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IEEE Recommended Practice for Preferred Ratings for High-Voltage (>1000 volts) AC Circuit Breakers Designated Definite Purpose for Fast Transient Recovery Voltage Rise Times

IEEE Power and Energy Society

Sponsored by the
Switchgear Committee

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Abstract: The preferred ratings of transformer-limited fault duty (fast transient recovery voltage rise times) of indoor and outdoor high-voltage circuit breakers rated above 1000 V for use in commercial, industrial, and utility installations are described.

Keywords: fast transient recovery voltage rise times, high-voltage circuit breakers, IEEE C37.06.1™, transformer-limited fault, transient recovery voltage, TRV

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Introduction

This introduction is not part of IEEE Std C37.06.1-2017, IEEE Recommended Practice for High-Voltage (>1000 volts) AC Circuit Breakers Designated Definite Purpose for Fast Transient Recovery Voltage Rise Times.

This IEEE recommended practice is a revision of ANSI C37.06.1-2000 (Guide for High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis Designated "Definite Purpose for Fast Transient Recovery Voltage Rise Times") and deals with special applications with fast TRV requirements calling for definite purpose circuit breakers with special TRV requirements and for circuit breakers in transformer-limited fault applications. This document provides preferred values of standard ratings of fast transient recovery voltage rise times. This recommended practice provides (1) preferred interrupting current and TRV values for manufacturers to test their circuit breakers against, and (2) recommended TRV values for users from which to choose when selecting circuit breakers for these applications. This document takes into account the fact that the highest TRV rates of rise are obtained in TLF (transformer-limited fault) conditions. There might be some cases of TRVs associated with faults near series reactors with a rate of rise greater than TLF. In such cases the manufacturer should be consulted for circuit breaker suitability.

This document also introduces a transformer-limited fault (TLF) current breaking capability, as the current specified would correspond to the actual need in service instead of a fixed percentage (10% or 30%) of the rated short circuit current that is in many cases far from the real need. As per CIGRE Technical Brochure 362 [B1],[1] in the majority of cases it has been found that the TLF current is less than 11 kA and it is not relevant to link the TLF current to 30% of the rated short-circuit current (63 kA).

The revision also includes a change from the 1-cosine to a two-parameter TRV envelope. A range of transformer impedance data (600 examples) ranging from 115 kV to 765 kV was analyzed. The data (expressed as current from infinite source) was spread over large spectrum.

ANSI C37.06.1-2000 was initially approved as a "trial-use" guide in 1997, and then approved for more general use as a guide in 2000.

The rated transformer-limited fault breaking current is the highest transformer-limited fault current required to be interrupted under the conditions of use and behavior prescribed in this recommended practice in a circuit having a power-frequency recovery voltage corresponding to the rated maximum voltage of the circuit breaker and having a transient recovery voltage equal to the value specified in Table 2 or Table 3.

Table 1 gives the standard rated transformer-limited fault breaking current selected from the R10 series. The current specified would correspond to the actual need in service instead of a fixed percentage (10% or 30%) of the rated short-circuit current that is in many cases far from the real need. The values of time t_3 corresponding to these TLF currents are recalculated, and are represented as function of U_r and transformer-limited fault current in Table 2 and Table 3.

Table 2 gives the corresponding TRVs for circuit breakers with rated voltages higher than 1 kV and less than 100 kV.

Table 3 gives the corresponding TRV parameters for circuit breakers rated 100 kV and above. The other related parameters [time to peak t_3, time delay t_d, and rate-of-rise of recovery voltage (RRRV)] can be deduced per Annex A.

Annex A shows the determination of the equation that gives t_3 as function of U_r and the rated short-circuit current for circuit breakers rated 1 kV and above.

[1]The numbers in brackets correspond to those of the bibliography in Annex C.

Annex B shows the transformer-fed fault current data for voltage ranges 115–765 kV collected through survey.

Tables are consistent as they are all based on the same relation between t_3, U_r and the fault current. The ratings were suggested by the working group and are purely based on the transformer impedance data collected for voltages 115 kV to 765 kV from different utilities. The TRVs for currents more than or equal to 60% of rated short-circuit current remain the same as for general purpose circuit breakers. Circuit breakers not identified by the manufacturer as “definite purpose for fast transient recovery voltage rise times” shall be understood to be “general purpose circuit breakers,” meeting the IEEE C37.06 standard TRV requirements.

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IEEE Recommended Practice for Preferred Ratings for High-Voltage (>1000 volts) AC Circuit Breakers Designated Definite Purpose for Fast Transient Recovery Voltage Rise Times

1. Overview

1.1 Scope

This recommended practice is issued as a supplement to IEEE Std C37.06 for high-voltage circuit breaker applications where the transient recovery voltage (TRV) peak is higher and/or its rise to the crest value occurs more rapidly than those specified in IEEE Std C37.06.

1.2 Purpose

The purpose of this document is to introduce transformer-limited faults, similar to that established by IEEE Std C37.016 [B5], and specifically to provide preferred values for standard ratings of fast transient referred to as transformer-limited fault recovery voltage rise times and to introduce a transformer-limited fault (TLF) breaking current.[2]

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.

[2]The numbers in brackets correspond to those of the bibliography in Annex C.