Standards

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The standards mentioned in this document

Where can you order IEC publications?
IEC central office
3, rue de Varembé
CH - 1211 Geneva 20 Switzerland
www.iec.ch

LPCT Electronic current transformer	IEC 60044-8
High voltage test techniquesGeneral definitions and test requirements	IEC 60060-1
Insulation coordination: Application guide	IEC 60071-2
Power transformers - Part 11: dry-type transformers	IEC 60076-11
Power transformers - Part 12: loading guide for dry-type power transformers	IEC 60076-12
Power transformers - Part 13: self-protected liquid-filled transformers	IEC 60076-13
Power transformers - Part 15: gas-filled power transformers	IEC 60076-15
Power transformers - Part 16: transformers for wind turbines application	IEC 60076-16
Power transformers - Part 6: reactors	IEC 60076-6
Power transformers - Part 7: loading guide for oil-immersed power transformers	IEC 60076-7
High-voltage fuses - Part 1 : current-limiting fuses	IEC 60282
Railway applications - Traction transformers and inductors on board rolling stock	IEC 60310
Degrees of protection provided by enclosures	IEC 60529
Classification of environmental conditions - Part 3-3: classification of groups of environmental parameters and their severities - Stationary use at weather protected locations	IEC 60721-3-3
Classification of environmental conditions. Part 3: classification of groups of environmental parameters and their severities. Section 4 : stationary use at non-weather-protected locations-protected locations	IEC 60721-3-4
Short-circuit currents in three-phase AC systems calculation of currents	IEC 60909-0
Converter transformers - Part 1: transformers for industrial applications	IEC 61378-1
Convector transformers - Part 2: transformers for HVDC applications	IEC 61378-2
Instrument transformers - Part 1: general requirements	IEC 61869-1
Current transformers	IEC 61869-2
Inductive voltage transformers	IEC 61869-3
Power installations exceeding 1 kV a.c. - Part 1: common rules	IEC 61936-1
Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)	IEC 62262
High-voltage switchgear and controlgear - Part 1: Common specifications	IEC 62271-1
Alternating current circuit breakers	IEC 62271-100
High-voltage switchgear and controlgear - Part 102: alternating current disconnectors and earthing switches	IEC 62271-102
High-voltage switchgear and controlgear - Part 103: switches for rated voltages above 1 kV up to and including 52 kV	IEC 62271-103
Inductive load switching	IEC 62271-110

The standards mentioned in this document

Environmentally conscious design for electrical and electronic products	IEC 62430
Material declaration for products of and for the electrotechnical industry	IEC 62474
AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV	IEC 62271-200
High-voltage switchgear and controlgear - Part 202 : high-voltage/low-voltage prefabricated substation	IEC 62271-202
High-voltage switchgear and controlgear - Part 306 : guide to IEC 62271-100, IEC 62271-1 and other IEC standards related to alternating current circuit-breakers	IEC/TR 62271-306
Guidance for evaluation of products with respect to substance-use restrictions in electrical and electronic products	IEC/TR 62476
Guidelines for end-of-life information provided by manufacturers and recyclers and for recyclability rate calculation of electrical and electronic equipment	IEC/TR 62635
Tutorial and application guide for high-voltage fuses	IEC/TR 62655
High-voltage switchgear and controlgear - Part 304: design classes for indoor enclosed switchgear and controlgear for rated voltages above 1 kV up to and including 52 kV to be used in severe climatic conditions	IEC/TS 62271-304
Selection and dimensioning of high-voltage insulators intended for use in polluted conditions - Part 1: Definitions, information and general principles	IEC/TS 60815-1
IEEE Standard Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis	IEEE C37.09
IEEE Standard of Common Requirements for High Voltage Power Switchgear Rated Above 1000 V	IEEE C37.100.1
IEEE Standard for Metal-Clad Switchgear	IEEE C37.20.2
IEEE Standard for Metal-Enclosed Interrupter Switchgear (1 kV–38 kV)	IEEE C37.20.3
Environmental labels and declarations - Type III environmental declarations - Principles and procedures	ISO 14025
Corrosion of metals and alloys - Corrosivity of atmospheres - Classification, determination and estimation	ISO 9223
Enclosures for Electrical Equipment (1000 Volts Maximum)	NEMA 250
Standard for Electrical Safety in the Workplace®	NFPA 70 E

IEC - ANSI/IEEE comparison

IEC - ANSI/IEEE harmonization process

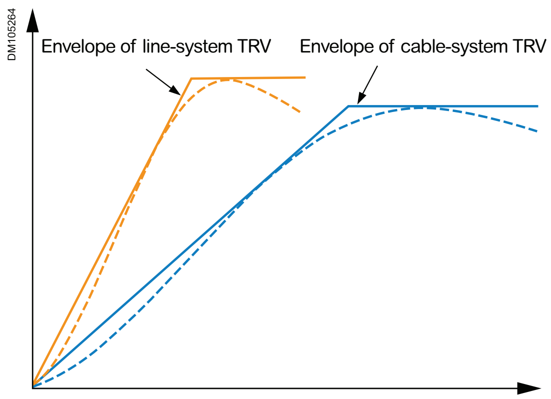
Basically, the differences between IEC and ANSI/IEEE standards come from their respective philosophies.
IEC standards are based on a functional approach. Devices are defined by their performances and this allows for various technological solutions.
ANSI/IEEE standards were based on the description of technological solutions. These solutions are used by the legal system as “minimum safety and functional requirements”.
A few years ago, IEC and ANSI/IEEE organizations began a harmonization process on some topics. This is now supported by an agreement on joint IEC – IEEE development project, established in 2008. Due to the process of harmonization, the standards are today in a transition phase.
This harmonization allows simplifying the standard on places where the “minor” differences exist. This is specifically true for the definitions of short circuit current and transient recovery voltages.

ANSI/IEEE has developed standards for special applications such as for instance “Auto-reclosers” and “Generator Circuit-breakers”. These documents will be transformed into equivalent IEC standards after harmonization of definitions and ratings. Harmonization should not be understood as Unification. IEC and IEEE are by nature very different organisations. The structure of the former is based on National Committees, whereas the latter is based on Individuals. Therefore, IEC and ANSI/IEEE will keep their own revised harmonized standards also in the future. Physically different network characteristics (overhead lines or cable networks, in- or out-door application) and local habits (voltage ratings and frequencies) will continue to impose their constraints on the switchgear equipment.

Rated voltages

See clause 3.1

TRV Harmonization



One of the main purpose was to define common switching and breaking tests in both IEC and ANSI/IEEE standards.
Since 1995, three main actions have been undertaken:

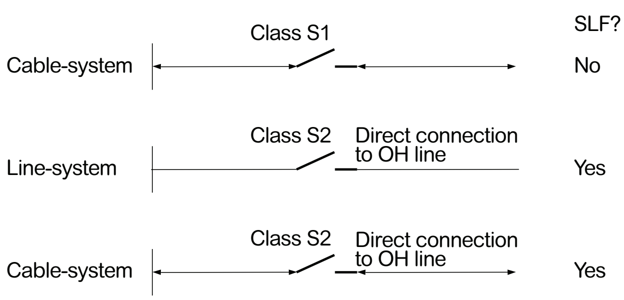
- Harmonization of TRVs for breaking tests of circuit breakers rated 100 kV and higher,
- Harmonization of TRVs for breaking tests of circuit breakers rated less than 100 kV.
- Harmonization of ratings and test requirements for capacitive current switching.

IEC introduced 2 classes of circuit breakers, defined by 2 TRV characteristics in IEC 62271-100 (2007): ANSI/IEEE is using the same classes in C37.06 (2009) standard.

- S1 for cable-systems
- S2 for line-systems,

As some S2 breakers of voltages below 52 kV may be directly connected to an overhead line, they have to pass a short line fault breaking test.

Classes of circuit breakers



IEC - ANSI/IEEE comparison

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Capacitive switching

Capacitive switching tests are also harmonized.
Class C1 of circuit breakers with low probability of restrikes and a new class C2 of circuit breakers with very low probability of restrike were introduced. The rated values and acceptance criteria still remain different for the two standards
IEEE will have a C0 classification.

Assembled product

There is no harmonization for assembled products.
Assembled products include metal-enclosed or insulation enclosed MV switchgear or Gas insulated switchgear. Today, no coordinated action exists to harmonize the assembly standards in IEC and IEEE/ANSI. Therefore, many salient differences persist. These are caused by network and local habits as stated earlier.

IEC - ANSI/IEEE comparison

IEC - ANSI major discrepancies

Identified difference

Two main categories are listed, according to influence on the design or on the qualification tests. In each case of design difference, it should be clear if the point is a requirement which does exist in one system and not in the other, or if a requirement is expressed in conflicting manners between the two systems.

For testing procedure differences, the question concerns the possibility to cover one system requirements by the qualification according to the other system.
A major difference in the two systems especially for the MV range is the need for 3rd party witness certification. This also includes "follow-up" services.
This program is called labelling.

Ratings

ANSI/IEEE has two characteristics in the rating structure; Requirement and preferred values
Requirements are non-negotiable and preferred ratings are values achieved when the requirement are met.
C37.20.2, which covers metalclad switchgear, considers a minimal bus rating of 1200 A for metal-clad (withdrawable).
Short-circuit withstand is expressed in two different ways:

- IEC defines the rms value of the alternative component (duration to be assigned) and the peak value (2.5)
- ANSI defines the rms value to the alternative component for 2 seconds, and the "momentary current" which means the rms value, including DC component, during major first peak (2.6 or 2.7).

C37.20.3, which covers metal-enclosed switches, considers the "normal" short time withstand current duration to be 2 s (the preferred value for the IEC is 1 s).

Design

- Max. allowed temperatures differ; reference for IEC is provided by 62271-1; reference for ANSI is provided by IEEE C37.100.1, as well as C37.20.2, C37.20.3, C37.20.4.
- acceptable temperature rises are much lower in ANSI than IEC. For instance, for bare copper-copper joints, the C37.20.3 (& C37.20.4) specifies a max. overhaul temperature of 70°C, while IEC accepts up to 90°C. Furthermore, ANSI considers all plating materials as equivalent (tin, silver, nickel) while IEC specifies different acceptable values. ANSI/IEEE requires that the lower temperature limit be used when two different contact surfaces are mated. Special values are provided by ANSI when connecting an insulated cable (value lower than the equivalent joint between two bare bars)
- acceptable temperatures for accessible parts are also lower for ANSI (50°C versus 70°C, when touched for normal operation, and 70°C versus 80°C, when not touched during normal operation). Not accessible external parts have also a maximum allowed temperature in ANSI: 110°C.
- Mechanical endurance for withdraw operations is stated as 500 operations for ANSI C37.20.2, 50 for ANSI C37.20.3. It is the same for IEC 62271-200, except if the withdraw capability is intended to be used as disconnecting function (to be stated by the manufacturer), then minimum 1000 operations as for disconnectors
- Other design discrepancies
  - insulating materials have minimum fire performances stated in ANSI, not currently in the IEC.
  - ANSI C37.20.2 and C37.20.3 requires ground bus with momentary and short-time current capability. IEC accepts current flowing through the enclosure, and the performance test is performed as a functional test (if bus is made of copper, minimum cross section is expressed).
  - ANSI C37.20.2 requires that VT are fitted with current limiting fuses on HV side.ANSI C37.20.2 & 3 requires the CTs to be rated at 55°C.
  - ANSI C37.20.2 and C37.20.3 specify minimum thickness for metal sheets (steel equivalent: 1.9 mm everywhere, and 3 mm between vertical sections

IEC - ANSI/IEEE comparison

IEC - ANSI major discrepancies

and between "major parts" of primary circuit; larger values apply for large panels). IEC 62271-200 does not specify any material nor thickness for the enclosure and partitions, but functional properties (electrical continuity, by means of a DC test with maximum drop of voltage).

- ANSI C37.20.2 specifies minimum number of hinges and latch points according to dimensions.
- ANSI metalclad shall have insulated primary conductors (minimum withstand = phase to phase voltage)
- ANSI metalclad shall have barriers between sections of each circuit. That applies to the busbar, the compartment of which shall be split in "sections" along the switchboard
- for ANSI, withdrawable CBs shall be prevented by interlock from complete draw-out until their mechanism is discharged
- ANSI expresses dimensional requirements for the connection points of switches (NEMA CC1-1993)
- position indicators differ by color and markings
- auxiliary power supplies shall have a short-circuit protection within the switchgear for ANSI C37.20.2 & 3
- ANSI: primary connections of VTs shall incorporate fuses. Secondary connections according to the application.

Basic testing procedures

- For withdrawable cubicles, power frequency dielectric tests between upstream and downstream conductors in the withdrawn position are specified as 110% of the value phase to ground in ANSI in all cases. For IEC, a test at the open gap value of disconnectors is required only if the withdraw capability is intended to be used as disconnecting function (to be stated by the manufacturer).
- Momentary current test to be at least 10 cycles long for ANSI, peak current withstand test to be at least 300 ms long for the IEC (and making tests to have at least 200 ms current after).
- For ANSI, all insulating materials, bulk or applied, need to demonstrate minimum flame-resistance (C37.20.2 § 5.2.6 and 5.2.7). The topic is not yet addressed by the IEC, but under discussion for the revision of the "common specifications" standard.
- For ANSI, paint on external ferrous parts needs to demonstrate protection against rust by mean of salted fog test.
- Switches according to ANSI C37.20.3 and C37.20.4 shall withstand an "open gap" dielectric test voltages (both power frequency and impulse) 10% higher than the phase to ground value; in IEC, similar requirement is expressed only for disconnectors.
- BIL tests have different sequences and criteria between IEC and ANSI (2/15 in IEC, 3 by 9 in ANSI). Equivalence between the two approaches is a controversial issue, and could not be considered valid.
- ANSI/IEEE temperature rise tests: cross sections of the supplying and shorting connections are defined by the standards, with no tolerances... Therefore, they can't comply with both standards at the same time.
- For routine tests, auxiliary circuits are checked at 1500 V x 1 min in ANSI (C37.20.3) instead of 2 kV x 1 min for IEC.
- ANSI switches according to C37.20.4 shall perform load-breaking tests before any of the optional rating tests (fault making for integral switch-fuse, cable charging switching current, unloaded transformer switching current).
- Dielectric test as condition check after power tests or mechanical endurance tests is specified at 80% of the rated power frequency withstand voltage by IEC (common clauses), and only at 75% by ANSI (C37.20.4).
- Fuse to checked current to ground during power tests of switches is specified differently in IEC and ANSI (100 mm long and 0.1mm diameter for IEC, 3 A rating or 2 inches long and #38AWG for ANSI).
- Circuit breakers require single phase testing per C37.09 Table 1 lines 6 & 7.
- Circuit breakers require the accumulation of 800% Ksi within the type test sequence.