

NOTE ON SHORT CIRCUIT WITHSTAND CAPABILITY



Short circuit withstand strength test clause-10.11 of IEC 61439-1

A short circuit can take place at any location of the electrical system at any point of time. Hence the switchgear panel will be called upon to withstand the electrodynamic mechanical forces developed at the bus bars /cabling point /at the equipment terminals/at the load point and so on

The amount of current which is normally expressed in kA will be proportional to the kVA capacity of the incoming source transformer and the distance to the location of fault

Shorter the distance, higher will be the fault current, which could be almost equal to the transformer terminal fault level. On the other hand, as we travel towards the load point, because of the additional impedance included in the circuit the magnitude of fault current will taper down

So, in a power distribution system, we may find highest fault level in main LT and least fault level in tail end power distribution panel

Because of industrialisation, happening at a faster rate the fault level is also getting increased at 415Volts level.

In today's circumstances 50kA fault level has almost become a default level specified by customers and in few cases, we also find 65kA and 80kA levels reached

Even though it could be technically possible to design switchboards beyond 80kA, it becomes a life-threatening circumstance for the operators who work closure to such high-power switchgear panels

Let us now look at what exactly happens to a switchgear panel when this test (Short circuit withstand test) is conducted

Basically, there are two tests under this heading of Short circuit withstand strength test as given below

- (a) Icw test (For example 65kA for 3seconds with a peak of 143kA)
- (b) Icc test (65kA with a peak of 143kA)

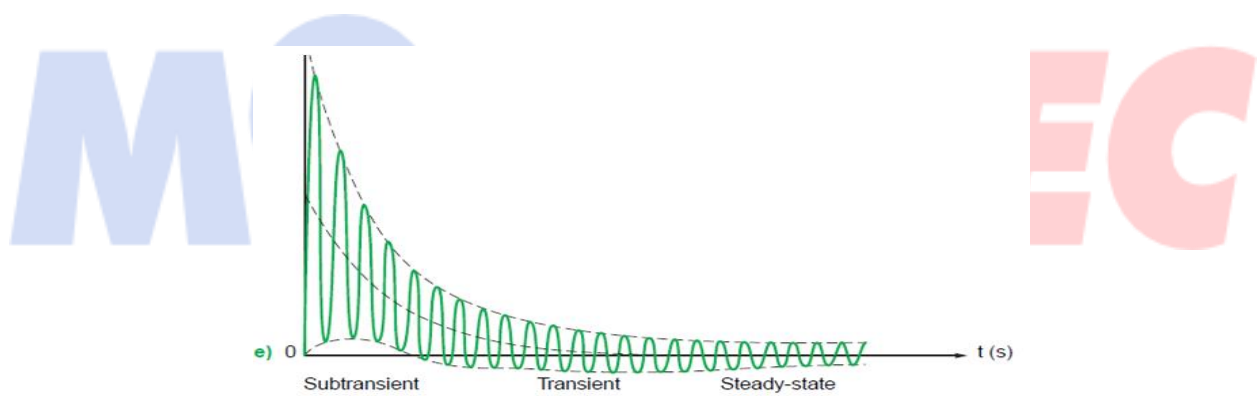
ICW test is generally conducted for incomer circuit, main bus bars & vertical bus bar raisers for a given kA rating and time duration of either 1 second or 3 seconds. 1 second or 3 seconds are the two standard time durations recognised by the standard.

Whereas the conditional short circuit test will be conducted for incomer switching device like ACB and all outgoing circuits having either MCCB, MPCB or fuses provided as the short circuit protection device (SCPD).

Icw test (Explained)

The significance of this test will be to check the strength of the horizontal /vertical bus bar assembly to withstand the peak dynamic mechanical forces developed during a short circuit fault.

The peak value of the applied current during the ICW test will be 2.1 times the thermal current up to 50kA and 2.2 times above 50kA as per table -7 of IEC 61439-1 standard.



Sketch-10

When the fault current is in the subtransient zone (Immediately after the fault inception), its magnitude will be multiple times the RMS value as shown above in sketch-10. Since the DC component dies away with respect to time, the current passes on to transient zone after few cycles and finally enters steady state zone, where only the basic value like 50kA or 65kA as applicable. However the initial peaks will be $50 \times 2.1 = 105\text{kA}$ peak (for 50kA systems) and $65 \times 2.2 = 143\text{kA}$ peak (for 65kA systems).

This first peak will be applicable for both I_{cw} and I_{cc} tests conducted.

The method of testing will be to create a star point at the farther end of main bus bar and to inject the specified 3 phase, RMS value of short circuit current, with

the first peak adjusted to the value as calculated above (Incomer SCPD tripping signal mechanism will be opened to avoid tripping)

The entire incomer circuit, and main bus bar system will experience the flow of fault current and thus gets exposed to the electro dynamic mechanical forces

A similar test is subsequently conducted for incomer circuit including vertical bus bars. This time the star point will be created at the end of vertical bus bars instead of at farther end of main bus bars

Criteria to pass the test

The bus bar system should remain intact without any deformation of the bus bars, without any breakage / development of hair line cracks/ chipping of insulators etc, of bus bar supporting insulators. The temperature developed in the bus bars at the end of the test, should not burn the insulators

Icc test (Explained)

Conditional short circuit current test (Icc test) is conducted for all switching devices which could trip on fault

1. Incomer switching device will be subjected to this test. Star point will be created at the farther end of main bus bar. Specified value of RMS current with the specified peak will be applied.
2. Similar test will be conducted for all outgoing circuits one by one, by feeding the specified test current through the incomer SCPD but tripping disabled. Star point will be created at each outgoing at load end during the test
3. If there are components with different breaking capacities, separate tests could be conducted for each device as assigned

Criteria to pass the test

To pass this Icc test, after the application of the specified RMS current with specified peak value

The SCPD is expected to trip, chamber door should not open, and after few seconds the switching device tested must be able to get switched ON&OFF manually normally without any trouble like contacts getting welded or requiring too much extra effort to operate the same manually

ICW test for neutral bus bar and earth bus bar

ICW test will be applicable for neutral conductor and earth bus also but the value of test current will be 60% of test current used for phase bus bars

Time duration: Time duration for neutral bus bar could be same as tested for phase bus bars, but for earth bus bar time duration could be reduced to as low as 0.1 second to avoid risk of failure

This ICW test on neutral and earth bus bar will be a single-phase current test. For neutral bus bar test the adjacent phase bus bar will be used to complete circuit

For testing of earth bus any phase convenient will be used to complete the circuit

Criteria to pass the test

1. No abnormalities should be there as applicable to neutral bus bar
2. There can be sparking at some points because of poor contact to panel frame, but any burning out caused should not defeat the degree of protection for which the panel is assigned

Every test conducted on a switchgear panel has an objective.

Let us take an example to explain as to how we set the objective

Short circuit test (Current test)

Let us consider a panel designed for a short time current (STC) rating of 50kA for 1 second

The objective of the STC test would be to pass 50kA current through the bus bar system of the panel for 1 second and prove that the assembly will withstand both the electrodynamic force that is developed during test and the change in the thermal status (because of the generated thermal energy) of the bus bars at the end of the test is not detrimental to the bus bars tested or the insulating medium that is holding the bus bars in position

It could be observed that the objective is to protect the switchgear panel from any sort of either mechanical or thermal damage

Difference between short circuit withstand strength test for 1 second and 3 seconds

As could be seen in sketch-10 given above, the first peak dynamic current remains same for 1second test or 3 seconds test however the thermal energy released will be significantly higher in 3 seconds test

If we ask the question, whether 3 seconds test induce any additional mechanical stresses in the panel, the answer is NO because as the time passes the test current will move on to transient zone and later to steady state zone where only

concern will not be of mechanical stresses but the concern will be of thermal stress

When the bus bars get heated up beyond 200 °C they move towards their softening point. When the bus bars become soft its mechanical strength will get reduced and thereby they may yield to the mechanical stress present at that point of time and may get permanently deformed

So, 3 seconds testing will bring much more concern to the designer as compared to 1 second design

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