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GROUP REF. : B4  
PREF. SUBJECT : PS 1-4  
QUESTION N° : 1.7

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**Question:**

- What are the existing worldwide experiences on the coupling/interference between HVDC cable systems and HVAC overhead lines/cables?
- What are the practical mitigation actions? Is there any case where remedial actions had to be taken in existing cable systems?

**Answer & contribution:**

Impacts between HVDC/HVAC cables are mutual to both systems' operation. The increasing demand of parallel cable placement introduces the problem. What has been learned from the studies and industrial experiences:

- The electromagnetic interference between HVDC and HVAC underground cables is not observed risky in steady-state harmonic frequency range, which was also noticed from practical projects. The source harmonic current is relatively low, especially for VSC. A further damping at harmonic frequency is another aspect in the victim system.
- However, the induced fundamental component from HVAC to HVDC cables should be noted and be further investigated, to avoid saturation of HVDC converter transformer by cross-modulation due to the DC side fundamental current. As well the tolerance of the saturation needs to be studied, or a mitigation method is needed.
- As well the electromagnetic interference between HVDC and HVAC cables due to transient is observed non-negligible. The immunity against the coupling of transient needs to be investigated on both HVDC and HVAC systems.

Possible mitigation actions could be found from the causes of electromagnetic interaction principle, or either the impacting issues of the parallel cables, and even some external approach without changing the hardware:

- The sensitivity study in the paper indicates a few of mitigation actions, such as shorter length of the parallel cables, larger separation between HVDC and HVAC cables, and lower earthing resistance of cable sheath. Beside these actions, the placement and configuration of underground cables impact the mutual coupling. The distance between DC poles and distances between AC phases shall be small enough compared to the distance between DC and AC cables, which can mitigate the induced voltage in principle.
- For an existing cable system, a better earthing for the cable sheath can reduced the electromagnetic interference efficiently. A possible approach, such as application with smaller earthing resistance, is believed to reduce the induction effectively as also shown in the sensitivity study.
- Another approach, without any change of hardware, is to damp the induced components for example by the HVDC converter control system. So that the system can resist the induced fundamental component on HVDC transmission or interference due to transients on HVDC/HVAC transmissions