

# TechTopics No. 66

## Clearances

One of the more common questions we hear from customers concerns the clearance distances mandated by the ANSI/IEEE standards for switchgear and circuit breakers. Our answer is the standards do not dictate the required clearances used in these products, at least not in terms of inches or millimeters.

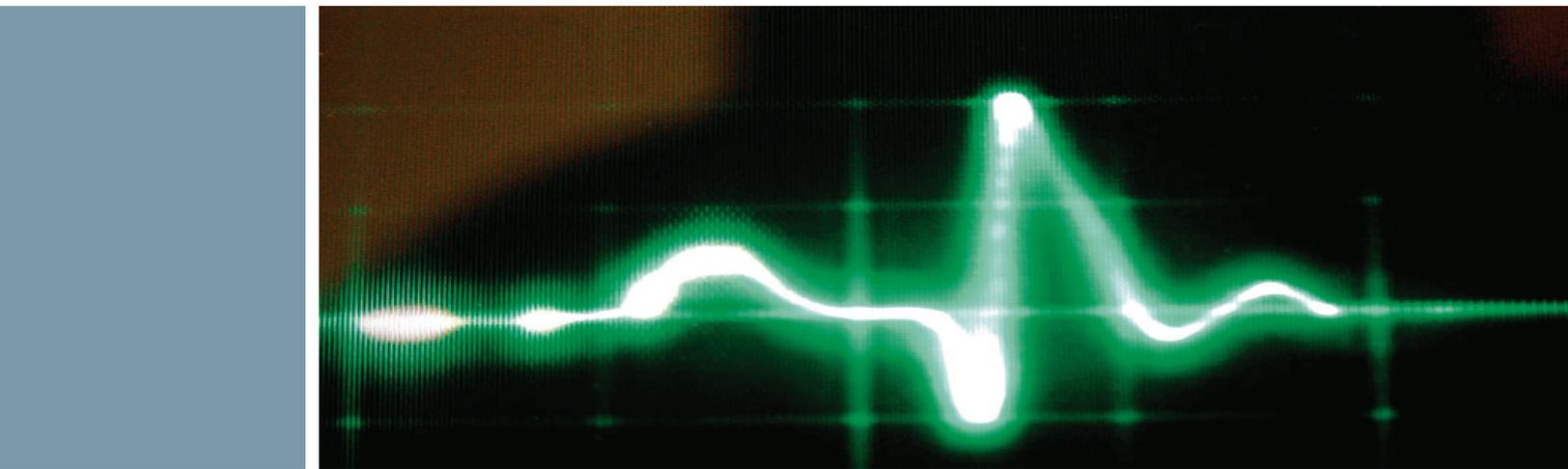
The standards for switchgear and circuit breakers are essentially performance standards, not construction standards. In some cases, certain minimum distances are required by UL, but these are not often the major determinant of clearance distances used in the designs.

Users and specifiers frequently point to the distances required in the ANSI/IEEE transformer (C57) standards or to those in the National Electric Safety Code (ANSI C2 or NESC), and argue that these distances also apply to switchgear and circuit breakers. This is generally incorrect, as the application is completely different.

In capsule form, here are some representative clearances from the C57 and NESC standards. The various standards do not list the clearances in a consistent manner, either with respect to the maximum voltage or the unit of measure, and do not list the impulse capability (BIL) consistently. The purpose of this table is for illustration rather than for precision. In the first column, the voltage in parenthesis is the typical maximum design voltage of the switchgear or circuit breaker.

Maximum design voltage of switchgear (kV)	Voltage (kV)	BIL (kV)	NESC C2-2007 table 124.1 clearance in (mm)	IEEE C57.12.00-2010 table 11 clearance in (mm)
----	0.6	----	----	1 (25)
----	0.6	10	2 (50)	----
4.76	5.0	60	----	2.5 (64)
15.0	15.0	95	4 (101)	5.5 (140)
15.5	15.0	110	6 (152)	----
27.6	25.0	125	7 (177)	7 (178)
27.6	25.0	150	9 (228)	----
38.0	34.5	150	----	----
38.0	34.5	200	12 (304)	13 (330)

Table 1: Clearances in NESC and ANSI/IEEE C57.12.00



The clearance values stated in these documents are for external clearances between live parts of different phases, for applications exposed to the weather.

The application in switchgear and in circuit breakers, and particularly to the clearances used internally, is different. Since the environment of the energized conductors inside the switchgear does not include exposure to rain, snow and similar conditions, the clearances can be smaller than those allowed for external conductors.

The ANSI/IEEE standards for switchgear and circuit breakers require that the product pass design tests, including power frequency voltage-withstand (60-second) and impulse voltage-withstand (1.2 x 50  $\mu$ s waveshape) tests.

The standards do not specify the minimum clearances. The manufacturer is free to choose values appropriate to the product design and manufacturing process.

The clearance needed to achieve a particular dielectric performance is a function of the shape of the conductors, the shape of the electric field resulting from nearby structures, the presence and amount of insulation, and other factors. Because these factors can significantly affect the clearance distance necessary to achieve a particular performance, the standards leave it up to the manufacturer to decide on the combinations of electrode shape, surface finish, insulation and clearance used to meet the performance requirements in the standard.

There is one area that differs from this discussion, and that is when the equipment has external conductors. The most common instance of this is a circuit breaker with roof bushings, whether the equipment is outdoor metal-clad switchgear or is an outdoor substation-type circuit breaker, such as our type SDV7 circuit breaker. In this situation, we do meet or exceed the clearances shown in the C57 or NESC standards, as the external portion is exposed to rain, snow and other environmental factors.

The information provided in this document contains merely general descriptions or characteristics of performance which in case of actual use do not always apply as described or which may change as a result of further development of the products. An obligation to provide the respective characteristics shall only exist if expressly agreed in the terms of contract.

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