



# IEEE Guide for Testing Metal-Enclosed Switchgear Rated Up to 38 kV for Internal Arcing Faults

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**IEEE Power Engineering Society**

Sponsored by the  
Switchgear Committee

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# **IEEE Guide for Testing Metal-Enclosed Switchgear Rated Up to 38 kV for Internal Arcing Faults**

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**Switchgear Committee  
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IEEE Power Engineering Society**

Approved 27 September 2007  
**IEEE-SA Standards Board**

**Abstract:** A procedure for testing and evaluating the performance of metal-enclosed 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.

**Keywords:** accessibility, arc, bus, compartment, internal arcing fault, metal-clad switchgear, metal-enclosed interrupter switchgear, metal-enclosed low-voltage power circuit breaker switchgear, metal-enclosed switchgear, overpressure, protection

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## Introduction

This introduction is not part of IEEE Std C37.20.7-2007, IEEE Guide for Testing Metal-Enclosed Switchgear Rated Up to 38 kV for Internal Arcing Faults.

The standards and guides in the IEEE C37™ series 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 includes a detailed application guide and improvements in the testing procedure. The development of this guide rests heavily on Annex AA of IEC 298-1981<sup>a</sup> and Amendment 1: 1994. This revision is harmonized with the IEC and incorporates many of the refinements made to the original IEC 298, as contained in the current IEC 62271-200 edition.

This revision reflects lessons learned from use of the previous 2001 version. This revision also extends the scope to include testing of low-voltage metal-enclosed power circuit breaker 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 1kV and Up to and Including 52kV” was issued by the IEC in 1981 and revised in 1990. It was redesignated IEC 62271-200 and revised in 2003.

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 Metal Clad 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™-2002,<sup>b</sup> IEEE Std C37.20.2™-1999, or IEEE Std C37.20.3™-2001. 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 C37.20.2-1999; however, the possibility cannot be disregarded completely. The intent of this guide is to address the testing procedure for internal arcing faults in metal-enclosed 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 must be 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 test contained within this document (refer to 4.3).

<sup>a</sup> IEC publications are available from the Sales Department of the International Electrotechnical Commission, Case Postale 131, 3, rue de Varembe, CH-1211, Genève 20, Switzerland/Suisse (<http://www.iec.ch/>). IEC publications are also available in the United States from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA.

<sup>b</sup> IEEE publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, Piscataway, NJ 08854, USA (<http://standards.ieee.org/>).

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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# IEEE Guide for Testing Metal-Enclosed Switchgear Rated Up to 38 kV for Internal Arcing Faults

## 1. Overview

### 1.1 Scope

This guide establishes methods by which metal-enclosed switchgear, as defined by IEEE Std C37.20.1™-2002,<sup>1</sup> IEEE Std C37.20.2™-1999, and IEEE Std C37.20.3™-2001, may be tested for resistance to the effects of arcing due to an internal fault. This guide applies only to equipment utilizing air as the primary insulating medium and rated up to 38 kV ac. It applies to both indoor and outdoor equipment; however, special consideration must be given to the building size and construction for indoor applications (not 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 all doors and covers are properly secured. This guide does not apply to arcing faults that occur within components of the switchgear assembly, such as instrument transformers, sealed interrupting devices, fuses, and so on.

Switchgear designs that meet the requirements of this guide will be referred to as arc-resistant, metal-enclosed low-voltage ac power circuit breaker switchgear, arc-resistant metal-enclosed interrupter switchgear, or arc-resistant metal-clad switchgear as applicable, or generally, as arc-resistant switchgear.

### 1.2 Background

#### 1.2.1 Consequences of internal arc faults

Metal-enclosed 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” in IEEE Std C37.100™-1992. The ability of metal-enclosed switchgear to withstand the effects of the bolted fault is demonstrated in the Short-Time Withstand Current Tests and in the Momentary Withstand Current Tests in IEEE Std C37.20.2-1999 and IEEE Std C37.20.3-2001 or the

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<sup>1</sup> Information on references can be found in Clause 2.