Approaching with Tools

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Back in the 70's, a friend with a '65 Volkswagen had a service manual for such, which contained a picture subtitled "Man Approaching the Car with Tools". Though it was the source of much humorous bantering back then, it points out two important concepts when beginning a power quality survey or troubleshooting investigation. Both the "approach" and the "tools" are very important for carrying out an efficient, productive and safe monitoring program.

If you can communicate with the persons affected by the problem and those responsible for the electrical infrastructure maintenance before you head out to the site, you might be able to ask the right questions to figure out what equipment you need to bring ahead of time. If is a troubleshooting job, having the customer keep a log of what problems are noticed at what time and where in the building will help you start at a more optimum point once you get there.

As one slide in the Dranetz-BMI power quality seminar series presentation aptly points out, use all of your senses except the sense of touch (though one seminar attendee rightly pointed out that the sense of taste should also be avoided). As you approach the site, look at the power lines in the area for power factor correction capacitor banks, the distance from the substation if possible, what the other industry in the neighborhood consists of.

Seeing an auto body shop next door may indicate that an arc welder may be in use. The closer the facility is to the capacitor banks, the more severe the effect will probably be when the caps switch in. Long runs from the substation and from the local transformer will increase the effective source impedance. The higher the impedance, the more severe will be the sag when large currents flow from either loads or fault conditions. Areas where the tree branches are no longer cut back from the power lines may be a source of intermittent sags when the wires contact the trees in a storm. If there are transformers on site, look to see if they appear to be well maintained. Listen for the sounds emitting from them that are characteristic of high harmonic content.

Once inside the building, keep a mental note of the different types of equipment in the facility. Note if the dominant load consist mainly of fluorescent lighting, PCs and other

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information technology equipment, electrical motors by themselves or electronically powered such as adjustable speed drives. Large harmonic loads coupled with a loud hum in the transformers means that you better have equipment that can measure harmonics and true RMS measuring current and voltage equipment. The smell of overheated motors, light ballasts, and transformers is usually quite distinct. Occasionally, there may be access to an accurate, up-to-date, one-line diagram of the wiring in the facility, but is unlikely in older facilities.

Though you may have a preconceived notion as the problem before hand, use your ears to listen carefully to what the people think that they have observed. Ask questions about what has recently changed in the loads or infrastructure in the facility. Many people do not correlate the fact that a new machine, HVAC unit, or copier was added just before the problem began to appear.

The most important equipment to have is the proper safety equipment, including eye protection and insulating gloves. Though fire retardant clothing may be uncomfortable, the discomfort is nothing compared to burn treatment. Like other types of accidents, everyone thinks that they happen only to someone else. One moment of inattention can change the rest of your life, and not for the better.

Measuring current as well as voltage will usually point to the source of the problem much quicker. Use the rule that if the current and voltage amplitude changes are in opposite directions (voltage decrease, current significantly increase), then the problem probably originates downstream or towards the load from the monitoring point.

Find out what amperage services you will be dealing with so that you have the right size CTs with you. Using a 3000A CT at 10 amps will usually give misleading results. CTs should generally not be used below 10% of full scale, since the core in not sufficiently magnetized. Likewise, if you are conducting a survey in a facility that has peak currents of 500 amps in the summer time, 300A CTs may saturate and produce clipped waveforms. This would significant distort the true harmonic picture. For long term surveys, toroid transformers (where the circuit is de-energized before passing the wire through the center of a closed loop) are usually used, as they tend to have a wider current operating range. Clamp-on current probes, ranging from 5A to 3000A full scale, are often used on short duration surveys or troubleshooting jobs. A flexible CT is often useful getting around wires in tightly packed distribution panels.

While a separate DVM, harmonics analyzer, power meter, and oscilloscope may do the job, most newer power quality monitoring equipment includes all of these features in a single instrument, as shown in the figure below. As pointed out in a previous editorial, an infrared cameras can point out hot connections, caused by high impedance from

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loose or oxidized wires. But is often the screwdriver that can very helpful. Using it first to remove the cover and then safely tightening the loose connections that come from the repetitive heating and cooling with the daily load changes makes a good standard procedure.

As the elementary teachers used to point out in English lessons, the "what, when, where, why, and how" used inconjuction with your senses (especially common sense) can produce results quickly and safely.

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