C57.110™

IEEE Recommended Practice for Establishing Liquid-Filled and Dry-Type Power and Distribution Transformer Capability When Supplying Nonsinusoidal Load Currents

IEEE Power Engineering Society

Sponsored by the
Transformers Committee

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Abstract: This recommended practice provides calculation methods to conservatively evaluate the feasibility for an existing installed dry-type or liquid-filled transformer, to supply nonsinusoidal load currents as a portion of the total load. This recommended practice also provides necessary application information to assist in properly specifying a new transformer expected to carry a load, a portion of which is composed of nonsinusoidal load currents. A number of examples illustrating these methods and calculations are presented. Reference annexes provide a comparison of the document calculations to calculations found in other industry standards. Suggested temperature rise calculation methods are detailed for reference purposes.

Keywords: accuracy, current transformer, instrument transformer, primary winding, rated secondary voltage, routine tests, secondary winding, type tests, voltage transformer

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Introduction

(This introduction is not part of IEEE Std C57.110-2008, IEEE Recommended Practice for Establishing Liquid-Filled and Dry-Type Power and Distribution Transformer Capability When Supplying Nonsinusoidal Load Currents.)

The widespread use of static rectification equipment in industrial loads on small and medium power dry-type and liquid-filled transformers has resulted in a dramatic increase in the harmonic content of the load current of these transformers. It has become common for the harmonic factor of the current to exceed 0.05 per-unit, which is the limit specified for "usual service conditions" in IEEE Std C57.12.00™ and IEEE Std C57.12.01™. The higher harmonic content in the load current of these transformers causes higher eddy current loss in the windings and the structural parts linked by the transformer leakage flux and, consequently, higher operating temperatures. Users of this document should also recognize that liquid-filled transformers may have different load limitations than dry-type transformers and that the harmonic loading practices should treat the two types of transformers differently when necessary.

This recommended practice provides guidance for the conservative loading of transformers carrying nonsinusoidal load currents such that overheating is avoided. The intent of this document is to provide simple methods of calculating these effects on either a new transformer or an existing transformer. More specifically, it is expected that this recommended practice would be used for the following situations:

a) A new transformer required to carry some nonsinusoidal load currents, but ***will not*** be entirely devoted to a rectifier load.

b) An existing transformer not originally specified for supplying nonsinusoidal load currents, but is now required to supply a load, a ***portion*** of which is nonsinusoidal.

Two methods are described in this recommended practice. The first method is intended to illustrate calculations by those with access to detailed information on loss density distribution within each of the transformer windings. The second method is less accurate and is intended for use by those with access to transformer-certified test report data only. It is anticipated that the first method will emphasize the information necessary to specify a new transformer and show how this information is used by transformer design engineers, whereas the second method will be employed primarily by users. This recommended practice will provide methods for conservatively evaluating the feasibility of applying nonsinusoidal load currents to existing transformers and will clarify the requirements for specifying new transformers to supply nonsinusoidal loads.

New transformers that are intended to supply loads with high harmonic content must be specified with a harmonic current distribution. The designer cannot "assume" nor can the user expect the designer to use "standard" or "typical" current distribution tables. If the harmonic content of the load is unknown, then both the user and the transformer designer are at risk and reasonable steps should be taken to ensure a conservative design for the application. Guidelines on how this information is used to develop proper transformer sizing is provided in this document, but appropriate calculations specific to the type of transformer design are the responsibility of the designer. Approximate calculation techniques that provide conservative results are provided for the typical user who has much less information than the transformer designer.

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1. Overview

1.1 Scope

This recommended practice applies only to two winding transformers covered by IEEE Std C57.12.00, IEEE Std C57.12.01, and NEMA ST20.[1] It does not apply to rectifier transformers.

1.2 Purpose

The purpose of this document is to establish uniform methods for determining the capability of transformers to supply nonsinusoidal load currents of known characteristics.

[1] Information on references can be found in Clause 2.