Results and verifications from REE experience on monitoring isolated cables with DTS

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The ampacity of isolated cable, for the transmission grid or for the distribution grid, is conditioned by the maximum temperature that its insulator could withstand (without compromising its life span). This temperature is related to the maximum current that the circuit could transmit. Red Eléctrica de España (Spanish Transmission System Operator) calculates the ampacity (current-carrying capacity of cables) under the hypothesis of steady state (Std. IEC 60287), as well as standard ground and environmental conditions. The Power Control Centre operates the isolated cables in such a way that their ampacity is not exceeded taking the appropriate measures for this purpose.

The load regime of all transmission circuits, shows daily peaks, off - peaks and transitions between them, unique for each day, being far from constant or having a repetitive cyclic regime.

On the other hand, changes in the load regimen are not reflected instantaneously in the temperature of the isolated cable due basically to the heat storage capacity of the surrounding ground, and also the isolated cable, resulting in the concept of thermal inertia.

All this leads to the inference that the ampacity, under the hypothesis of steady state, may exceed the currently value, without reaching or exceeding the maximum isolated cable temperature, thus resulting in a more flexible and optimized system operation.

To verify this idea, REE has been monitoring real-time temperature in 220kV, 132kV and 66kV isolated cables with DTS technology (Distributed Temperature Sensing) since 2012, in the scope of different R&D projects. The DTS technology that is being used is based on Raman effect and all the results are fully satisfactory.

The distributed measure of temperature is taken in the sheath of the isolated cable, fiber optic cable with a stainless steel or plastic sheath was placed. This gives more accuracy in the calculation of conductor temperature than the usual installation of external optical fiber. The analyzed facilities include: shallow buried sections (in concrete ductbank), deeply buried sections (casing pipes) and, in the coming months, submarines sections (interconnection between islands) and aerial sections (ascend to towers).

Some of the objectives of this experience consist in the verification and quantification of thermal inertia, as well as quantification of maximum temperature peaks and their correlation with load regime and other parameters. Furthermore, thermodynamic models used in the simulations have been verified with FEM simulations based on the real data from DTS and current measurements.

These solid arguments can be applied to the development of new flexible and optimal procedures for the efficient and safe operation of isolated cable circuits under a more realistic approach to ampacity.