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IEEE Guide for Dry-Type Transformer Through-Fault Current Duration

IEEE Power and Energy Society

Sponsored by the
Transformers Committee

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USA

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Abstract: Recommendations believed essential for the application of overcurrent protective devices that limit the exposure time of dry-type transformers to short-circuit currents are set forth in this guide. This guide is not intended to imply overload capability.

Keywords: dry-type transformers, fault current, IEEE C57.12.59™, mechanical damage, mechanical duty, normal base current, short-circuit current, short-circuit impedance, thermal damage

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Introduction

This introduction is not part of IEEE Std C57.12.59™-2015, IEEE Guide for Dry-Type Transformer Through-Fault Current Duration.

This guide provides recommendations for the application of overcurrent protection devices to limit the exposure time of dry-type transformers to short circuits. It shall not be confused with IEEE Std C57.109™, IEEE Guide for Liquid-Immersed Transformer Through-Fault Current Duration, which applies only to liquid-immersed transformers.

Dry-type transformers differ significantly from liquid-immersed types in several respects:

a) There are significant variations in dry-type winding constructions, including conventional varnish impregnated layered windings, vertically stacked varnish-impregnated disk windings, solid cast windings, and combinations thereof, all of which have different transient heating characteristics during time intervals greater than about 100 s.

b) The transient heating of liquid-immersed transformer windings is considerably buffered by the insulating medium in which the windings are immersed, providing a relatively long thermal time constant as compared to dry-type transformers.

Because of the foregoing, the through-fault protection curves for dry-type transformers are limited to overload time intervals of 100 s or less. No one curve for longer time intervals would characterize the thermal performance of all the different dry-type transformer constructions and temperature ratings. Moreover, such curves are not known or, at least, not available. Consequently, the curves in this guide pertain to the temperature rise of the windings during time intervals less than 100 s, where nearly all the heat generated is stored in the conductors. For longer time intervals, it is recommended that reference be made to IEEE Std C57.96™ [B1], IEEE Guide for Loading Dry-Type Distribution and Power Transformers.

As short-circuit time intervals become progressively less than 100 s, mechanical considerations become more important than thermal characteristics.

Short-circuit performance characteristics are contained in IEEE Std C57.12.01™. This guide supplements that information, but in no way supersedes it.

The substantive revisions of this guide include expansion of the scope to include Category III transformers. The basis for the equations and the thermal and mechanical damage curves of Figure 1, Figure 2, and Figure 3 were developed and are detailed in Annex A. Figure 2a was corrected for consistency with the details of Annex A.

Contents

IEEE Guide for Dry-Type Transformer Through-Fault Current Duration

1. Overview

1.1 Scope

This guide for dry-type transformer through-fault current duration applies to dry-type distribution and power transformers built in accordance with IEEE Std C57.12.01™.[1]

1.2 Purpose

This guide sets forth recommendations believed essential for the application of overcurrent protective devices that limit the exposure time of dry-type transformers to short-circuit currents. This guide is not intended to imply overload capability.

1.3 General

Protective devices, such as relays and fuses, have well-defined operating characteristics that relate fault magnitude to clearing time. It is desirable that these characteristic curves be coordinated with comparable curves applicable to dry-type transformers that relate duration and fault magnitude to withstand capability.

The magnitude and duration of fault currents are of utmost importance in establishing a coordinated protection practice for transformers, as both mechanical and thermal effects of fault currents shall be considered. For fault-current magnitudes near the maximum short-circuit current rating of the transformer, mechanical effects are more significant than thermal effects. The maximum symmetrical short-circuit current should not exceed

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