Don't Overlook the Obvious

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In training sessions while in the fire service, the instructors more than once warned about not overlooking the obvious. Eager firefighters would attempt to use the Halligan bar and axe to force open the door into a dwelling before checking to see if the door was unlocked. Likewise, at a motor vehicle accident, the "Jaws of Life" or a similar extrication tool would be taken off the rescue truck, powered up, and the firefighters would start to force the door open before going around to all four doors to see if one of them was unlocked. The same type of scenarios can occur when trying to solve power quality related problems. Checking for the obvious first can often lead to a more cost-effective solution more quickly than just dragging out the power quality analyzer and begin collecting data.

The process begins with observing "what is" and "what was". Use all of your senses except your touch (and "taste" as someone at a seminar recently pointed out). Looking for code violations, such as neutral-to-ground bonds at distribution panels (shown in Figure 1) that are not from separately derived sources. These bonds are in violation of the National Electric Code, and can pose a safety problem as well as a power quality problem. Part of the current that should normally flow through the neutral or phase conductors will flow through the ground conductor. As Ohm's Law states, current multiplied by impedance will result in a voltage. This voltage on the ground conductor can elevate the metal chassis and anything else connected to the ground conductor to unsafe voltage levels for humans and equipment. While this can be detected by measuring the neutral to ground voltage at an outlet fed by the distribution panel, and observing 0 Volts between neutral and ground. Since normally this value is between 0.5 and 3 volts, a zero volt reading may point to such, though the eyes could also detect it with the panel removed.

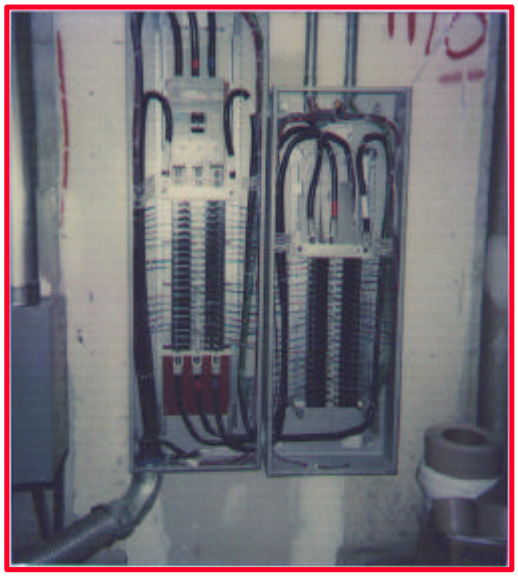

Figure 1. Electrical Distribution Panel

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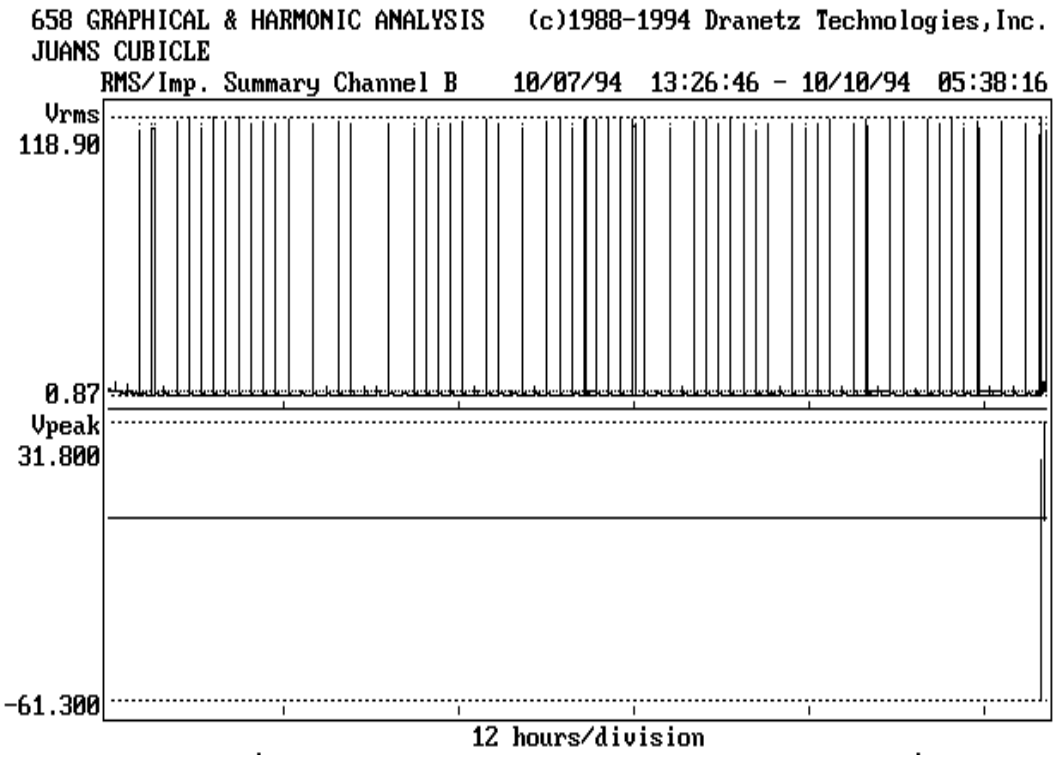
A visual inspection of the panel can also show other wiring problems. A person using a desktop computer experienced problems with the computer locking up every couple of hours. After incorrectly blaming the user, the software and the hardware, a power quality monitor was used to monitor the outlet that feed the computer. Neutral-to-ground swells over 100V were measured, as shown in Figure 2.



The wiring was traced back to the distribution panel on the second floor, where it was observed that the neutral wire was not properly connected down to the first floor, where the point-of-common-coupling to the electrical utility was. In addition, the ground wire from the panel went to building steel, which was painted gray, and presented a high impedance paths to earth ground. Clearly, if the cover had been removed first from the panel and the same observations were made first, it would not have been necessary to use the analyzer.

While the panel is off, it is good time to use one of the most important power quality tools, the screwdriver. In most facilities, the current flows during only part of the day. Today, this current is often contains heat-generating harmonic currents. The heating/cooling/heating/cooling cycle and resulting expansion and contraction of the wires can cause the connections to loosen over time. This loosening increases the impedance of the connection, which further increases the heating effects. Tightening loose connections with the screwdriver can help reduce voltage drops and minimize the fire potential. A thermal imaging camera can be used to detect infrared radiation given off by the hot connections, but it may be just as easy to just periodically tighten all of the connections.

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Another key observation skill is determining what has changed. When systems run fine for months on end and then suddenly start to fail regularly, determining what has changed is usually the first step. There is a story circulating among the PQ community about a person who went into their family room, and turned on the light switch. After trying unsuccessfully for a couple of seconds to change the channel of the TV with the remote control, he went into the kitchen to get new batteries for the remote control. Returning to the family room, the remote control worked fine. The next night, the same events repeated. He again went into the kitchen and put in the other two batteries from the 4-pack. Again, the remote control now worked. When the same events were repeated the third night, he smashed the remote control and went out to buy a new one. What he failed to observe (until later) is that he had just changed the light bulb in the fixture in the family room that he turned on first each night when the remote control failed. He had replaced an incandescent bulb with a compact fluorescent that emitted a large amount of infrared radiation during its warm-up stage and interfered with the infrared transmitter and receiver used in the remote control and the TV. By the time he walked to the kitchen and back, the levels had diminished so that the remote control worked. The remote control hadn't changed, but the environment that it operated in did.

An executive for a manufacturing company used his laptop computer without any problems for some time. He then changed to a desk-top computer, and found it locking up occasionally. Excessive neutral-to-ground voltage was found again, but it was there all along when the laptop worked. The laptop's power supply isn't referenced to ground, as it turns AC voltage into DC in the external "brick" used to charge the batteries. The desktop computer used a three-prong plug, and its power supply and circuitry were referenced to the ground. The wiring (though faulty) hadn't changed, but the load with a different susceptibility to PQ phenomena had.

Many power quality problems will require the use of some type of measuring or monitoring equipment, and some will be nearly impossible to solve without. Having the right tool at your disposal can shorten the time to uncovering the source, and getting the process running smoothly again. But the tools of observation and common sense should be the first that are brought out.

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