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IEEE Recommended Practice for Performing Temperature Rise Tests on Liquid-Immersed Power Transformers at Loads Beyond Nameplate Ratings

IEEE Power and Energy Society

Sponsored by the
Transformers Committee

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IEEE Std C57.119™-2018
(Revision of IEEE Std C57.119-2001)

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Abstract: Recommendations are made, where possible, regarding the performance and evaluation of temperature rise tests on liquid-immersed power transformers beyond nameplate ratings in this recommended practice. The intent is to assist power transformer manufacturers, and the ultimate users, in evaluating thermal performance of the transformers under varying loads.

Keywords: bottom oil temperature, conditioning loads, hottest spot factor, IEEE C57.119™, liquid-immersed, loading, load tap changer, power transformers, rated load, thermal capacity, top oil temperature

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Introduction

This introduction is not part of IEEE Std C57.119-2018, IEEE Recommended Practice for Performing Temperature Rise Tests on Liquid-Immersed Power Transformers at Loads Beyond Nameplate Ratings.

This introduction provides background related to the development of this recommended procedure. Additional information may be found in Annex B.

Over the years, there has been a marked increase in the practice of loading transformers beyond their nameplate rating. In the past, many transformers were loaded beyond nameplate rating only during short time emergencies. Today, many users have established loading practices that subject transformers to loads beyond nameplate rating on a planned basis during periods of seasonal or daily peak loads, in addition to unexpected loads occurring during short or long time emergencies.

Former ANSI standard C57.91 provided loading guidelines for distribution transformers, IEEE Std C57.92™-1981 [B9] provided loading guidelines for power transformers rated 100 MVA and below, and IEEE Std C57.115™-1991 [B10] provided loading guidelines for transformers rated above 100 MVA.[1] All of these documents have been combined into a revised IEEE Std C57.91™.[2] These documents provide transformer loading guidelines based on judgment gained from years of experience of loading transformers. However, prior to this document, no standard test procedure existed to evaluate the consequences of loading a transformer at loads beyond nameplate rating.

Investigations carried out in the past by transformer users raised concern about the accuracy of the equations and empirical constants used in the transient loading equations of these loading guides. Their experience with monitoring operating transformers indicated that transformers could carry loads greater than nameplate rating, without apparent damage. Also, there has been concern that ancillary equipment, such as tap changers, bushings, and instrumentation may not have the same overload capabilities as the core and coil assembly.

The preceding conditions and concerns led to a desire for a test procedure that would:

a) Provide data on the thermal characteristics of liquid-immersed transformers to be used to evaluate the accuracy of the equations and empirical constants used in the loading equations in the liquid-immersed transformer loading guides.

b) Demonstrate that a transformer may be loaded with a specified sequence of loads, including loads beyond nameplate rating, without exceeding those temperatures specified or agreed upon by the user and manufacturer.

c) Demonstrate that the ancillary equipment on a liquid-immersed transformer would not impose limitations on those loading conditions recommended in the loading guides.

This recommended practice describes three test procedures. Clause 9 describes a test procedure for determining the thermal characteristics of an oil-immersed power transformer. Clause 10 describes a test procedure for performing load cycle temperature rise tests to assess the capability of a transformer to be loaded with a specific load cycle. Clause 11 describes a recommended integrated procedure for determining thermal characteristics and performing a load cycle temperature rise test.

It is anticipated that data obtained from tests performed in accordance with these procedures will assist in improving the accuracy of the assumptions and equations used in future loading guides.

[1]The numbers in brackets correspond to those of the bibliography in Annex D.
[2]Information on references can be found in Clause 2.

References to other standards have been updated where applicable and all units of measurements are specified in metric units only, wherever practical.

All cooling class designations have been replaced with new cooling class designations per cooling class designations from IEEE Std C57.12.00™ latest revision.

The latest 2017 changes to this were made to bring this recommended practice in conformance with the Transformers Committee general agreement on the use of the wording *liquid-immersed* instead of *oil-immersed* in the body of the Transformer Standards and Guides. These "Recommendations to the IEEE Transformer Committee (TC) on Recommended Changes, Deletions, and Insertions Related to Normalizing the References of Insulating Liquids throughout the IEEE TC Standards Series" were presented to the TC Standards Subcommittee October 22, 2014.

Annex B was not normalized as this is the informative tutorial on this subject and it was thought better to leave it in its original form to provide emphasis as to the need for normalizing of references of insulating liquids.

Contents

IEEE Recommended Practice for Performing Temperature Rise Tests on Liquid-Immersed Power Transformers at Loads Beyond Nameplate Ratings

1. Overview

This document consists of three recommended test procedures, each to determine or verify transformer thermal capabilities for different purposes. Clause 1 through Clause 8 include information applicable to all three test procedures. Clause 9 is a recommended test procedure for determining the thermal characteristics of a liquid-immersed power transformer from data obtained from three temperature rise tests at three specified loads. Clause 10 is a recommended procedure for performing a temperature rise test while applying a varying load, conforming to a specified loading profile, to verify that specified transformer temperatures do not exceed guaranteed values when the transformer is loaded to the specified loading profile. Clause 11 is a recommended procedure, combining the procedures in Clause 9 and Clause 10, with the objective of achieving the purpose of both clauses with reduced test time. Clause 11 is similar to Clause 10, except that the three loads are selected to simulate the temperatures expected to occur during a specific load cycle. Each of the procedures may be performed independent of the other. However, it is recommended that tests per Clause 9 be performed before Clause 10, if both tests are to be performed.

NOTE—IEEE Std C57.12.90™-1999, Chapter 11, states the test procedures to be followed to establish the temperature rise at the transformer nameplate ratings.[3,4]

1.1 Scope

This recommended practice covers temperature rise test procedures for determining those thermal characteristics of power transformers needed to appraise the transformer's load carrying capabilities at specific loading conditions other than rated load.

1.2 Purpose

These recommended test procedures for performing temperature rise tests on power transformers are for the purpose of the following:

a) Determining the thermal characteristics of a transformer needed to appraise the thermal performance of a transformer at loads other than nameplate rating

[3]Information on references can be found in Clause 2.
[4]Notes in text, tables, and figures of a standard are given for information only and do not contain requirements needed to implement this standard.