Reasons for selecting MIRUS Harmonic Mitigating Transformers in Lieu of K-Rated

The first signs of the incompatibility between conventional building power distribution systems and personal computers became obvious in the mid-1980s as more and more personal computers appeared in the workplace. One decade later, personal computers, monitors, powerful workstations, laser printers, and other modern electronic office equipment typically form a large portion of the electrical load in a building. Because these loads are very non-linear, their load currents are rich in harmonics, causing problems for both the power distribution system and for the electronic equipment itself.

The ill effects due to current harmonics generated by these non-linear loads include:

1. **Large currents in the neutral wires of the power distribution system.** The neutral current will generally be larger than the current in any of the phase wires. Because only the phase wires are protected by circuit breakers or fuses, this is a very real fire hazard.

2. **Overheated electrical supply transformers.** Overheating shortens the life of a transformer and will eventually kill it. When a transformer fails, the cost of lost productivity during the emergency repair time far exceeds the replacement cost of the transformer itself.

3. **Poor power factor.** The harmonic currents caused by the non-linear loads do not carry any real power (kW) even though they do increase the volt-amperage (kVA). This lowers the power factor (PF = kW/kVA) at the building electrical service entrance. Electrical utilities have a monthly penalty charge for major users with a power factor less than 0.9.

4. **Lowered reliability of computer systems.** Distorted 120VAC supply voltage and increased the neutral-to-ground voltage may cause hardware problems which often appear at first to be software problems. IEEE Std. 519-1992 recommends that the voltage distortion for computer use be limited to a maximum of 5% total harmonic distortion (THD) and that the largest single harmonic not exceed 3%.

The electrical industry's first response to these four problems was to double the ampacity (current carrying capacity) of the neutral conductors so that they would not burn-up. This is becoming a standard design practice in office buildings.

The second response was to beef-up the distribution transformer so that it would not fail due to the higher heat losses caused by the harmonic currents flowing through it. These transformers are now known as k-factor rated transformers. The k-factor is a mathematical formula which predicts that the eddy current losses in a transformer will be increased in direct proportion to the sum of the products of each harmonic current amplitude squared multiplied by its harmonic number squared.

Doubling the neutral and using a k-factor rated transformer will solve the electrical safety half of the harmonics problem. **Unfortunately, these two steps do nothing to solve problem 3, poor power factor, nor problem 4, lowered computer system reliability.**

On the other hand, using a combination of **MIRUS Harmonic Mitigating transformers**, doubling the neutrals, and keeping the distribution panels close to the transformers will solve all four problems at once. Here's why.

The **MIRUS transformer is an isolation transformer with a special secondary winding configuration which minimizes the voltage distortion caused by the 3rd and 9th current harmonics that make up the major portion of the neutral current. It is suitable for supplying loads up to k-factor 20.**

The **MIRUS Harmony-1™ transformer** can be manufactured with either a zero degree or a 30 degree phase shift (at the fundamental frequency of 60Hz) between its input and output windings. The 30 degree phase shift at the fundamental results in a 180 degree phase shift for the 5th, 7th, 17th, and 19th harmonic currents. We can take advantage of this fact to **cancel these harmonic currents from one half of the building against those from the other half.** This can be done by supplying one-half of the building through Harmony-1™ transformers with a zero degree shift (zero degrees for the fundamental and all the harmonics) and the other half through Harmony-1™ transformers with a 30 degree shift at the fundamental (180 degrees for 5th, 7th, 17th, and 19th harmonics). This will remove the balanced portions of all four of the largest current harmonics (3rd, 5th, 7th, and 9th). **There will be a substantial improvement in power factor, solving problem 3.** For even better performance, the Harmony-2™ transformer produces the cancellation of 5th & 7th harmonics at the secondary of the transformer using 2 outputs.

Voltage distortion is caused by the interaction of the harmonic currents with the various impedances of the distribution systems at the harmonic frequencies. Canceling the 3rd, 5th, 7th, and 9th harmonic currents with the Harmony-1™ transformers will result in a worthwhile improvement in voltage distortion level. Each application is different, but typically the new voltage distortion level will be about half of the original level and comfortably within the IEEE recommended maximum of 5%. As a final step, keeping the distribution panels close to the transformers will limit the length of the 120/208V, 4-wire runs. This will minimize the neutral-to-ground voltage which can develop. Hence, **computer system reliability is improved, solving problem 4.**

In summary, using the basic k-factor rated transformer will permit solving just the first two problems. Using MIRUS Harmonic Mitigating transformers will permit solving all four problems, ensuring that the computer system loads and the power distribution system are completely compatible with each other.