Study of the behaviour of a n-metal cable screen subject to an adiabatic short-circuit.

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The standard IEC 60949 “Calculation of thermally permissible short-circuit currents, taking into account non-adiabatic heating effects” considers only one current carrying component to determine the admissible fault current and duration for a given cable design, as can be seen in the expression found in its point 3 (page 9 of the standard). The Amendment 1 of this standard indicates the possibility of taking into account several carrying conductor components when they are connected in parallel, distributing the fault current among them in inverse proportion to their resistances.

This presents a problem whose resolution is not obvious, since components made of metals with different electric resistivity and different temperature coefficients will grow their respective temperatures and resistances at diverse rates. Therefore, during the fault time, the proportion of current carried by each single component will be in constant evolution, leading the whole screen to a situation that will diverge from that obtained assuming fixed current ratios.

The lack of a clear procedure showing how this calculation should be made leads very frequently to dimension one of the components to withstand alone the entire fault current. This results into cables that are more expensive, and also a little heavier than necessary. Additionally, the design optimisation will reduce the power losses when the cables are installed in solid-bonding configurations, due to smaller induced currents in the screen.

The study first demonstrates that the expression of the point 3 of the standard can be deducted from physical laws. And then it proceeds exactly in the same way to solve the case of several conductor components working in parallel. The result is an analytical expression whose exactitude has been checked with a numerical algorithm that generates a sequence whose limit is the exact solution of the problem. The equation found in the point 3 of the standard is a particular case of the solution of the “n-metal” problem.

The main limitation to this study is the assumption of concentricity between all the components involved in the calculation, so it should not be used taking into account the common armour of three core cables, for instance. This is due to the fact that the mutual inductances between the conductor and the screen and other components connected in parallel have not been considered, and in any eccentric configuration they will not be compensated, thus altering the distribution of the current between the different metallic components.

Key words

Short-circuit calculation; Cable screen; IEC 60949; Cable design