C.8.1.6.

Current rating of cables installed in tunnels

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The current rating of power cables is directly depending upon the thermal characteristics of the surrounding medium, where they are located.

In some occasions, several cable circuits are installed in a tunnel: for instance, in Paris area, some distribution cables are laid together with 225 kV underground feeders, in the same tunnel.

In the IEC approach, the ambient temperature within the tunnel is required to derive the ampacities of the various circuits installed in the tunnel.

But there is no guidance for evaluating the ambient temperature from the heat dissipated by the circuits, as it is the case for installations in unfilled flush troughs.

In addition, to take into account the two involved heat transfer ways, convection and radiation, a single coefficient is used. This coefficient, which is a function of the cable diameter, is determined from 3 parameters which depend on cable installation and are given for some typical arrangements.

To deal with groups of cables, reduction factors may be found in some standards and in the literature.

The paper reports the studies carried out by EDF in order to get a better understanding of the thermal behaviour of cable circuits installed in air, and, finally, to improve the current rating of cables laid in tunnels.

Calculations were performed, using a finite element method to assess the IEC proposed value of the heat transfer coefficient for many laying conditions: a single cable (single-core cables, 63 kV or 400 kV as nominal voltages) with various distances to the tunnel walls, 3 cables in trefoil or flat formation, different tunnel sizes …Coupling different softwares was necessary to take into account heat transfers through convection, radiation, and conduction, too (within the cable, and in the soil around the tunnel).

The main models for heat transfer mechanisms in air and in the soil around the tunnel, and the different approaches that may be found in the literature were reviewed on and compared.

Also, a full-scale test equipment was set up to get experimental temperature rises with actual cable installations. Test results are reported, involving various installation conditions of the cables in the tunnel, for different loads in the cables, and variations in the climatic conditions (solar radiation, wind, air temperature above the tunnel..).

A synthesis is proposed, pointing out the main concerns to betaken into account, and some conclusions are drawn, in order to enable an improved rating of cables installed in a tunnel.