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IEEE Guide for the Application of Tertiary and Stabilizing Windings in Power Transformers

IEEE Power and Energy Society

Sponsored by the
Transformers Committee

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Abstract: The application of tertiary and stabilizing windings in liquid-immersed power transformers, as covered by IEEE Std C57.12.00™, as well as recommendations to evaluate the need or convenience of having such windings, are addressed in this guide. The primary application of this guide is for transformers and autotransformers with wye-wye-connected windings, with or without a delta-connected tertiary or stabilizing winding. Tertiary windings in conventional delta-wye and delta-delta–connected transformers are not addressed by this guide.

Keywords: buried tertiary, IEEE C57.158™, stabilizing winding, tertiary, unbalanced loading of transformers, wye-wye-connected transformers, Y-Y transformers connection

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Introduction

This introduction is not part of IEEE Std C57.158-2017, IEEE Guide for the Application of Tertiary and Stabilizing Windings in Power Transformers.

In all mature industries, as for instance the electric power supply industry, there is always a knowledge that is commonly applied, even though its fundamentals have not been summarized in a single, comprehensive source. In most cases, impact of such "missing links" is very minor, and more important issues become privileged for development into standards, as resources are naturally scarce.

This document deals with the subject of application of stabilizing windings in modern electric power systems, where some issues with wye-wye-connected transformers emerging in the early days were solved with practical sense by adding extra components in transformers, without an exact account of all real and potential benefits.

Part of the fundamentals for those applications is a tacit, empirical knowledge, with arbitrary interpretations of successful or unsuccessful events giving rise to a series of "rules," from which very different versions are implemented.

The purpose of this document is, first, to synthesize the fundamentals for contemporary application of a technical solution, and second, to review and present to the industry a more organized set of application rules and recommendations.

The IEEE working group that developed this application guide started working as a task force in 2009, and originally developed a proposed new subclause 5.11.1.2 for IEEE Std C57.12.00™-2014. The purpose of that specific subclause was to standardize interpretation for the power and/or thermal rating required for stabilizing windings, also known as *buried tertiaries*.

In this document, a wider scope is offered, including power systems application concepts, zero-sequence currents, nonlinear magnetization of ferromagnetic cores, a more repeatable and user-friendly definition for the kVA rating of the stabilizing winding, some basic concepts to support correct application of short-circuit withstand requirements, and many practical recommendations to improve specification, design, testing, and application of stabilizing and tertiary windings.

An important driver for this work has been the view that our industry constantly faces new challenges that not only require new solutions, but that frequently can be solved with just a better understanding about the capabilities of existing elements. Trial and error is an expensive way to solve problems affecting an industry, especially in one where structural components are expected to last from two to five decades.

Examples of new challenges for which proper assessment and solution might require a more understandable definition of stabilizing winding capabilities are the impact of geomagnetic induced currents on transmission transformers, and the potential development of transient or temporary operation of transmission links with just two, instead of three, lines. Under such conditions, heavy circulating currents can be produced in the stabilizing and tertiary windings. Economy, of course, is a permanent driver to constantly question and better evaluate needs for "auxiliary" elements, and basic principles of systems reliability tend to favor the simpler solutions.

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IEEE Guide for the Application of Tertiary and Stabilizing Windings in Power Transformers

1. Overview

1.1 Scope

This guide addresses the application of tertiary and stabilizing windings in liquid-immersed power transformers, as covered by IEEE Std C57.12.00, as well as recommendations to evaluate the need or convenience of having such windings. The primary application of this guide is for transformers and autotransformers with wye-wye-connected windings, with or without a delta-connected tertiary or stabilizing winding. The guide does not address tertiary windings in conventional delta-wye, or delta-delta-connected transformers.

1.2 Purpose

This guide provides users with a conceptual framework and recommendations for the specification, application, and performance evaluation of tertiary and stabilizing windings.

2. Normative references

The following referenced documents are indispensable for the application of this document (i.e., they must be understood and used, so each referenced document is cited in text and its relationship to this document is explained). For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

IEEE Std C57.12.00™, IEEE Standard for General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.[1, 2]

IEEE Std C57.12.70™, IEEE Standard for Standard Terminal Markings and Connections for Distribution and Power Transformers.

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