostics and condition monitoring.