

When Voltage Sags, Productivity Lags

Pervasive Drops in Voltage Can Be Troublesome and Costly

They Can Be Corrected with Affordable New Technologies

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Sags have become a prevalent and costly cause of facility shutdowns. These power quality disturbances will become even more frequent and troublesome as plants invest in new technology and utilities. Facilities, pressed by deregulation, continue to push their generation and distribution systems to design limits and beyond.

If You Can't Stop 'em (You Can't), Live Affordably with 'em (You Can)

Sags are drops in voltages of between 10 and 90 percent of system nominal voltages and generally last from one half cycle to several seconds. They are caused by faults on the power provider's transmission or distribution lines. The faults are caused by unmanageable and unpredictable phenomena such as lightning, wind, ice, animals and accidents involving construction or maintenance vehicles. Single line-to-ground (L-G) account for the majority of faults. In addition, sags occur more frequently on the distribution system than on transmission lines.

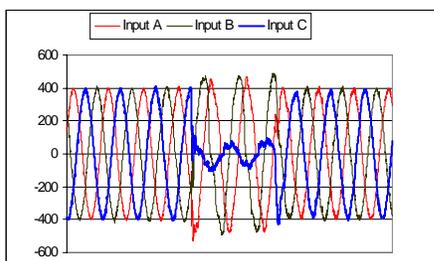


Figure 1: During a typical sag, the voltage drops to between 10 and 90 percent of the system's nominal voltage for a period of 0.5 to 120 cycles.

Power providers commit significant funds, manpower, and equipment to prevent faults on their delivery systems. In many cases they apply line arrestors, insulator washing, add animal guards and trim trees to reduce the possibility of voltage sags. Additional precautions include implementing line reclosers, adding loop schemes and modifying feeder designs. These practices reduce the number and duration of momentary interruptions and voltage sags, however, utility faults can never be completely eliminated. The responsibility of successfully enduring sags, falls into the realm of prudent plant management and engineering.

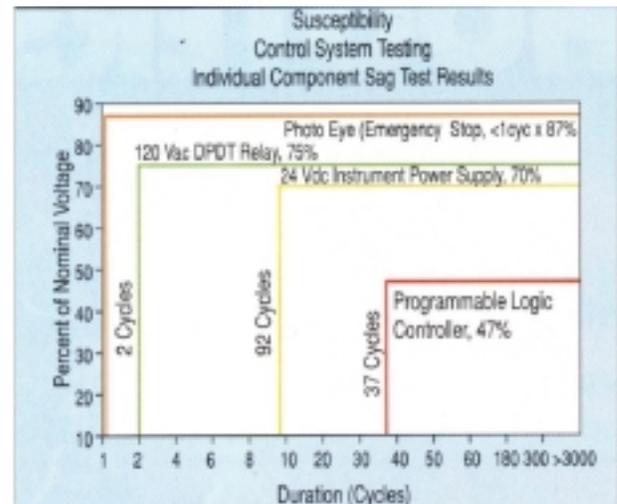


Figure 2: The sensitivities of equipment to sags varies widely by design and manufacturer. The above testing by Duke Power illustrates the sag voltage and duration where different components drop out¹.

Sensitivity Training for Industrial Facilities

Equipment, used in modern industrial plants, such as microprocessors, PLCs, adjustable speed drives and robotics, is becoming more sensitive to voltage sags because of the complexity of the equipment. The sensitivities of different devices varies with design, manufacture and application.

The new sag correction devices assure that all plant equipment rides through the deepest and longest sags.

Sag Ride Through (SRT)

SRT devices are relative newcomers to the task of sag correction. They correct 90 to 95 percent of power quality events that affect plants. An SRT responds to sags within two milliseconds (sub-cycle), which is considerably faster than conventional voltage regulators. This is an important feature that can prevent shutdowns.



Figure 3: Cutler-Hammer's Sag Ride Through device, available in ratings from 20 kVa to 700 kVa, responds to sags in only 1/8 of a cycle to correct input voltages ranging from ten to seventy percent reduction in RMS voltage.

SRT: Sag Ride Through

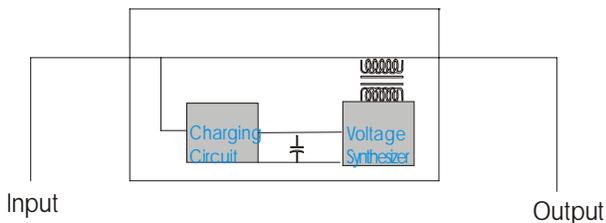


Figure 4: Efficient and reliable, the SRT boosts voltages through a series transformer and other proven components. Options include full diagnostics and response to phase shifts.

The SRT design is patented. The unit electronically synthesizes the voltage required to correct the sag and provide momentary ride-through. A series-connected transformer produces a clean, stabilized output voltage.

The series connected voltage compensation device, employed in the SRT, is the ideal solution for sags. The SRT responds more quickly and corrects deeper sags when compared to less effective ferroresonant and tap changing technologies.

Those Pesky Sags: Four a Month is Typical, Each a Threat to the Bottom Line

Electric Power Research Institute (EPRI) conducted a two-year study of 300 sites, served by 24 different power providers. EPRI determined that there were more than six million events (e.g. interruptions or voltage sags) that were 90 percent of nominal voltage and below. Among the conclusions of the study was that a typical facility served by a distribution system is subject to:

- 50 events per year when the voltage drops to below 90 percent of nominal
- 4 interruptions per year, during which the voltage drops to zero for two cycles or longer.

If the facility is served by a transmission system, the number of sags that are 70 percent below nominal voltage decreases to 10 - 15 per year, and interruptions to virtually none.

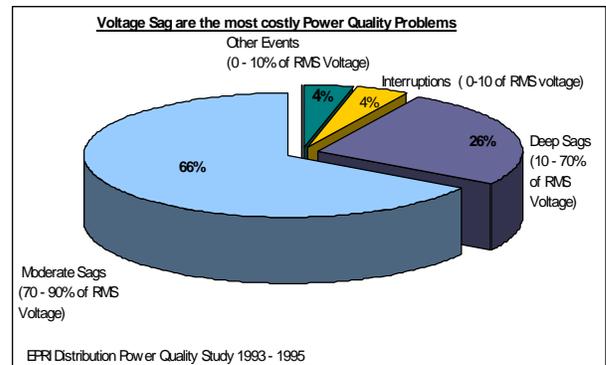


Figure 5: A two-year study concluded that the typical production facility experiences approximately 50 voltage disturbances per year of which 92 percent are sags.

Many events can shut-down an entire process or individual load depending on the sensitivity of the equipment. The more sensitive the equipment, the more shutdowns. The lower the sensitivities, the fewer shutdowns there are.

So, what are the costs of sags, and of correcting them?

As there is a wide variation among facilities, the following points highlight ideas for power quality improvement:

- The preferred solution for facilities experiencing **long duration over/under voltages or brownouts** are Electronic Voltage Regulators (EVRs). Brownouts often occur in developing countries or site specific locations in the US where utilities can not deliver stable voltage. The Cutler-Hammer EVR is available in ratings from 10 kVA to 700 kVA and is a patent-pending, microprocessor controlled, tap switching transformer.
- The cost per each sag or interruption can be calculated and tracked. The cost per event ranges from \$500 to millions of dollars depending upon the facility. Since a facility will experience many events per year, the annual cost, due to sags, is often over \$75,000.
- A Plant Manager is faced with two options when deciding how to manage the effects of sags: do nothing, or install one or more sag correction or other mitigating devices.
- The most expensive option for production facilities is to do nothing. Recent studies demonstrate that the cost per year of doing nothing is more than six times that of installing SRTs. An SRT can eliminate or cut the cost of sags by 90 percent.
- Voltage sags, transients and momentary interruptions are the most costly electrical disturbances typically grouped under the heading "Power Quality."

The cost of an SRT is often returned in less than a year. For some facilities, it can be as little as four to six months. The payback period varies with the number of sags and interruptions experienced by a specific facility, the sensitivity of that facility's equipment, and the cost of each shut-down.

For further information, contact your local Cutler-Hammer sales office or the Surge Protection & Power Conditioner product line, at (403) 717-2000 or at www.cutlerhammer.eaton.com.

- 1 Dougherty, J. & Huffman, M. 1999, 'Plastics Industry Teams Unite on Power Quality Issues', *Power Quality Assurance*, October, pp. 26-31.