Efficiency of cable transposition to decrease the induced voltage on linear third-party installations

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The new European standard EN 15280:2013, which deals with potential corrosion of metal pipes due to the long-term influence of alternative currents, mainly caused by inductive coupling, requires an rms value of 15 V only, as a maximum permissible induced voltage in operating conditions (i.e. excluding fault).

This new threshold to comply with, creates a serious constraint for RTE to be overcome, especially in the framework of its underground cable system projects of long length, which imply significant vicinity with gas transmission metal pipes for example.

The connection of offshore wind farms is a topical example and presents an additional difficulty: the French considered design is based on two parallel systems in trefoil formation with crossbonding of metal sheaths. Circulating currents raise significantly the electrical influence of underground cables on third-party installations.

The simulation of cable systems emphasises that the different combinations of the two underground power links, playing on the geometry (trefoil 180° rotated or not) and on the phase sequence, lead to very heterogeneous results.

It is surprising to observe that the combinations considered as optimal when sheath currents are ignored are actually the most constraining, due to their currents in the sheaths, which are tuned on both links, with a total vector sum of dominating influence on the resulting induced voltage.

On the contrary, some combinations expected as unattractive can emerge as advantageous, because their sheath currents flow in the opposite direction from a connection to the other, with a total vector sum, which makes negligible the global contribution of the sheath currents (even with significantly higher current ratings). The resulting induced voltage is then mainly linked to the influence of the conductor currents, based on combinations far from optimal, which may remain not sufficient to avoid exceeding the 15 V threshold.

The efficiency of cable transposition is already recognised in the case of a single underground system, with non-existent or negligible sheath currents: the rotations of a 2π/3 angle of the induction system at each joint bay can change the direction of the induced electromotive force and result in a “controlled accumulation” along the induced system.

Our simulation of underground double-system points out another advantage: the cable transposition makes possible resulting sheath currents of very low magnitude. It follows that the induced voltages obtained are significantly lower, especially from combinations made optimal only for the conductors, leading to a result about 10 times lower.

The results show that cable transposition is more efficient that simulations take into account major sections, which are not divided into three electrically identical minor sections along the cable route.

Authors will discuss their feedback, based on the location of joint bays of real projects.