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IEEE Guide for Testing Switchgear Rated Up to 52 kV for Internal Arcing Faults

IEEE Power and Energy Society

Sponsored by the
Switchgear Committee

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IEEE Std C37.20.7™-2017
(Revision of IEEE Std C37.20.7-2007)

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Abstract: Procedures for testing and evaluating the performance of switchgear for internal arcing faults is covered. A method of identifying the capabilities of this equipment is given. Service conditions, installation, and application of equipment are also discussed. As used in this document, the term *switchgear* is used as a general term covering switching and interrupting devices and their combination with associated control, instrumentation, metering, protective and regulating devices, assemblies of those devices with associated interconnections, accessories, and supporting structures used primarily in conjunction with the generation, transmission, distribution, and conversion of electrical power.

Keywords: accessibility, arc, arc-resistant, bus, compartment, IEEE C37.20.7, internal arcing fault, medium-voltage controllers, metal-clad switchgear, metal-enclosed bus, metal-enclosed gas-insulated switchgear, metal-enclosed interrupter switchgear, metal-enclosed low-voltage power circuit breaker switchgear, metal-enclosed switchgear, motor control centers, overpressure protection, switchboard

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Introduction

This introduction is not part of IEEE Std C37.20.7™-2017, IEEE Guide for Testing Switchgear Rated Up to 52 kV for Internal Arcing Faults.

The standards and guides in the IEEE C37™ series[1] have been developed over a period of many years through the cooperative efforts of users, specifiers, manufacturers, and other interested parties. This edition of IEEE Std C37.20.7[2] includes a detailed application guide and improvements in the testing procedure. The original development of the 2001 edition of this guide rests heavily on Annex AA of IEC 298-1981[3] and Amendment 1: 1994. This revision reflects lessons learned from use of the 2001 and 2007 editions of IEEE Std C37.20.7. This revision also extends the scope to include testing of low-voltage motor control centers, switchboards, medium-voltage ac controllers, metal-enclosed bus, metal-enclosed medium-voltage outdoor circuit breakers, and gas-insulated switchgear.

In the 1970s, principally in Europe, interest in evaluating electrical equipment under conditions of internal arcing emerged. As a result, a draft Annex AA to IEC 298 "A.C. Metal-Enclosed Switchgear and Controlgear for Rated Voltages Above 1 kV and Up to and Including 52 kV" was issued by the IEC in 198[illegible] and revised in 1990. It was redesignated IEC 62271-200 and revised in 2003 and 2011.

Subsequent to the creation of IEC 298, IEC subcommittee 17D issued Technical Report IEC/TR 1641 in 1996 (now redesignated as IEC/TR 61641) entitled "Enclosed Low-Voltage Switchgear and Controlgear Assemblies—Guide for Testing Under Conditions of Arcing Due to Internal Fault."

Knowledge of the arc resistance testing guide in IEC 298 spread to North America, and it was used as the basis for EEMAC G14–1, 1987, "Procedure for Testing the Resistance of Metalclad Switchgear Under Conditions of Arcing Due to an Internal Fault." EEMAC G14-1 incorporated improvements in knowledge and understanding in over a decade of use of Annex AA of IEC 298 in Europe.

Failure within a switchgear assembly, whether from a defect, an unusual service condition, lack of maintenance, or misoperation, may initiate an internal arc. There is little likelihood of an internal arc in equipment meeting the requirements of IEEE Std C37.20.1™, IEEE Std C37.20.2™, IEEE Std C37.20.3™, IEEE Std C37.20.9™, IEEE Std C37.23™, UL 347, UL 845, or UL 891. There is even less likelihood of an internal arc in equipment that has insulated bus, compartmentalization, barriers, and interlocks, such as those described in IEEE Std C37.20.2; however, the possibility cannot be disregarded completely. The intent of this guide is to address the testing procedure for internal arcing faults in switchgear.

Even when arc-resistant construction is specified, it is strongly recommended that supplemental power system protection be provided. This supplemental protection should limit the total energy that can be delivered in the event of internal arcing faults. This protection can be provided in a variety of ways, depending on the nature of the system. Among the forms of protection that may be appropriate are current-limiting fuses, current-limiting circuit breakers, zone differential or bus differential relaying, ground differential protection, or arc-sensing systems sensitive to light or pressure effects that accompany internal arcing faults. The objective of such protection is to cause the interruption of all sources of power to the arcing fault in a time interval that is shorter than the rated arcing duration capability demonstrated by the tests contained within this document (refer to 4.4).

In addition to supplemental power system protection, adequate personal protective equipment is required, as all hazards associated with an internal arcing fault are not eliminated when equipment tested to this guide is used.

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[3]IEC publications are available from the International Electrotechnical Commission (http://www.iec.ch) and the American National Standards Institute (http://www.ansi.org/).

This revision also incorporates the changes found in Corrigendum 1 (2010) to IEEE Std C37.20.7–2007.

In this document, the term *switchgear* is used in its broadest sense (see definition of switchgear in Clause 3), and is not restricted only to equipment as described in IEEE Std C37.20.1™, IEEE Std C37.20.2™, or IEEE Std C37.20.3™.

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IEEE Guide for Testing Switchgear Rated Up to 52 kV for Internal Arcing Faults

1. Overview

1.1 Scope

This guide establishes methods by which equipment may be tested for resistance to the effects of arcing due to an internal fault. Equipment types covered in this guide include metal-enclosed switchgear as defined by IEEE Std C37.20.1™, IEEE Std C37.20.2™, IEEE Std C37.20.3™ and IEEE Std C37.20.9™; metal-enclosed bus as defined by IEEE Std C37.23™; medium-voltage ac controllers as defined by UL 347; motor control centers as defined by UL 845; switchboards as defined by UL 891; and metal-enclosed medium-voltage air-insulated circuit breakers for outdoor application defined by IEEE Std C37.04™ (see note). This guide applies only to equipment utilizing air or other insulating gas as the primary insulation medium and rated 52 kV ac or below. It applies to both indoor and outdoor equipment; however, special consideration should be given to the building size and construction for indoor applications (not fully addressed by this document).

The tests and assessments described in this guide are only applicable to arcing faults occurring entirely in air within the enclosure when doors and covers are properly secured in accordance with the rated accessibility type. This guide does not apply to arcing faults that occur within components of the equipment, such as instrument transformers, sealed interrupting devices, fuses, and so on.

Designs that meet the requirements of this guide will be referred to as *arc-resistant*.

NOTE—These circuit breakers are sometimes referred to as dead-tank circuit breakers.[4]

1.2 Background

1.2.1 Consequences of internal arc faults

Switchgear is designed to withstand the worst-case mechanical forces between conductors, which occur when a short circuit occurs directly on the load terminals of the switchgear. This condition is referred to as a *bolted fault*, a short-circuit condition that assumes zero impedance exists at the point of the fault. The ability of switchgear to withstand the effects of the bolted fault is demonstrated in the short-time withstand current tests and the short-circuit current withstand tests as required by the specific equipment standard or the corresponding tests in the relevant standards for other equipment types. When a bolted fault occurs, the voltage at the fault

[4]Notes in text, tables, and figures are given for information only and do not contain requirements needed to implement the guide.