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17. Am I not safe from harmonics if I use K-Rated transformers and oversized neutrals?

K-Rated transformers made their appearance several years ago as a means of preventing transformers from failing when subjected to heavy non-linear loading. They are essentially 'beefed up' transformers with extra steel in their cores and copper in their windings to allow for better dissipation of the excessive losses produced by harmonic currents. They are not designed to cancel harmonics or their fluxes and therefore, do nothing but protect themselves from overheating. Harmonic losses are normally not significantly reduced and voltage distortion will typically remain quite high under more heavily loaded conditions. To improve power quality in the form of reduced voltage distortion and to save energy costs, the use of a transformer designed to cancel harmonics is necessary.

Over-sizing neutrals, on the other hand, can be a reasonably low cost method for the prevention of neutral conductor overheating. It is important to remember that the non-linear loads are the source of the harmonic currents. They must flow from the loads back to the transformer. Because the 3rd and 9th current harmonics created by the 120 VAC switch-mode power supplies are flowing back on the neutral, the neutral current is usually larger than the phase currents (see Question 7). This is of minimal consequence provided the neutral has suitable ampacity to carry the extra current and the 120/208V 4-wire run length is not too long.

A point of caution. When selecting phase and neutral conductor sizes in a non-linear load application, the electrical code requires that an ampacity adjustment or correction factor be applied. This is because the neutral conductor is considered to be a current carrying conductor along with PhA, PhB and PhC. With more than 3 current carrying conductors in a conduit or raceway, a 0.8 factor must be applied.

To minimize harmonic problems in new installations, avoid the old approach of using a large central transformer with a 120/208V secondary and long 4-wire risers or radial runs through the building. The impedances of these long runs are high so that harmonic currents flowing through these impedances will create high levels of voltage distortion and neutral-to-ground voltage. To prevent these problems, an effective rule of thumb is to limit each 120/208V run length to that which would produce a 60Hz voltage drop not greater than 1/2% to 3/4%. For a typical 200 amp feeder this would be < 50 ft.

Combining the use of Harmonic Mitigating Transformers with short 120/208V feeder runs and double ampacity neutrals will ensure compatibility between the distribution system and the non-linear loads. Generally this will keep voltage distortion safely below the maximum of 5% as recommended for sensitive loads in IEEE Std 519-1992.

