The Impact of Poor Power Quality

Why Power Quality Matters

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Poor power quality can result in equipment damage, costly scrap loss, and even costlier downtime. A single process interruption can result in substantial costs, ranging from ten thousand to millions USD per occurrence. Costs to certain industries such as data centers, banks, customer service centers, and the like can be even higher. Momentary voltage sags lasting less than 0.1 second can cost as much as a total outage lasting minutes.

Electrical downtime in a plant can cause electrical and mechanical failures, loss of production time, increased scrap, and increased unscheduled maintenance costs, to name a few. The cost of power quality disturbance can be typically seen and calculated in product-related costs including lost capacity, disposal charges, and increased inventory; labor costs including idle labor, overtime, and cleanup; other costs such as damaged equipment; opportunity costs; and penalties. These costs vary widely depending on severity of the disturbance, industry, product produced, scarcity, labor costs, and other basic economic drivers.

IEEE Standard 1346 provides a standard framework to calculate factors to be considered in determining the cost of power quality disturbances.

Analysis - Causes and Signs of Poor Power Quality

One might suspect poor power quality when seeing evidence such as unexplained alarms, control system faults, and electrical component failures. Voltage sags and swells are also a sign of poor power quality. A voltage sag is defined as a momentary decrease for a duration of 0.5 to 30 cycles, with the voltage falling to 90% to 10% of nominal. An interruption is defined as a voltage sag with a less than 10% retained voltage. Power system faults or large motor starting events can cause voltage sags.

Sag severity is directly related to the magnitude and duration of the sag. Equipment without sufficient ride through capability will trip, or become inoperable, resulting in potential greater cost due to downtime. Voltage sags are one of the most costly occurrences, often resulting in large economic impact.

IEEE Standard 1159 (Recommended Practice for Monitoring Electric Power Quality) classifies sags by duration. Instantaneous sags last 0.5 cycles to 30 cycles. Momentary sags last 30 cycles to 3 seconds. Temporary sags last 3 seconds to 1 minute. It is important to record and document sag magnitude and duration for each leg of a 3-phase power system. This data can impact the identification of equipment sensitivity and root cause analysis of specific equipment malfunctions.

Measurement Metrics

Real time monitoring is required to fully identify the root cause of power quality degredation. Load related power quality issues can usually be identified by monitoring for a full duty cycle. Utility related problems may require an extended period of weeks or months. Factors for machine derived issues such as motor starting, frequency, voltage magnitude variations, electrical noise, harmonics, phase unbalance, common mode voltage/noise, notching, grounding and bonding issues should be measured. Long-term power supplier issues such as sags, surges, sustained interruptions, phase shifts, and high frequency switching transients, should be monitored along with other variables.

Determining the Solution: Economic Calculations

In order to define what equipment is needed to improve power quality and then decide if that investment should be made, it is imperative to characterize the system power quality performance first. This is typically done by assessing and monitoring the environment for power quality, estimating the costs of variations, and economically comparing alternative options. A "do nothing" base case is typically compared against several alternative scenarios, using a total lifecycle cost or calculated ROI approach. Calculations can also be combined with energy monitoring costs.

Installing equipment to mitigate voltage sags is one way to reduce downtime as well as reduce ongoing wear on equipment. Typically the higher the cost of interruption, the more reason to purchase mitigating equipment, as proven by cost-benefit analysis calculations.