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IEEE Guide for Evaluation and Reconditioning of Liquid Immersed Power Transformers

IEEE Power and Energy Society

Sponsored by the
Transformers Committee

IEEE
3 Park Avenue
New York, NY 10016-5997
USA

IEEE Std C57.140™-2017
(Revision of
IEEE Std C57.140-2006)

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Abstract: Guidelines for the following are included in the standard: insulating liquid maintenance and diagnostics, liquid reclamation, testing methods for the determination of remaining insulation (paper) life, and upgrades of auxiliary equipment such as bushings, gauges, de-energized tap changers (DETCs), load tap changers (LTCs) (where applicable), and coil re-clamping. The goal of this guide is to assist the user in extending the useful life of a transformer.

Keywords: condition evaluation, IEEE C57.140™, life extension, maintenance, power transformers, reconditioning, risk assessment

The Institute of Electrical and Electronics Engineers, Inc.
3 Park Avenue, New York, NY 10016-5997, USA

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[illegible]gerio Verdolin
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Roy Ayers
Peter Balma
Thomas Barnes
Barry Beaster
W. J. (Bill) Bergma[illegible]
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Introduction

This introduction is not part of IEEE Std C57.140-2017, IEEE Guide for Evaluation and Reconditioning of Liquid Immersed Power Transformers.

At the turn of the century, approximately one-half of all transformers used in the electric utility industry reached their 30-year design life. Because of today's economics, many of these transformers will be called upon to supply reliable service for an additional 20 to 30 years. Transformer owners intending to extend the equipment life should address the key areas of economics, inspection and diagnostics, expected cost of failure/loss of production; and materials and design.

A comprehensive economic study should be carried out before the investment of significant resources to recondition a transformer. This study involves load forecasts, reserve margins, new capacity plans, cost-benefit analyses, operating costs, capital costs, and continued reliability and availability.

Once a financial decision to extend the transformer life is made, an inspection and diagnostic strategy should be determined. This evaluation should include the following: manufacturer, size, age, operating history, thermal load, electrical tests, maintenance history, and failure history.

New materials, major component replacement, and other design changes may significantly affect the life extension decision of units manufactured in the last 50 years. The development of better core steel and better solid insulation has been ongoing for a number of years. The better operating efficiency of new materials may remove the economic advantage for life extension.

Material added to this document includes information on corrosive sulfur in the insulation liquid and correlation curves of furanic content with degree of polymerization. There are also sections and updates with 5.4 solid insulation system analysis, power factor, and information on frequency response analysis.

Acknowledgement

Grateful acknowledgement is given to CIGRE for granting permission to reprint copyrighted material from "Technical Brochure N 445, Guide for Transformer Maintenance" and Technical Paper "New diagnostic for High Voltage Bushings."

Dedication

This standard is dedicated to the memory of our friend and colleague, Roland James.

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IEEE Guide for Evaluation and Reconditioning of Liquid Immersed Power Transformers

1. Overview

1.1 Scope

This document provides guidelines for the following: insulating oil maintenance and diagnostics, oil reclamation, testing methods for the determination of remaining insulation (paper) life, and upgrades of auxiliary equipment such as bushings, gauges, de-energized tap changers (DETCs), load tap changers (LTCs) (where applicable), and coil re-clamping. The goal of this guide is to assist the user in extending the useful life of a transformer.

1.2 Purpose

The purpose of this guide is to provide guidelines for evaluation and reconditioning of transformers. This guide should prove helpful to users who do have evaluation and reconditioning programs in place, and who may not be aware of other activities and processes that are available. The guide is intended as a comprehensive document to aid users in selecting the proper approaches to upgrading, reconditioning, refurbishing, or other activities in extending the useful life of a transformer.

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.

ASTM D395, Standard Test Methods for Rubber Property—Compression Set.

ASTM D1275, Standard Test Method for Corrosive Sulfur in Electrical Insulating Liquids.

ASTM D1933, Standard Specification for Nitrogen Gas as an Electrical Insulating Material.

ASTM D4243, Standard Test Method for Measurement of Average Viscometric Degree of Polymerization of New and Aged Electrical Papers and Boards.

ASTM D5387, Standard Guide for Elements of a Complete Data Set for Non-Cohesive Sediments.