

# HOW MANY POWER QUALITY PROBLEMS IN LARGE FACILITIES ARE CAUSED INTERNALLY

The costly effects of power quality problems are most clearly seen in large industrial and commercial facilities when equipment or products suffer damage. Not only is there downtime for the affected equipment, but there are also repair and replacement costs. In addition, loss of product means expensive rework, loss of productivity, and higher overhead costs.

While most people think that power quality problems only affect sensitive electronic components, other aspects, in particular harmonic distortion, also affect normal loads such as motors, and transformers. The entire system, from transmission, to distribution, to utilization, is now subject to damage and destruction from various power quality phenomena.

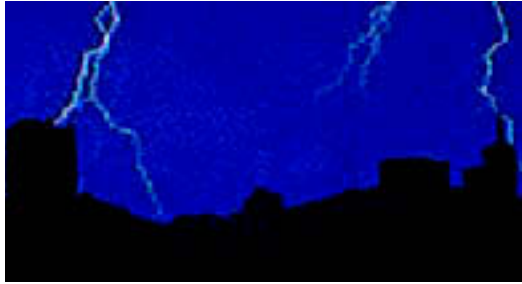
By far the majority of power quality problems happen on a customer's premises. Problems such as equipment damage, loss of product or productivity, and downtime can usually be traced to something happening within the business itself. All types of power disturbances are found on a customer's premises in varying degrees.

## Transients

Transients generated inside a building or office are very common. They come from three sources — electrostatic discharge (ESD), device switching, and arcing.

ESD is like a very small lightning strike. Static electricity builds up between two dissimilar materials. The resulting attraction force is what we commonly call static cling. If the electric field becomes large enough, an arc occurs, discharging the buildup. Humans usually don't feel a static "zap" unless the voltage is above about 1500 volts. But voltage levels as low as 500 volts can disrupt and damage electronic components.

Reactive loads turning on and off generate spikes whether these loads are heavy motors or copy machines. The term "reactive load" is generic. Basically, any piece of equipment can cause impulses. The compressor motor in a soda vending machine is one example.



HVAC and refrigeration equipment can also be culprits.

Another source of transients is arcing. Arcing occurs when there are poor or degraded connections in the wiring system. Arcing is almost always associated with other disturbances. Momentary interruptions, higher voltage distortion, and sags are likely companions to arcing.

Most of the time it is difficult to determine where transients come from. Wherever they originate, most of the solutions are similar. TVSS systems and power conditioners, when properly specified and installed, can reduce transients to non-damaging levels. These devices are usually plugged into a standard outlet, and sensitive devices plugged into them.

By troubleshooting and diagnosing the transient activity, it is possible that the source of the spike can be located. If it is, then three more options exist.

First, if the offending device is failing or there is a bad connection somewhere, get it fixed. Eliminate the source rather than attempt to protect everything else.

Second, try stopping the transient at the source if it cannot be eliminated. Place a power conditioner on the vending machine, for example. This will prevent the normal spike of the compressor motor from traveling to other loads.

Third, relocate the offending device or the sensitive device. The normal wiring system is a great transient reducer. It is far cheaper to address these problems at the source, or side-step them altogether, than to invest time and money into device-based solutions.

## Voltage Sags & Swells

Sags and swells are short duration

changes in the RMS level of the voltage. They typically last for less than a few seconds. Basically, sags and swells occur whenever there is a sudden change in the load current. Ohm's Law tells us that changes in the voltage occur when a changing current interacts with system impedance. If there is a sudden increase in current due to a load turning on, then a sag will result. On single phase circuits, a corresponding neutral-ground swell also occurs. If a load turns off, it produces a momentary increase, or swell, in the voltage. The greater the system impedance, the greater the magnitude of the disturbance.

Swells, including N-G swells, can easily damage equipment. Power supplies controlling all manner of devices are the most common victims of a swell.

Sags, however, do not directly cause damage. They initiate problems indirectly. For example, a sag may cause a laser CNC machine to restart, thus damaging the product it was making.

When internal voltage instability is a problem, the first step in solving it is to identify what is failing or being damaged and why. Where is the load causing the changing current? If that load or group of loads can be located, then a solution may be as simple as relocating either the victim or the culprit.

Since sags and swells are closely dependent on the wiring impedance, another possible solution is to increase the wire size in the distribution path. Increasing the size decreases the impedance, ultimately reducing the magnitude of the disturbance.

If these steps are not possible, then you must introduce voltage regulation to maintain voltage stability and protect

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reduced as described above.

There are two ways to reduce voltage distortion. Remember that internal voltage distortion is the result of the business's non-linear loads interacting with the wiring. The first way to reduce the distortion is to reduce the harmonic current. The second way is to reduce the impedance of the wiring. This is done by increasing the size of the conductors.

Where the total voltage distortion is the sum of internal and external distortion, these techniques reduce the internal contribution.

### Power System and Large Industrial Facilities

Large industries require large amounts of power. To satisfy this need, the utility typically provides a higher service voltage to these industries than they do to smaller businesses. Service voltages ranging from 12 kV to 138 kV are common in heavy C/I facilities. This higher voltage changes the complexity of what goes on at the service entrance.

Instead of simply being the point of marriage between the utility and the facility, several substation type activities take place at the service entrance. Voltage regulation and power factor correction capacitor banks may be used to control the incoming voltage.

Large facilities commonly have two sets of distribution lines brought in from the utility. This enhances power reliability. Facility switchgear selects which line the building connects to. When these control systems are operated, momentary interruptions and transients are generated and sent into the building.

Due to this increased complexity, it is also common to find some form of power monitoring or control equipment at the service entrance. This equipment may range from simple strip chart voltage recorders, to advanced digital monitoring systems, to Supervisory Control And Data Acquisition systems, known as SCADA. While all of these may help prove the presence of power disturbances, they also require the expertise to know how to use them and their data effectively.

By the very nature of large industries, the larger the overall power system, the greater the risk for error and failure. Problems can easily arise from having so many conductors, panels, transformers, and even service drops. The hot conductor for a load may come from one panel while the neutral comes from another. Loads from different panels may all share the same neutral. Wires get crossed, panel schedules quickly become outdated, recommended color codes are ignored, and what is expedient usually replaces what is appropriate. The larger the facility, the more critical it is to comply with Code.

### Grounding

Anytime sensitive loads are used, great care should be taken to ensure that the wiring and the grounding are appropriate. Every aspect of the power system should meet, or exceed, code requirements.

The impact of improper grounding cannot be understated. Poor grounding can significantly affect the performance and reliability of devices such as process control computers, variable speed drives, and electronic machinery.

Proper grounding practices take on a whole new dimension when ensuring good ground connection between multiple service drops. Ground loops between a computer on one system and the control mechanism it communicates with on another must be prevented.

### Multiple Buildings

The fact that many businesses are housed in multi-build-

ing facilities makes matters more complex because each building may not have its own service entrances. Some may be fed through outdoor branch circuits from these buildings. In these situations, grounding and voltage stability become key areas of concern.

If data communication between buildings is required, then the use of modems, or better yet, fiber-optic cables, will prevent ground loop problems. If modems or direct cable connections are used, be sure to provide data line transient protection.

Where modems or direct cable connections exist, take care to minimize picking up high frequency interference (EMI) on the signal or ground conductors, or on the outer cable shield itself. This, coupled with grounding concerns, can become so troubling that many experts strongly discourage using direct cable connections between buildings.

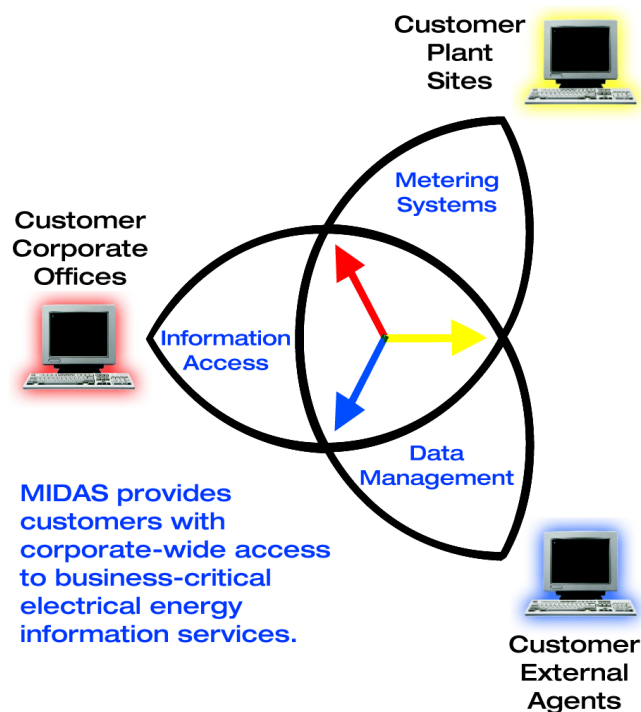
If wiring is found that violates the Code, it should be fixed immediately. Often, bringing the electrical system up to Code resolves many power quality problems.

If poor grounding is a concern, the use of isolated ground receptacles, isolated ground busses in the panel, and isolated ground conductors will alleviate most problems.

If an isolated ground conductor is used, it should be run in the same raceway as the power conductors, and terminated at the neutral-to-ground bond of the power source. This source is the transformer or service entrance directly feeding the loads.

*With material from the Niagara Mohawk Power Corporation website. For more information visit [www.niagamohawk.com](http://www.niagamohawk.com). ET*

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