PROPAGATION OF VOLTAGE UNBALANCE FROM HV TO MV POWER SYSTEMS

The recently released IEC Technical Report IEC/TR 61000-3-13 for voltage unbalance allocation requires quantitative measures of the propagation of voltage unbalance from higher voltage to lower voltage power systems in terms of transfer coefficients. IEC/TR 61000-3-13 indicates a method for estimating the MV to LV transfer coefficient giving it a value of unity for passive loads in general. This unity value has been seen to be conservative in the presence of commonly prevailing constant power loads. As a continuation of the work that has been carried out to develop an improved method which overcomes the above limitation for estimating the MV to LV transfer coefficient, this paper addresses the propagation of voltage unbalance from HV to MV power systems. The paper reports on a systematic method for estimating the HV to MV transfer coefficient ($T_{hv-mv}$) in terms of system and load characteristics and downstream load composition, which could be considered in future updates of IEC/TR 61000-3-13.

It is seen that although the HV to MV transfer coefficient ($T_{hv-mv}$) is equal to unity for constant impedance (Z) loads, it can be up to 1.4 in the presence of constant power (PQ) loads. Furthermore, $T_{hv-mv}$ can be as smaller as 0.5 for three-phase induction motor (IM) loads. Illustrations are given in Figures 1 – 3.

![Graph](image-url)

Figure 1: Variation of $T_{hv-mv}$ with $k_n$ for $k_{sc-mv}= 12$ (loads are supplied directly at the MV busbar): (a) for load mixes of PQ and IM loads, (b) for load mixes of Z and IM loads
Notations: $k_{sc-mv}$ – ratio between the short circuit capacity (in MVA) at the MV busbar and the total load (in MVA) supplied by the MV busbar, $klv$ – fraction of the LV loads supplied by the MV system, $km$ – proportion of three-phase induction motor loads supplied by the LV system.

Figure 2: Variation of $T_{hv-mv}$ with $klv$ for $k_{sc-mv}= 4$ (loads are supplied directly at the MV busbar): (a) for load mixes of PQ and IM loads, (b) for load mixes of $Z$ and IM loads

Figure 3: Variation of $T_{hv-mv}$ with $klv$ for $k_{sc-mv}= 4$ (LV loads are supplied through MV lines): (a) for $k_{sc-mv} = 12$, (b) for $k_{sc-mv} = 4$