Power Quality: Identifying the problem.

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Power quality is becoming an important issue with property managers. Problems have multiplied with the increased use of electronic devices such as computers, variable frequency drives and electronic ballasts. Not only are these items more susceptible to poor power quality, they can also be a source of power quality disturbances.

How do I know when there is a power quality problem in my facility? This is a question frequently asked by facility managers. Most of the investigations that consultants get involved with centre around a critical piece of equipment that experiences chronic failure for which there is no explanation. The customer is only interested in getting the piece of equipment operating again. However if the customer is experiencing power quality problems in one area of their facility, there is a high probability that there are problems throughout the facility. This article will assist facility managers in establishing a process to improve power quality in their facility.

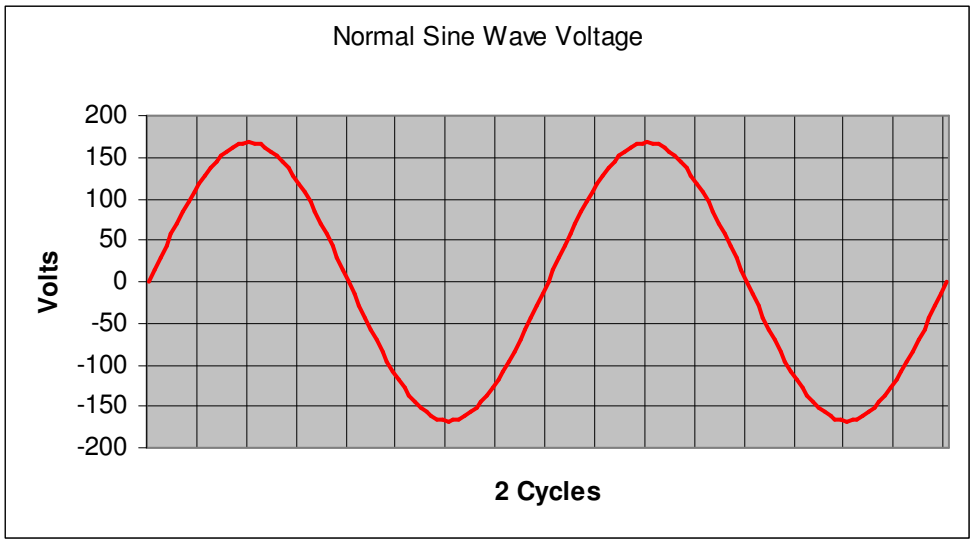
How do you know there is a power quality problem in your facility?

Look for the signs. Here are 12 of them:

1. Failure of motors and transformers.
2. Light flicker.
3. Nuisance tripping of circuit breakers.
4. Unexplained fuse operation.
5. Loss of computer or controller memory.
6. Tripping of variable speed drives.
7. Motor overload operation.
8. Computer system data alterations.
9. Microprocessor controlled equipment errors.
10. Damage to equipment electronic components.
11. Damage to electrical contactors.
12. Failure and damage to power factor correction capacitors.

If your facility is experiencing any of these problems chances are there is a power quality problem lurking somewhere within your system. The next step is to understand the different power quality disturbances that can be present, their effects and what can cause them.

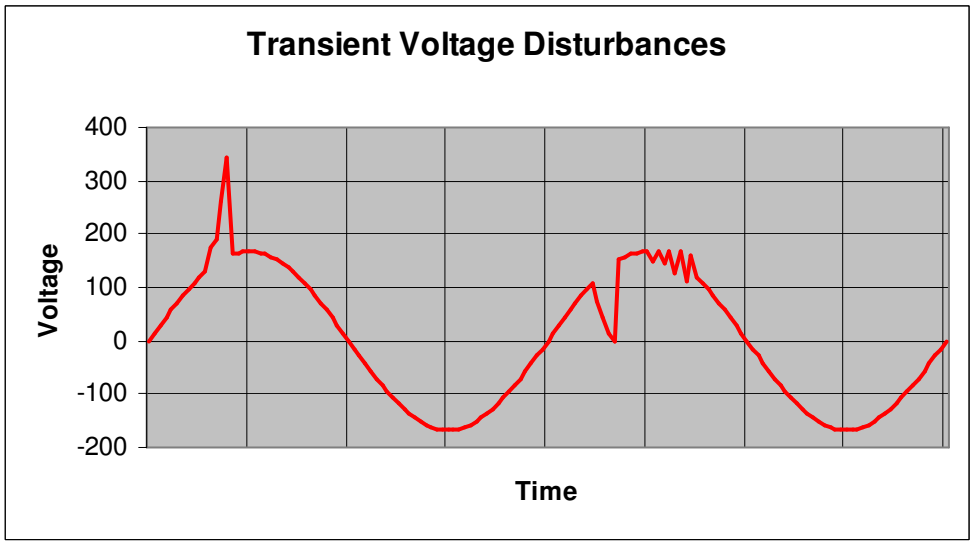
The Sine Wave



The diagram above illustrates how the voltage should appear in your facility. Electricity is supplied in the form of alternating current (A.C.), voltage that alternates in magnitude in the shape of a sine wave from zero to maximum positive, maximum negative and back to zero again 60 times per second. The rate of change is referred to as frequency. In most of North America, the frequency of utility voltage supply is 60 cycles or commonly referred to as 60 Hertz. This is what electrical equipment is designed to utilize in order to perform it's designated task. Most equipment is able to withstand variations in the voltage supply but very often power quality disturbances exceed the tolerance envelope of the equipment. Now it is time to look at the different power quality disturbances.

Transients

A transient disturbance is defined as a temporary short duration voltage disturbance in which there is a high amplitude voltage change. The diagrams below illustrate the three basic types of transients; impulses, notches and oscillations in order from left to right. The amplitude of transients can vary. The magnitude of transient amplitude is proportional to the potential for causing damage.



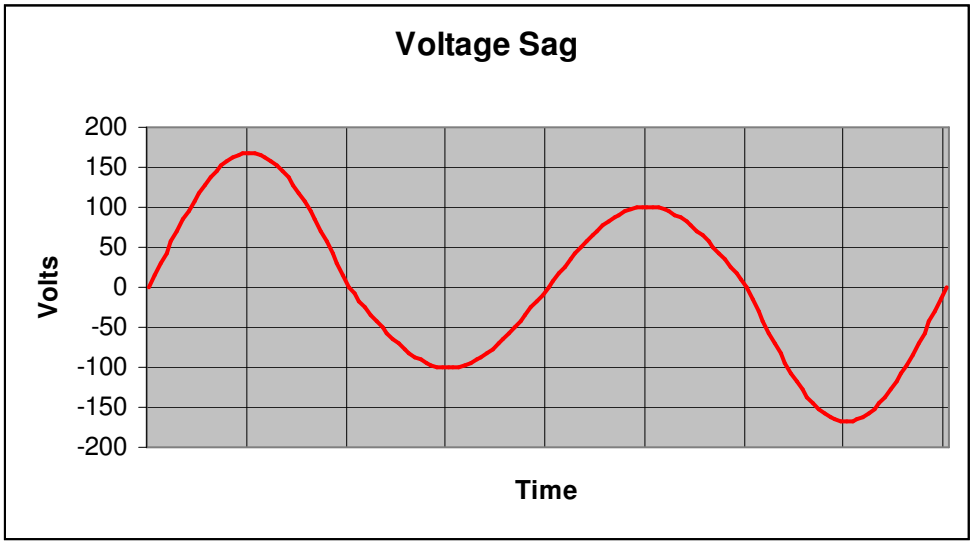
Transient disturbances are capable of causing effects 4,6,8,9,10 and 11. Transient disturbances can be caused by:

- Lightning.
- Utility fault clearing.
- Facility faults.
- Power factor correction capacitor switching.
- Switching of large inductive loads (motors).

Sags and Swells

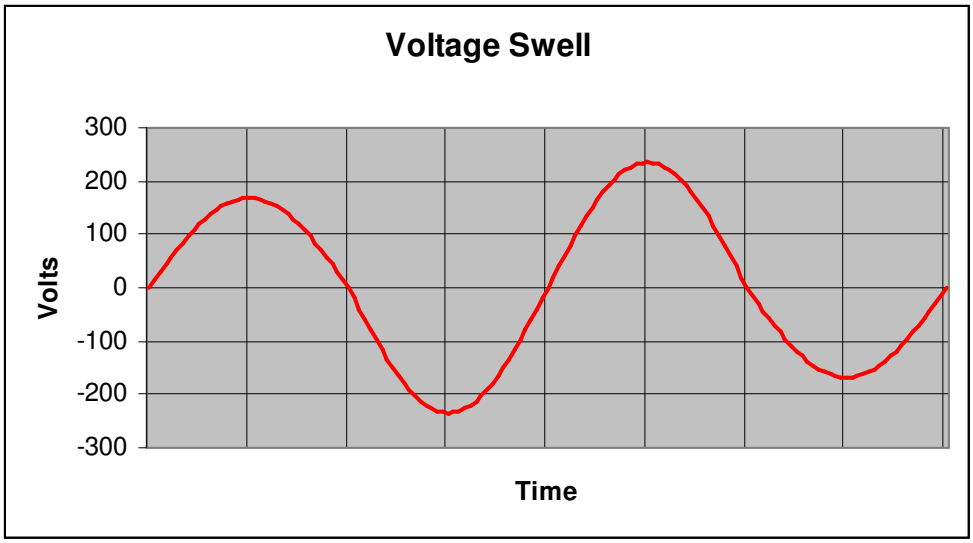
A voltage sag is defined as a disturbance where the voltage decreases for a period of up to 2 seconds. A sag is capable of causing effects 1,2,5,6,7,8. Voltage sags can be caused by:

- Lightning.
- Utility faults.
- Facility Faults.
- The starting of large electrical loads.
- Overloaded wiring, transformers and switchgear.



A voltage swell is defined as a disturbance where the voltage increases for a period of up to 2 seconds. A swell is capable of causing effects 2,6,11 and 12. Voltage swells can be caused by:

- Sudden load reductions.
- Utility faults on different phases.
- Open neutral connections.



Overvoltages and Undervoltages

Overvoltages (OV) and undervoltages (UV) are terms used to describe longer periods in which the supply voltage is outside the system design voltage window. UV is capable of causing effects 1,6,7,9,10. UV is caused by:

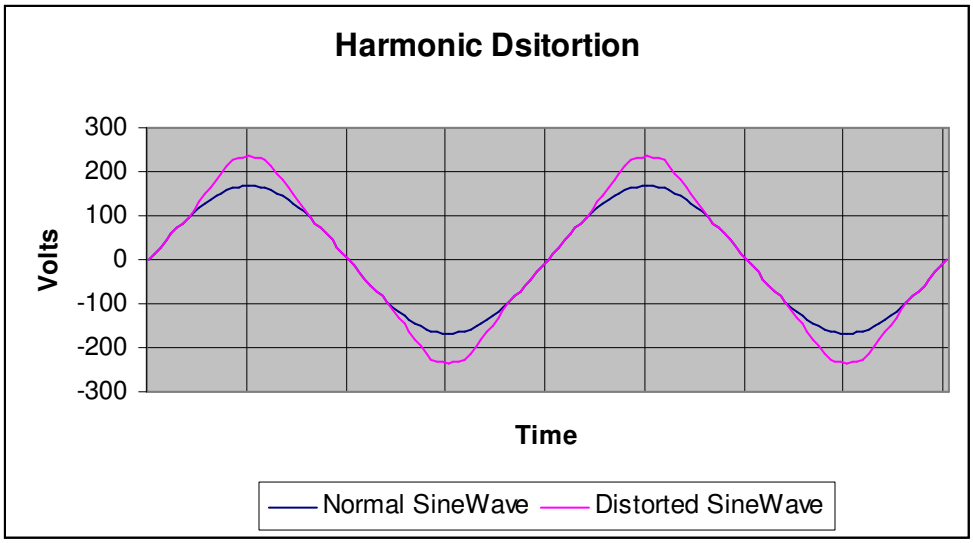
- Overloaded wiring, switchgear and transformers.
- Loose or improperly fitted connections.
- Unbalanced phase loading conditions.
- Incorrect transformer tap settings.

An OV is capable of causing effects 1,6,10,11 and 12. OV is usually caused by:

- Incorrect tap settings on transformers.
- Improper application of power factor correction capacitors.

Harmonic Distortion

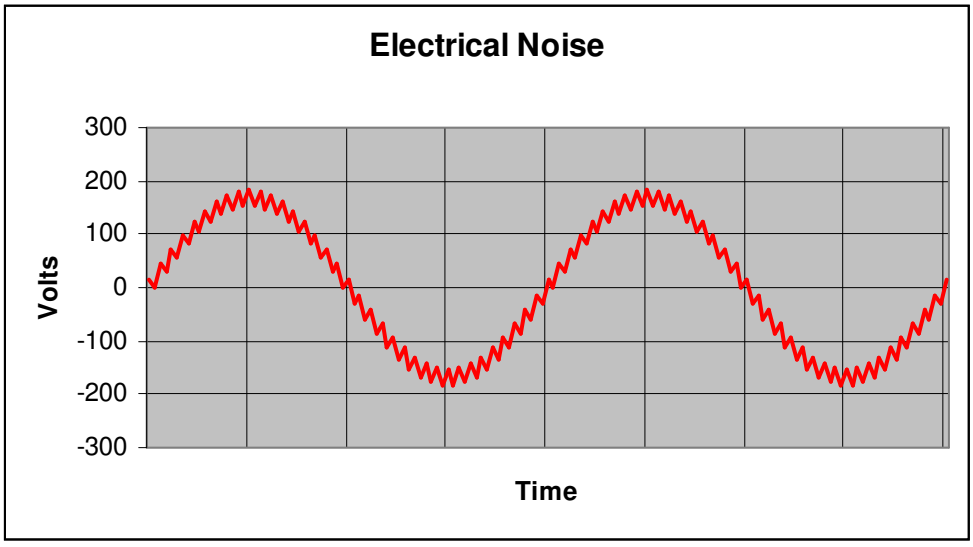
Harmonic distortion is expressed as a deviation of the voltage sine wave from a true sinusoidal shape. Harmonic distortion is capable of causing effects 1,3,4,6,7,10,11 and 12. Harmonic distortion is almost always produced by the presence of non-linear electrical loads within a facility. Non-linear loads are equipment that do not use voltage in a normal sinusoidal shape. Variable speed drives, computer power supplies, electronic ballasts, battery chargers and medical diagnostic equipment are examples of non-linear loads.



Electrical Noise

Electrical noise is a continuous occurrence of unwanted electrical signals superimposed on the voltage sine wave. Noise is capable of causing effects 8 and 9. The most frequent causes of noise are:

- Improper grounding techniques.
- Broken or corroded ground connections.
- Welding equipment.



Reducing The Risk

It is not economically feasible to eliminate the possibility of power quality disturbances at your facility. But there are a number of steps you can take to reduce the risk.

Maintenance. Even though most of a building's electrical system is fixed, components require regular maintenance. Everything should be regularly maintained from the transformer at the building entrance right down to the last receptacle.

- Transformers require annual liquid insulation testing, surface cleaning and tap setting checks. The units should be regularly inspected for temperature, gas pressure and load.
- Switchgear should be cleaned, with connections tested for wear and tightness and main breakers should be tested annually.
- Distribution switches, dry type transformers and breaker panels should be checked for connection wear, discolouration, cleanliness and tightness on an annual basis
- Switchgear, switches, panels and major motors should be monitored for load and power quality at least once and retested when there is an electrical load change.
- Conduct an annual thermal imaging survey of transformers, switchgear, distribution switches, panels and breakers, motors and motor control centres.
- Check grounding and bonding connections and measure ground resistance annually. Check distribution panels for ground loops.
- Check the polarity of 120 volt receptacles. Surveys indicate that up to 10% of electrical receptacles can be mis-wired.

Protection of sensitive and critical loads. Identify the sensitive and critical loads within your facility. Determine the cost of failure or destruction of these loads and develop a cost effective protection system. Remember that there are almost an infinite number of brands of protection equipment, they are not all equal. Match the protective capabilities of the equipment with the tolerance of the equipment it is supposed to protect.

Isolation and separation of potential disturbance producing loads. It may not be possible to protect all the sensitive equipment within your facility. It may make more sense to isolate or separate potential disturbing loads from the rest of the electrical system. The sensitive system contact could be minimized with the use of dedicated feeds from the main switchboard, isolation transformers and reduced voltage starting.

In conclusion power quality is a facility issue that will continue to rise in importance. The preponderance of electronic equipment in the workplace is constantly increasing yet many of our facilities were designed for a previous era. The very equipment we bring in to our facilities can at the same time generate power quality disturbances and be sensitive to them. You as the facility manager, engineer or maintenance person will require the knowledge and experience to ensure that the lights stay on.