The Hanover Insurance Group™

Hanover Risk Solutions

Power Quality Is Important: Here Is What You Can Do to Help Protect Your Equipment

When a transformer overheats, circuit breakers trip, or electronically controlled variable speed motor controllers drop off-line, all for no apparent reason, should you look only at the utility as the source of the problem, or should you also look at your own plant and equipment as the possible culprit? The answer may be both.

The microware clock was blinking again, its bright LED display flashing. The power had gone off for a brief moment. Yet, plugged into the same outlet as the microwave was an old electric motor driven clock, the sweeping hands of its analog dial seeming to not miss a beat. Has this ever happened to you? How many times have you had to reset digital clocks, the VCR or DVD recorder, or the microwave oven in the last year? When a momentary power interruption occurs at home, it can be a source of irritation. When the same momentary interruption occurs in an office, a process line, or production line, the result can be a costly equipment breakdown.

What's the Problem?

A momentary power outage can occur within thousandths of a second, and may only be obvious by a very rapid blinking of lights. Years ago a momentary outage was not considered a problem because, under most conditions, it was not perceptible. At that time, the majority of electrical equipment was based upon electro-mechanical technology, a technology which rarely reacted negatively to momentary power outages. A sustained power outage is typically much more readily identifiable, since it results in a complete loss of power for a comparatively extended time period. Sustained outages have always been considered a problem, but if they occurred infrequently and could not be avoided, most people were willing to accept the inconvenience.

Compared to the older electro-mechanical technology, solid state devices provide reductions in size and weight, increases in versatility and possible reductions in both initial and maintenance costs.

However, solid state devices are very sensitive to power system fluctuations. It is this drawback that brought about the increased awareness of power system variations, a reality of life which had always been present.

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Power Quality—What Is It?

Power quality is a term used to describe an old problem. To most people, power quality means how often the lights go out due to power interruptions. These interruptions can be caused by natural disasters (hurricanes, tornadoes, and ice storms), pole-line accidents, tree contact with power lines and other easily recognized factors. An interruption can be momentary or sustained. Historically, most calls and complaints received by electric utilities have been of the simple "lights out" variety.

Most of the older electro-mechanical equipment was robust and could handle minor changes in voltage with little or no impact on operations. Due to major technological advances several years ago in consumer electronics and commercial and industrial applications of solid state electronics, our understanding and definition of power quality has been expanded. Power system conditions included in today's definition include harmonic distortion, voltage variations (sags and swells), voltage reductions, power interruptions (momentary and sustained) and voltage surges.

Harmonic Distortion

Much of the equipment we use today, such as computers, automated process control equipment and solid state power conversion equipment, contains circuits which convert alternating current (AC) to direct current (DC). When energized, these power conversion circuits, themselves very sensitive to power fluctuations and abnormalities, create harmonics which can severely distort the power supply and cause problems for others connected to the same source.

Most circuits in the United States are designed to operate at a frequency of 60 hertz. The frequency of a harmonic current or voltage is a multiple of the original frequency. For example, in a 60 hertz system, the second harmonic would be 120 hertz; the third harmonic would be 180 hertz and so on. Harmonics add to the fundamental frequency in magnitude and can produce peak voltages greater than the line voltage. These voltages can become a problem when they exceed the design voltage of electrical devices.

It once was extremely difficult and very time consuming to identify the presence of harmonics in a power system. Most electrical measuring instruments could not respond fast enough to detect harmonics. Today, high speed analyzers are available to identify and record the frequencies present in the power system. Software and personal computers also help simplify the process of identifying each discrete frequency. With these tools, troublesome frequencies can be identified in a relatively short period of time.

Once identified, a variety of things can be done to reduce or eliminate the effects of these unwanted frequencies. For circuits generating harmonics, filtering circuits can be designed and installed. For electrical circuits which must carry additional harmonic current, neutral wires with higher current carrying capacities can be installed to minimize overheating and potential fire hazards. For transformers subjected to harmonic loads, the transformer's load can be reduced to accommodate the additional harmonic current, a larger transformer can be installed, or a transformer designed to handle harmonic currents can be specified.

Whenever changes are planned in an electrical power system or any potentially harmonic producing equipment is to be added, it is important to investigate the susceptibility of the power system to possible harmonic distortion problems. These investigations should be made in addition to any normal power system studies done whenever changes to an electrical system are anticipated.

Voltage Sags and Swells

When an electric clothes dryer is started, the lights may dim for an instant and then return to normal. In an industrial plant, starting a large motor produces similar results. In both cases the line voltage momentarily decreases due to the inrush of current drawn by the heavy starting load. When a large load is removed from a circuit, the voltage may increase slightly and lights may get brighter for an instant. These events are referred to as sags and swells respectively.

Older electro-mechanical equipment could typically handle these types of changes in voltage with little or no effect on operation. The worst case might be a machine tripping off-line. Modern solid state controls are more sensitive to these voltage variations, and can be damaged by higher voltage levels or trip off-line with a minor drop in voltage. This can become serious in process applications where it either takes considerable time to restart the interrupted process, or the work in progress is lost or a product spoiled.

When these situations occur, equipment owner/operators have successfully worked with electric utilities, consulting engineers and equipment manufacturers to find a solution. The results of this team approach have typically been the development of cost effective solutions to allow solid state controlled equipment to operate normally whenever voltage sags and swells occur.

Voltage Reductions

At times of extremely high power consumption, an electric utility may have to reduce the supply voltage for energy conservation purposes. This condition is called a "brownout." In other cases, the inadvertent overloading of a transformer may cause unplanned voltage reductions. In either case, solid state equipment may not operate within its voltage rating, resulting in malfunction or failure. In these cases it may be necessary to work with the utility to increase the size of the transformer supplying a plant, develop load management systems for a facility to prevent energizing major loads at the same time, or install an uninterruptible power supply (UPS) system to help protect sensitive loads.

Momentary Interruptions

Storms can cause a tree limb to come in contact with a power line. A squirrel or large bird may come in contact with an insulator on a power line or in an electric substation. These events can cause a circuit breaker to trip in order to protect the utility equipment. After the fault is cleared the breaker that opened is able to re-close, sometimes automatically, thereby restoring power. Fault clearing and automatic re-closing typically occur in a matter of milliseconds.

Electro-mechanical equipment was generally not affected by these brief outages.

However, computers and other electronically controlled equipment are extremely sensitive to even the briefest power interruption. A momentary power interruption can result in inaccurate data or incorrect signals to a process computer. The result can be an upset in a manufacturing process, a product which cannot be sold due to incorrect mixing or processing, or damage to expensive machinery. The use of a UPS system or other source of emergency power could help the process control system ride through these brief outages with no ill effects.

Sustained Interruptions

Sustained interruptions can be caused by storms, accidents involving utility owned equipment, or malfunctions of utility owned equipment. These longer-term power outages can last from hours to days. Extreme examples of sustained outages include the 1965 blackout that affected a large portion of the Northeast and the major outage of 2003 that knocked out power all over the Northeastern United States and Southeastern Canada.

Critical electrical equipment that requires an orderly shutdown should be provided with emergency back-up systems such as emergency generators, batteries, or UPS systems. For example, a furnace in a steel mill requires cooling water to prevent hot metal break-out. The loss of cooling water during a power outage can spell disaster. A back-up diesel driven pump or emergency generator will allow the cooling system to continue to operate, thereby averting a serious problem.

Voltage Surges

Surges in an electrical power system can be caused by lightning, utility switching operations and system faults. Surge protection is generally provided by surge arresters located either in the utility system or within the customer's power distribution system. Power supply circuits for computers and electronically controlled equipment should be evaluated to ensure that the installed surge protectors are properly sized and applied to help protect equipment during a power disturbance.

System Reliability

The fundamental quality of utility power systems throughout the world has not significantly degraded. What has changed is that today's society is a heavy user of solid state electronics. This "power quality-sensitive" technology has accentuated imperfections in the power supply which have always existed.

The equipment of "yesteryear" may have been less sophisticated and larger than today's solid state equivalents, but it operated very successfully in its electrical environment. It is inevitable that as older equipment is phased out, manufacturers will develop future generations of solid state equipment that are more resilient to an imperfect power supply.

Managing Power Quality

Problems with power quality are not, and should not remain, mysteries. Although these problems are not always easy to identify and sometimes expensive to investigate, once they are identified and resolved a very high degree of reliability can be restored to a power system.

It is important to remember that an electric utility is at least as interested in the satisfaction of its customers as are the customers themselves. To this end, they are generally willing and helpful in identifying a problem and recommending solutions. Consulting engineers and equipment manufacturers can also serve as resources, providing investigative services and expert advice on power quality problems.

To learn more about Hanover Risk Solutions, visit hanoverrisksolutions.com

Why The Hanover?

The Hanover is a leading Property and Casualty insurance company dedicated to achieving world-class performance. Our commitment is to deliver the products, services, and technology of the best national companies with the responsiveness, market focus, and local decision making of the best regional companies. This powerful combination has been a proven success since our founding in 1852, and is backed by our financial strength rating of "A" (Excellent) from A.M. Best.

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