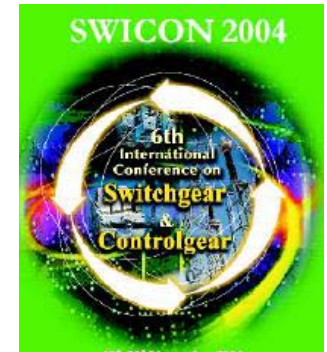


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Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия



Recent Evolution IEC Standards for High-voltage Switchgear & Controlgear

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Content

- ▶ Introduction
- ▶ General Considerations on SC17A & 17C Standards
 - ▶ Common Numbering System
 - ▶ New Standards of IEC SC 17A
 - ▶ Revision Common Clauses Std IEC 60694 (62271-1)
- ▶ IEC 62271-100 Standard for HV Circuit-breakers
- ▶ Conclusion



Introduction

- ▶ The past years have been marked by an **intense activity in the standardization work** for high-voltage switchgear and controlgear.
- ▶ Several major standards have been revised or are in the process of being revised in order to **improve their contents and in some cases to harmonize** with the requirements of ANSI/IEEE standards.
- ▶ New standards have been established either **to cover new types of equipment**, such as disconnecting circuit-breakers, or existing equipment already in service for years (e.g. series capacitor by-pass switches) and for which no international standard was existing.

General on SC17A & 17C Standards

▶ Common Numbering System

- ▶ A common numbering system has been established for High-voltage switchgear. **IEC 62271** is the basis of the standards of SC17A (High-voltage Switchgear) and SC17C (High-voltage Switchgear Assemblies).
- ▶ The following rule is applied to the numbering of the standards:
 - Common standards prepared by SC 17A and SC 17C start with **IEC 62271-1**;
 - Standards of SC 17A start with **IEC 62271-100**;
 - Standards of SC 17C start with **IEC 62271-200**;
 - Guides prepared by SC 17A and SC 17C start with **IEC 62271-300**.

General on SC17A & 17C Standards

▶ Common Numbering System Parts 1 to 104

IEC 62271 Part	Old IEC number	Title	Status
1	60694	Common specifications	Edition 2.2 (2002-01) Under revision
2*	-	Seismic qualification for rated voltages of 72,5 kV and above	Published 2003-02
3	-	High voltage switchgear and assemblies with digital interfaces based on IEC 61850	New standard Work in progress
100	60056	High-voltage alternating current circuit-breakers	Edition 1.1 (2001-05) Amendment 1 (2003-04) Amendment 2 in progress
(101)	60427	Synthetic testing of high-voltage alternating current circuit-breakers	Under revision
102	60129	Alternating current disconnectors and earthing switches	Published 2003-08
(103)	60265-1	Switches for rated voltages above 1 kV and less than 52 kV	Published 1998-01
(104)	60265-2	High-voltage switches for rated voltages of 52 kV and above	Published 1988-03 Amendment 1 (1997-07)

General on SC17A & 17C Standards

▶ Common Numbering System Parts 105 to 110

IEC 62271 Part	Old IEC number	Title	Status
105	60420	High-voltage alternating current switch-fuse combinations	Published 2002-08
(106)	60470	HV alternating current contactors and contactor-based motor-starters	Published 2000-05
107	-	HV a.c. fused circuit-switchers for rated voltages above 1 kV up to and including 52 kV	New standard Work in progress
108	-	Combined function disconnecting circuit-breakers	New standard Work in progress
109	-	Alternating-current series capacitor by-pass switches	New standard Work in progress Presently PAS (2002-07)
110	-	Inductive load switching	New standard, replacing TR 61233. Work in progress

General on SC17A & 17C Standards

► Common Numbering System Parts 200 to 205

IEC 62271 Part	Old IEC number	Title	Status
200	60298	A.C.-metal enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV	Published 2003-11
(201)	60466	A.C.-insulation-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 38 kV	Under revision
(202)	61330	High-voltage/low-voltage prefabricated substations	Under revision
203	60517	Gas-insulated metal-enclosed switchgear for rated voltages of 72,5 kV and above	Published 2003-11
(204)	61640	Rigid high-voltage gas-insulated transmission lines for rated voltages of 72,5 kV and above	Published 1998-07
(205)	-	Assemblies of high-voltage devices	New standard Work in progress

New IEC SC17A Standards

- ▶ IEC 62271-108: Combined function disconnecting circuit-breakers
 - ▶ This standard concerns equipment that **combines the circuit-breaker and disconnector functions**.
 - ▶ It is limited to apparatus where the distance between contacts of the circuit-breaker contribute to the BIL withstand.
 - ▶ In particular, it is required that the **dielectric withstand** across the disconnecting gap is demonstrated **after mechanical endurance** as well as **after specified short-circuit test duties**.
 - ▶ An international standard is planned for publication in 2005.

Common Specifications Std 60694 (62271-1)

- ▶ The common clauses standard for high-voltage switchgear and controlgear is presently under revision.
 - ▶ Main items considered in this revision:
 - EMC (immunity tests on secondary systems);
 - **Test procedure for impulse tests;**
 - Lightning impulse tests on vacuum interrupters;
 - Temperature rise tests;
 - X ray radiation test (introduced for vacuum interrupting devices).
 - ▶ International standard is planned for publication in 2006.

IEC 62271-100 High Voltage Circuit Breaker Std

- ▶ The revision of IEC standard for high-voltage circuit-breaker 60056 was started in March 1994. The main aims of this revision were to
 - Harmonize the content with IEC 60694;
 - Incorporate the new requirements for **mechanical endurance** and electrical endurance ($U_r < 72,5$ kV) in amendment 3 to IEC 60056;
 - Revise the clauses on **capacitive current switching** (considering CIGRE work);
 - Redefine the **criteria to pass the impulse tests**, in order to prove that non-self-restoring insulation is not damaged during tests;
 - Introduce a dielectric test to **check the condition** of a circuit-breaker after mechanical or breaking tests;
 - Define more precisely the procedure for **making and breaking tests** (arcing times for 1-phase tests made in substitution for 3-phase tests).

IEC 62271-100 High Voltage Circuit Breaker Std



▶ Main aims of the revision (Continued)

- Establish the procedure for single phase testing of test duty 5 (T100a);
- Consider as much as possible the Guide to the interpretation of IEC 60056 elaborated by STL (Short-Circuit-Testing-Liaison);
- Seek possible **harmonization** with ANSI/IEEE standards (change rated voltages 525 kV to 550 kV and 765 kV to 800 kV);
- Introduce the recording of a **mechanical travel characteristic** during type and routine tests.

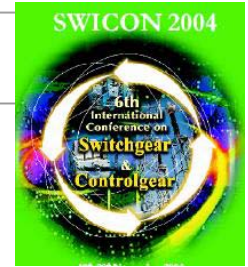
IEC 62271-100 High Voltage Circuit Breaker Std

- ▶ Main changes introduced in IEC 62271-100 Ed.1

Definitions

- ▶ **Classes E1 and E2** are introduced for circuit-breakers respectively with normal or extended electrical endurance.
- ▶ **Classes C1 and C2** are introduced for circuit-breakers respectively with a low expected probability or a very low expected probability of restriking during capacitive current breaking.
- ▶ **Classes M1 and M2** are introduced for circuit-breakers respectively with normal (2000 cycles CO) or extended mechanical endurance (10 000 cycles CO).

IEC 62271-100 High Voltage Circuit Breaker Std



- ▶ Main changes introduced in IEC 62271-100 Ed.1

Time constant of network

- ▶ The standard value of **45 ms** is kept.
- ▶ Values are defined for special cases, depending on rated voltage:
 - 120 ms ($U_r \leq 52\text{kV}$),
 - 60 ms ($72,5 \text{ kV} \leq U_r \leq 420 \text{ kV}$)
 - 75 ms ($U_r > 420\text{kV}$).

IEC 62271-100 High Voltage Circuit Breaker Std



- ▶ Main changes introduced in IEC 62271-100 Ed.1

Criteria to pass the impulses tests

- ▶ The number of disruptive discharges shall not exceed 2 for each series of impulses.
- ▶ The number of tests impulses per series is 15, and at least five impulses without disruptive discharge must follow the last disruptive discharge (d.d.).
- ▶ Additional tests may be necessary to verify that the non-self restoring insulation is not damaged.
- ▶ Ad-hoc meeting on this issue is scheduled end of November to recommend common the test procedure for SC17A standards.

IEC 62271-100 High Voltage Circuit Breaker Std



- ▶ Main changes introduced in IEC 62271-100 Ed.1

Voltage test as condition check

- ▶ A voltage test is performed as a condition check when required after making, breaking or switching tests or after mechanical or environmental tests
 - Circuit-breakers with $U_r \leq 72,5$ kV: a 1 min power frequency voltage test shall be performed. The test voltage is 80 % of the rated value.
 - Circuit-breakers with $72,5$ kV $< U_r \leq 245$ kV: an impulse voltage test shall be performed. The crest value of the impulse voltage is 60 % of rated lightning impulse withstand voltage.

IEC 62271-100 High Voltage Circuit Breaker Std



► Changes introduced in IEC 62271-100 Ed.1

Voltage test as condition check

- Circuit-breakers with $300 \text{ kV} \leq U_r \leq 420 \text{ kV}$: an impulse voltage test shall be performed. The crest value of the impulse voltage is 80 % of the rated switching impulse withstand voltage.
- Circuit-breakers with $550 \text{ kV} \leq U_r \leq 800 \text{ kV}$; an impulse voltage test shall be performed. The crest value of the impulse voltage is 90% of the rated switching impulse withstand voltage.

IEC 62271-100 High Voltage Circuit Breaker Std

- ▶ Main changes introduced in IEC 62271-100 Ed.1

Alternative operating mechanisms

- ▶ If a circuit-breaker is to be used with different types of mechanisms, under certain conditions **only one complete series of short-circuit type tests is required.**
 - One CO operation shall be done in no-load condition. The mechanical characteristic obtained with the original mechanism is the reference. The curve obtained with the alternative mechanism must be within an allowed envelope.
 - A short-circuit test T100s must be done also with the alternative mechanism
 - During T100s with the maximum arcing time, the mechanical characteristic with the alternative mechanism must be within the envelope obtained with the original mechanism.

IEC 62271-100 High Voltage Circuit Breaker Std



- ▶ Main changes introduced in IEC 62271-100 Ed.1

Capacitive current switching tests

- ▶ The revision of the clauses concerning capacitive current switching was based on the recommendations from CIGRE WG 13-04 and was elaborated by a common IEC-IEEE Task force.
- ▶ The aim was to have almost the **same requirements** in the new editions of **IEC 62271-100** and **ANSI/IEEE** standards for HV circuit-breakers C37.04 and C37.09.
- ▶ As indicated earlier, 2 classes of circuit-breakers were introduced, having a low or a very low probability of restrike.

IEC 62271-100 High Voltage Circuit Breaker Std



- ▶ Main changes introduced in IEC 62271-100 Ed.1

Capacitive current switching tests

- ▶ **Class C1:** testing of Class C1 circuit-breakers corresponds to the requirements in ANSI C37.09-1979 standard, and has the same number of tests as in IEC 60056.
- ▶ **Class C2:** the severity of tests for class C2 has been greatly increased, compared with those of class C1 by:
 - doubling the number of tests,
 - performing many tests with the minimum arcing time,
 - performing tests on a pre-conditioned circuit-breaker (3 interruptions of T60).

IEC 62271-100 High Voltage Circuit Breaker Std



▶ Amendment 1 to IEC 62271-100 Ed.1

- ▶ This amendment 1 has been prepared by WG 23 of SC17A. The objective was to **harmonize TRV** representation and parameters in IEC and ANSI/IEEE standards for high-voltage circuit-breakers with a rated voltage of 100 kV and above.

▶ The main changes that were introduced are:

- A new definition of the first reference voltage

$$u_1 = 0,75 \times k_{pp} \times U_r \sqrt{\frac{2}{3}} = 0,75 \text{ p.u.}$$

- Additional Tables for solidly earthed systems for rated voltages of 100kV to 170kV,
- A rate-of-rise of recovery voltage (RRRV) equal to 7 kV/ μ s for test duty T10 for all rated voltages.

IEC 62271-100 High Voltage Circuit Breaker Std



▶ Amendment 2 to IEC 62271-100 Ed.1

- ▶ An amendment 2 to IEC 62271-100 is currently under preparation by WG 35 and Maintenance Team 36 of SC 17A.
- ▶ Fragment **f2**: contains most items of the amendment , except
- ▶ Fragment **f1**: the revision of TRVs for circuit-breakers rated less than 100kV that is prepared by WG 35.

IEC 62271-100 High Voltage Circuit Breaker Std



- ▶ **Amendment 2 f1** to IEC 62271-100 Ed.1: Revision of TRVs for circuit-breakers rated less than 100 kV
 - ▶ This proposal for revision of TRVs uses the **input** coming from former Working groups of **CIGRE Study Committee A3** (Switching Equipment). Some results of the studies have been published in *Électra* N°88.
 - ▶ In 1992, together with CIRED, CIGRE SC A3 created the Working group CC-03 to investigate again the definition of TRV's for medium voltage switchgear. The outcome of these investigations has been published in CIGRE Technical Brochure 134 (1998) and is in line with earlier studies.

IEC 62271-100 High Voltage Circuit Breaker Std

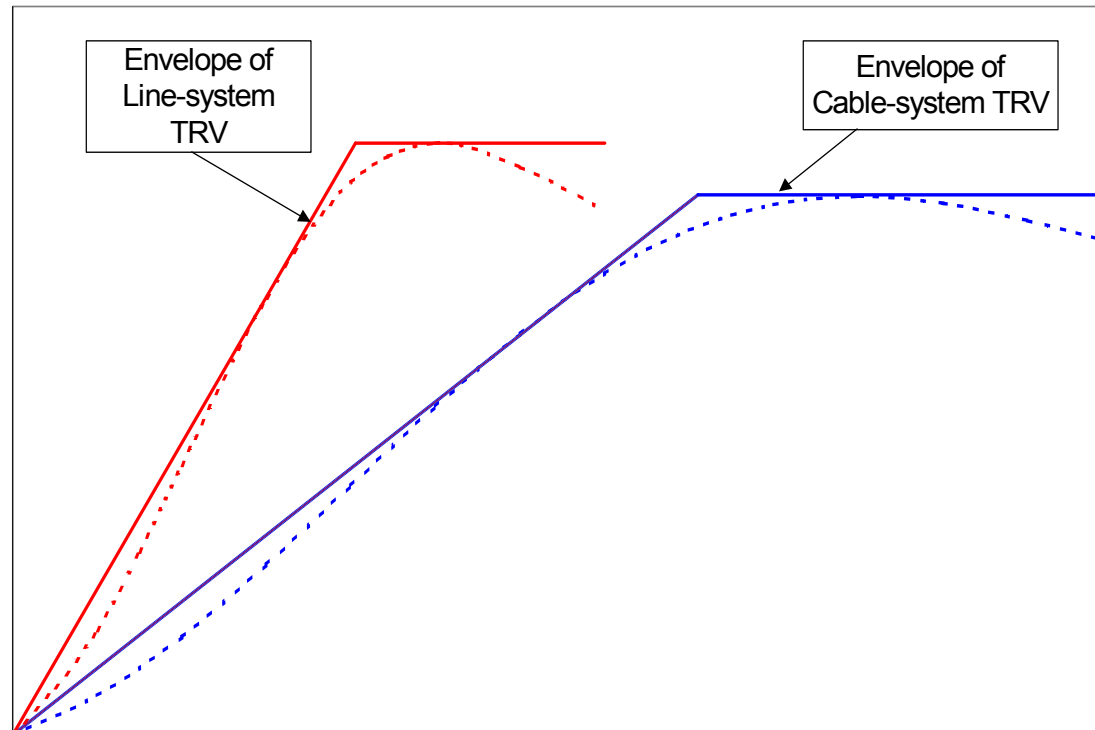


- ▶ **Amendment 2 f1** to IEC 62271-100 Ed.1: Revision of TRVs for circuit-breakers rated less than 100 kV
- ▶ In order to cover all types of networks (distribution, industrial and sub-transmission) in the range of rated voltages higher than 1 kV and less than 100 kV, and for standardization purposes, **two types of systems are defined:**
 - ▶ **Cable systems**
 - ▶ **Line systems**



IEC 62271-100 High Voltage Circuit Breaker Std

- ▶ **Amendment 2 f1** to IEC 62271-100 Ed.1: Revision of TRVs for circuit-breakers rated less than 100 kV



IEC 62271-100 High Voltage Circuit Breaker Std

- ▶ **Amendment 2 f1** to IEC 62271-100 Ed.1: Revision of TRVs for circuit-breakers rated less than 100 kV

Cable-systems

- ▶ Cable systems have a TRV during breaking of terminal fault at 100 % of short-circuit breaking current that does not exceed the two-parameter envelope derived from Table 1a of the present IEC 62271-100 standard.
- ▶ **Circuit-breakers of indoor substations with cable connection are in cable-systems.**
- ▶ Overhead-lines networks with cable termination are considered as cable-systems if the total length of cable on the supply side of circuit-breakers is at least 100 m.

IEC 62271-100 High Voltage Circuit Breaker Std



- ▶ **Amendment 2 f1** to IEC 62271-100 Ed.1: Revision of TRVs for circuit-breakers rated less than 100 kV

Line systems

- ▶ Line systems have a TRV during breaking of terminal fault at 100 % of short-circuit breaking current defined by the two-parameter envelope derived from Table 1aL of the standard (see IEC draft 17A/686/CD).
- ▶ **Systems with transmission lines directly connected to a busbar (without intervening cable connections) are typical examples of line-systems.**

IEC 62271-100 High Voltage Circuit Breaker Std



▶ Amendment 2 f2 to IEC 62271-100 Ed.1

A number of editorial changes will be done to improve the wording of IEC 622271-100 Ed.1 or to clarify some of the requirements. Other more significant changes include:

- The revision of all paragraphs concerning **NSDDs** (Non sustained disruptive discharges). A **new definition** from CIGRE WG A3-11 will be introduced.
- Introduction of a condition check for vacuum circuit-breakers in SF6 containers;
- **Incorporation of IEC 62271-308** (Guide for asymmetrical short-circuit testing T100a).

Conclusion

- ▶ The overview on the activities of IEC SC17A and 17C has shown that
 - ▶ **many standards have been revised** during the past five years,
 - ▶ **new standards** are currently under revision or will be published in the near future.
- ▶ This intense activity corresponds to the constant need to **improve the standards** but also to **cover new types of equipment** that are introduced on the market.
- ▶ **Environmental concerns** are taken into account in the revisions, in particular by introducing more strict requirements on the loss of SF6 to the atmosphere.

Conclusion (Continued)

- ▶ IEC SC 17A and the IEEE Switchgear Committee have done common work to harmonize as far as possible the electrical tests for high-voltage circuit-breakers.
 - ▶ **Harmonization of requirements** for capacitive current switching is almost completed with the new edition of IEC 62271-100 and the revised ANSI/IEEE C37-04a and 09a.
 - ▶ The description of TRVs with 2 or 4 parameters will be common in IEC and ANSI standards.
 - ▶ Some differences in the values of parameters could remain between the two standards, but they will not prevent the performance of common tests to cover requirements in IEC and ANSI.



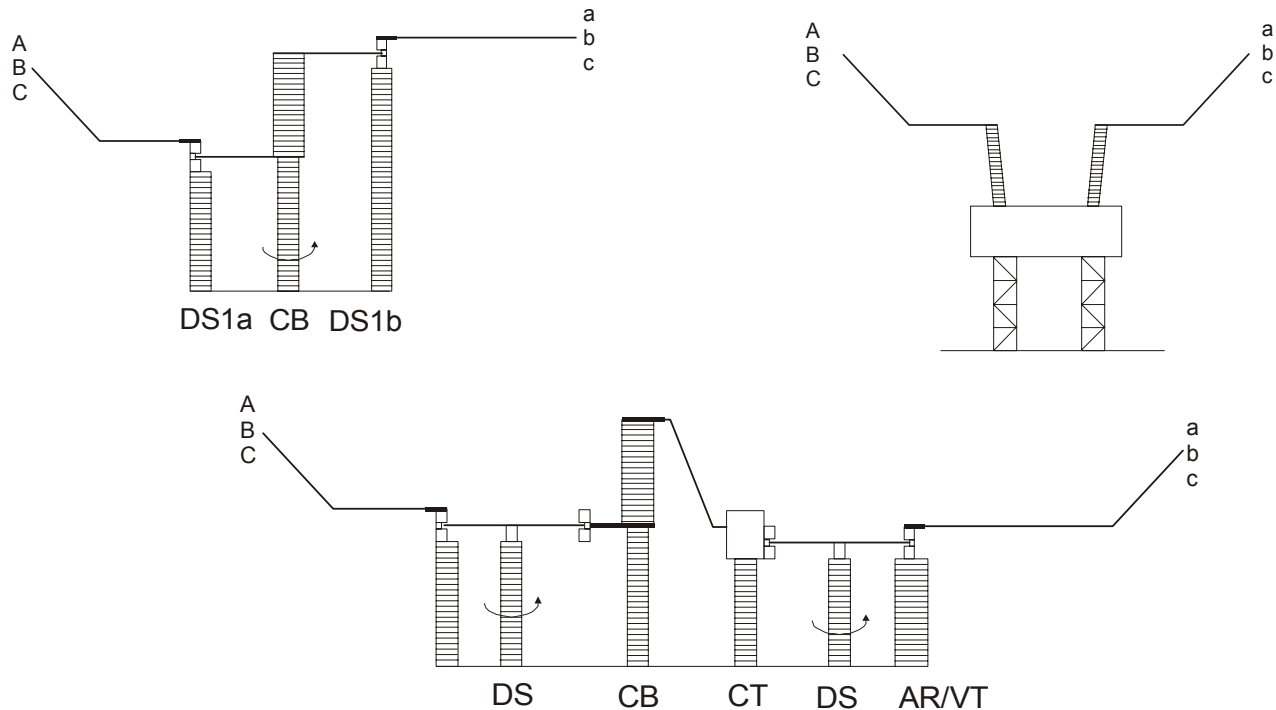
Thank you for your attention.

Questions ?



New IEC SC17C Standard

- ▶ IEC 62271-205 High-voltage switchgear assemblies for operation at rated voltages above 52 kV



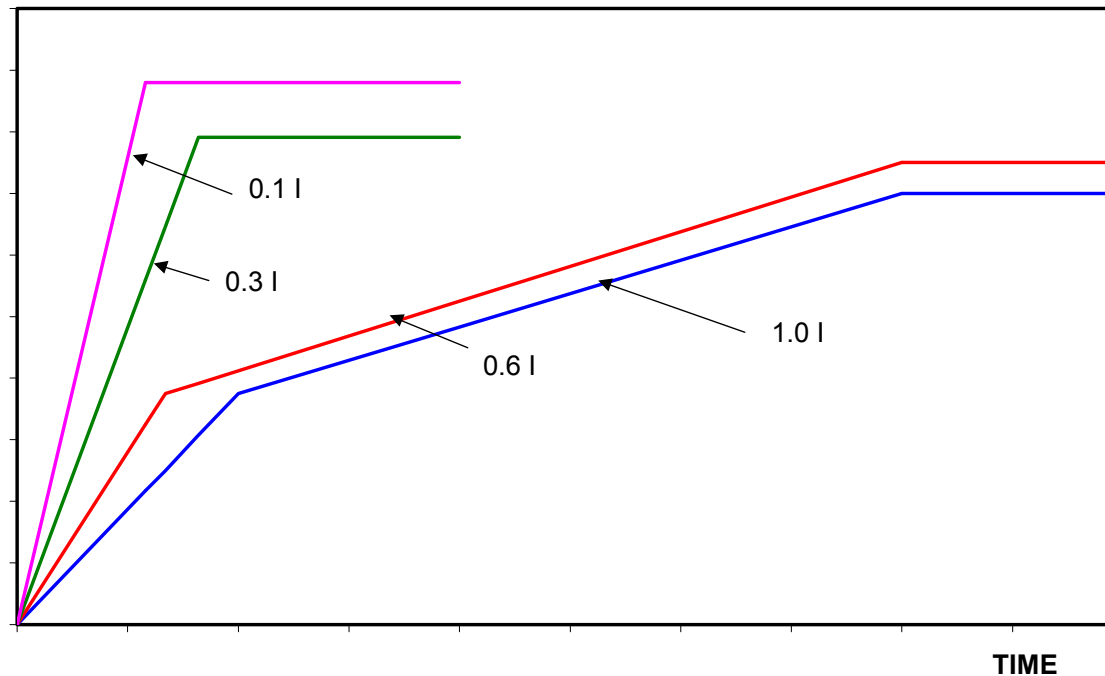


IEC 62271-100 High Voltage Circuit Breaker Std

► Amendment 1 to IEC 62271-100 Ed.1

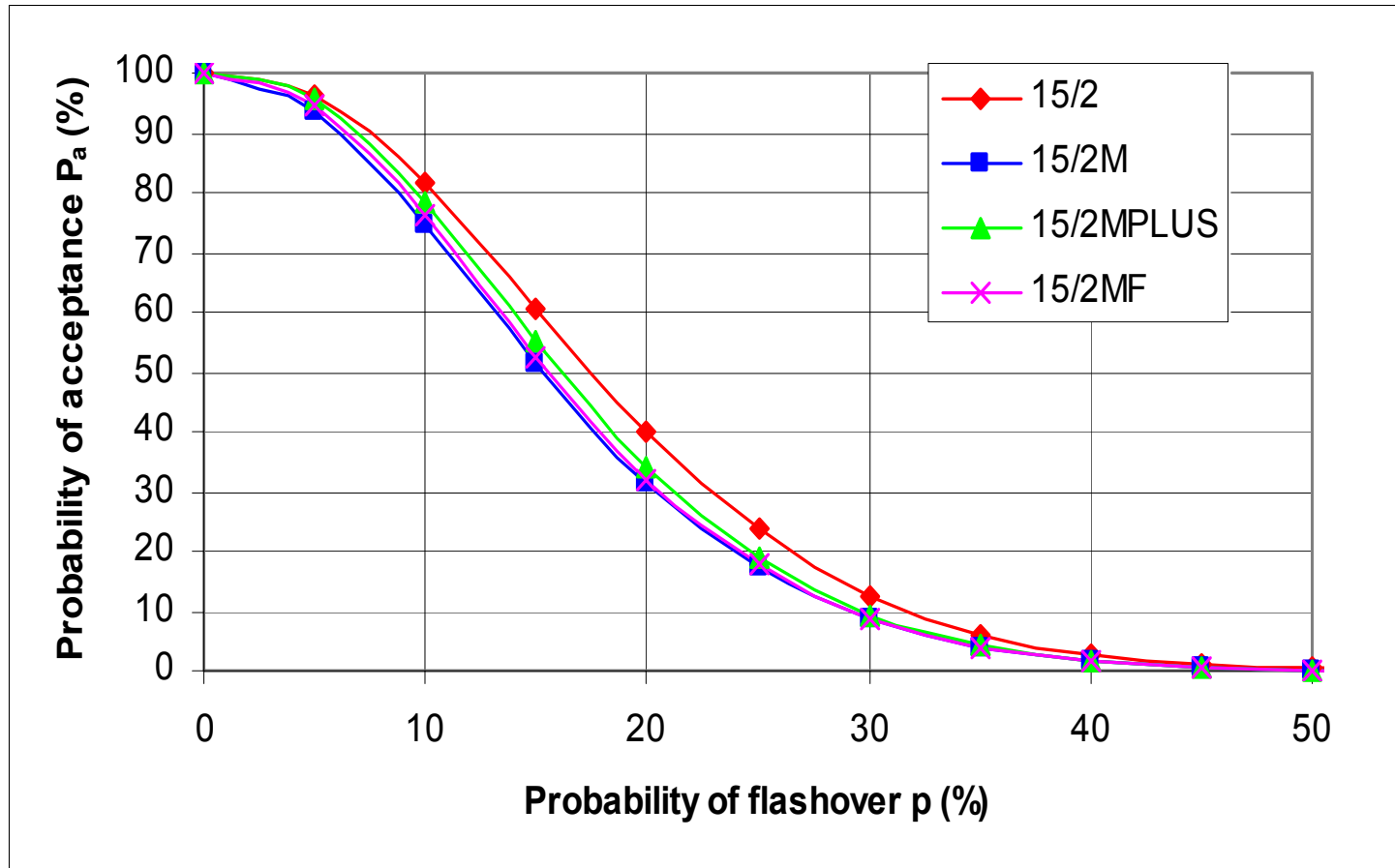
TRVs for Circuit-breakers rated 100 kV and higher

VOLTAGE



Review of Impulse Test Procedure for HV Switchgear & Controlgear

15/2 plan operating characteristics





IEC 62271-100 High Voltage Circuit Breaker Std

► Mechanical travel Characteristics

