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Excessive Neutral Current

The basic aspects of our electrical system have been around for over 100 years. During this time we have developed a pretty good idea of how to generate, transmit, distribute, and maintain electric power.

Within most businesses is the most typical type of building distribution wiring - a three-phase wye system. Nearly all small commercial or industrial facilities that have three-phase power will have a wye system.

With a wye system comes the expectation that if the three-phases have about the same amount of current in them, then the neutral will have very little current. Or, to put it another way, the more the system is balanced, the less current is in the neutral. If high currents are measured in the neutral, or at least higher than we expect, problems may result. This segment focuses on this concern.

Current in a facility or business is dependent on the loads inside. Therefore, there are no significant influencing factors from neighbors or the utility that affect how much current winds up in a panel or a neutral.

Excessive Neutral Current - Internal Causes and Solutions

High neutral currents in buildings usually result from two situations. The first, and most common, is one where there are simply heavily unbalanced loads. This situation is usually easy to explain and remedy.

The second situation involves current harmonic distortion. This is where the terms "unexplained" and "excessive" come into play, since harmonic distortion changes the rules we are used to playing by.

In today's environment, it is becoming increasingly likely that high neutral currents result from some combination of the two.

Unbalanced Loads

On a three-phase system where the dominant loads are single phase, the neutral carries the unbalanced amount of current. Even though the loads may have been balanced at one time, the normal changing of the system may have caused a large unbalance, leading to a large neutral current.

Many times, when sizing loads and distributing them within a panel, only the full load current is considered, not how often that load is on or off. So, at any given time there may be significant unbalance due to loads being on or off.

Whether because of load shifts and changes, or due to the diversity of loads being on or off at the same time, neutral current from unbalance may become high, but is seldom excessive. Problems happen when the neutral wire has been undersized and high currents still occur -- possibly leading to a burnt neutral. Quite often this is aided by illegal wiring practices.

High neutral currents from unbalance are fairly easy to resolve. Loads need to be powered from appropriate phase to ensure balancing, so relocate or rewire particular loads to bring balance about.

If diversity is the problem, then use a power flow monitor such as the BMI PowerProfiler to determine the current swings of loads and when the shifts occur. Then rewire or relocate to bring in a better balance.

In both cases, keep the neutral conductor at lease the same size as the phase conductors. For those who really want to think ahead, make the neutral one size larger. This will help deal with the concern over harmonics.

Harmonic Distortion - High Neutral Currents

Whenever the current in the power system is no longer sinusoidal, we say it is distorted, or that there is harmonic distortion. Harmonic distortion is problematic in that most of the power system's operation is based, and dependent on, the assumption of sine waves.

This has led to a number of commonly held beliefs that are now jeopardized by harmonics. Two are important for this discussion.

The first belief is that to find out the amount of current or voltage in the system, simply get a cheap voltmeter or ammeter. If we are concerned about "excessive" currents, we must measure to find out how much current there is.

The second belief, mentioned earlier, states that a fairly balanced panel will have little neutral current.

Current harmonic distortion changes both of these beliefs.

First, the actual technology used in most hand-held meters today assumes the signal being measured is sinusoidal. The meter reads the average value of the signal, assumes it is a sine wave, and adjusts it to display the value in RMS. This is known as an average detecting, RMS-calibrated meter, and is by far the most common type of meter used today.

However, when harmonics are present, the adjustment used by these meters is wrong. The actual measurements may be as much as 50% in error. Because of this, harmonically distorted signals must be measured with a true-RMS meter. These meters cost more, but they give accurate readings.

The second belief, that of there being no neutral current in a perfectly balanced panel, is based on the fact that three identical sine waves, each 120 electrical degrees apart from each other, will offset, or cancel out. Thus, three balanced loads should have little to no neutral current.

However, when harmonics are present we don't have sine waves, at least not solely at 60 Hz. The distorted waveform can be broken down into a set of sine waves. The basic component, called the fundamental, is a sine wave at 60 Hz. The second harmonic is a sine wave at 120 Hz. The third is a sine wave at 180 Hz, etc.

When distorted currents share a common neutral, most of these higher frequency sine waves cancel out just like what we expect from the 60 Hz sine waves. However, some harmonics don't cancel. In fact, they add in the neutral. These harmonics are called zero sequence harmonics, and they are the reason that high neutral currents exist, even though the loads may be perfectly balanced.

Currents as high as 200% of the phase conductors have been seen in the field. This large level of current can easily burn up the neutral creating an open neutral environment with very serious consequences.

If high neutral current due to distorted current is the culprit, then the first step to take is eliminate shared neutrals wherever possible. This mainly refers to branch circuits. Where this can't be done, such as on a three-phase wye panel, try oversizing the neutral wire so it won't overheat.

If these efforts don't work, then the next step is to reduce the distortion. This can be done through three methods. First, a passive filter can be used to reduce the current from one or two specific harmonics.

An active filter, the second method, reduces all the harmonic currents. It is more costly and complex to use, but it works better than passive filters.

The third method involves the use of transformers. Delta-wye transformers reduce certain harmonics, particularly zero sequence harmonics. Zigzag transformers can also be used to reduce zero sequence harmonics, but without changing the system type between delta and wye.