



IEEE PES Transformers Committee
Fall 2018 Meeting
Jacksonville, Florida USA



Tutorial on Guide for Application of Tertiary and Stabilizing Windings in Y-Y Connected Power Transformers

— Technical Presentation —
Thursday, October 18, 2018

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with support from Sukhdev, Hamid and other participants

1. Abstract

Stabilizing windings are auxiliary elements used in Y connected transformers to mitigate undesired harmonic phenomena and/or to improve zero sequence performance. On the other side, tertiary windings are frequently used to supply additional auxiliary loads at substations. When delta connected, such windings also work as stabilizing windings.

The tutorial will cover four main topics:

- Need for an application guide for tertiary and stabilizing windings in Y connected transformers
- Function of tertiary and stabilizing windings, harmonics and unbalanced loading phenomena, equivalent circuits, short circuit and thermal behavior
- Specification and testing of tertiary and stabilizing windings with some practical examples
- Further work

Based on brief excerpts from the guide and using supplementary material supplied by a group of members and guests, presenters will cover the following subjects during this tutorial:

- Systems engineering - the role of zero sequence impedance in line-to-ground faults
- Brief introduction to symmetrical components
- Application of Y connected transformers
- Zero sequence performance of different transformer connections
- Y connected transformers - transformer banks, three-phase transformers, core or shell type
- Exciting current phenomena on single-phase ferromagnetic cores
- Special operating effects of Y connected transformers - exciting current harmonics and unbalanced loading, stabilizing and tertiary windings
- Need for stabilizing windings in modern transformers
- Modeling and circuit analysis of Y connected transformers
- Thermal performance of Y connected transformers with stabilizing and tertiary windings, faults and temporary unbalanced loads, short circuit analysis
- Basic specification of power transformers with stabilizing or tertiary windings
- Further recommendations for specification/testing of transformers with stabilizing or tertiary windings
- Recommendation for Y connected transformers without a delta connected winding (SW/TW)
- Examples from some utilities in the U.S. and outside
- Conclusion and further work on application of tertiary and stabilizing windings

2. Learning Objectives

In general, this presentation is intended to improve the understanding the application of tertiary stabilizing windings. This presentation will also help improve utility personnel's understanding of the application, specification and testing of Y connected transformers so as to work as a team with transformer engineers and system engineers to improve current specifications and inspection practices.

3. Learning Outcomes

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

- Application of stabilizing and tertiary windings, from perspective of systems engineering as well as transformers design
- Recommendations from industry specialists for specification, construction and testing of transformers with stabilizing windings
- Open questions which would still require support from specialists, while those topics can be incorporated in future revision of the guide or in other IEEE standards

4. Presenters' Biographies

Enrique Betancourt is currently the Applied Research Manager at Prolec GE, in Monterrey, NL, Mexico, with his current work being on the development of new technologies for design and application of electrical transformers as well as new materials and simulation tools. Enrique started with Prolec SA in 1989. He is co-author of several patents and technical articles, as well as tools for design and analysis of power transformers. Enrique is a member of CIGRÉ national representative for the A2 SC on Transformers. He also worked for the NL State University teaching graduate level courses on High Voltage Engineering and Simulation of Electrical Transients.

Dr. Xose Lopez-Fernandez (IEEE Senior Member) is currently a Professor in the Department of Electrical Engineering, University of Vigo. He is the main editor and co-author of the monograph Transformers, Analysis, Design and Measurement and the founder and General Chairman of The International Advanced Research Workshop on Transformers. Xose is a member of the IEEE Transformers Committee as well as an active member of CIGRÉ working groups, Founder Member and President of the Spanish Association for Transformers Innovation (RedInTransf), Editorial Board Member of IET Science, Measurement & Technology (IET SMT Journal) and Vice President of IEEE PES Spanish Chapter.

Krishnamurthi Vijayan is currently Chief Engineer at PTI Manitoba Inc. in Winnipeg, Canada. He is a certified Professional Engineer in Canada with 37 years of experience in design engineering of large power transformers, EHV shunt reactors, phase-shifting transformers and mobile transformers. He has authored more than 12 technical papers on transformers.

