VOLTAGE SAGS: AN EXPLANATION - CAUSES, EFFECTS AND CORRECTION - PART II

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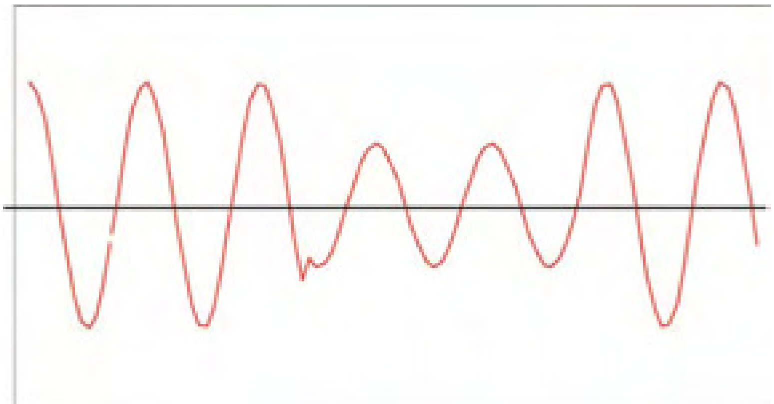
8.0 THE SOLUTION

8.1 First Identify the Problem

8.1.1 Equipment Identification

In order to provide an optimal and cost effective solution to voltage sag problems, it is necessary to determine which equipment is susceptible to unplanned stoppages. In most industries, there is still a significant amount of electrical equipment which is not sensitive to voltage variation or which can be restarted at little or no cost. Usually it is not necessary to protect an entire industrial facility, it is sufficient to protect the key sensitive equipment.



Voltage Sag - A reduced voltage for a limited period
Figure 1

8.1.2 Identify the Voltage Sags

The next stage is to determine the frequency, depth and duration of the voltage sags.

These can vary widely even in apparently similar industrial facilities. Collection of this data is essential if the optimal solution is to be identified.

In North America, only a small proportion of manufacturing businesses have installed electrical metering which is capable of measuring and recording the voltage variations which are responsible for the majority of their very costly Unplanned Production Stoppages.

8.2 Measure the Problem

8.2.1 Install Metering

To identify the depth of the voltage sags and their duration, the sag events need to be measured and recorded for subsequent analysis. As typical voltage sag events last only a few cycles, the most cost effective way to measure these is by installation of an electronic meter with wave form capture capability.

As and when a voltage sag occurs, these devices capture the 3-phase voltage values throughout the sag event, the duration of the event in cycles, and can time stamp the start and or finish of the event. The data is captured automatically and is downloaded to a computer for later analysis.

8.2.2 Record Unplanned Production Stoppages

It is extremely helpful to record precisely the time and date of unplanned production stoppages and then to compare these against voltage variations recorded by the meter, as not all voltage sags lead to stoppages. This analysis will show the value of the sag voltage which typically causes production problems and equally those events which have not caused problems.

Surprisingly, in many industries, people are so busy trying to restart the process, they fail to record the time of the stoppage with any formal system. Even in large companies, precise data on the number and duration of unplanned stoppages is often difficult to find.

8.2.3 Meter Cost vs. Cost of Unplanned Production Stoppage

The cost of an installation with a meter capable of wave form capture and its software is typically a few thousand dollars.

This is often only a small fraction of the cost of even one unplanned production stoppage. Unfortunately installation of such meters has not become commonplace in many industries as “there is no money in the budget for this”.

8.3 Choose a Solution

Once the characteristics of a typical voltage sag have been determined by examining recorded data from the waveform capture meter over a period of time, it is possible to calculate the type of voltage sag correction required to cover the depth and duration of expected future voltage sag events.

If it is possible to correct the problem by changing some sensitive components, this may well be the least expensive solution. This approach has been widely adopted in the semi-conductor industry and it is notable that this industry has invested heavily in high quality meters to identify the problems. This is an industry where an unplanned stoppage may cost $1 million per event or more.

If component substitution is not practical, it is necessary to identify the size of the load to be protected in kVA and its supply voltage. This may be an entire plant at medium voltage or a critical machine at low voltage or anything in between.

9.0 THERE ARE VOLTAGE SAG CORRECTION DEVICES AVAILABLE

9.1 Traditional Solutions

Traditional methods of Voltage Control included Transformer Tap Changers both mechanical and SCR switched units, Servo-Variac technology and Ferro-Resonant Transformers (constant voltage transformers).

In some cases and for some applications these traditional technologies may still be applicable and work well, but in many cases they were designed to correct problems other than voltage sags.

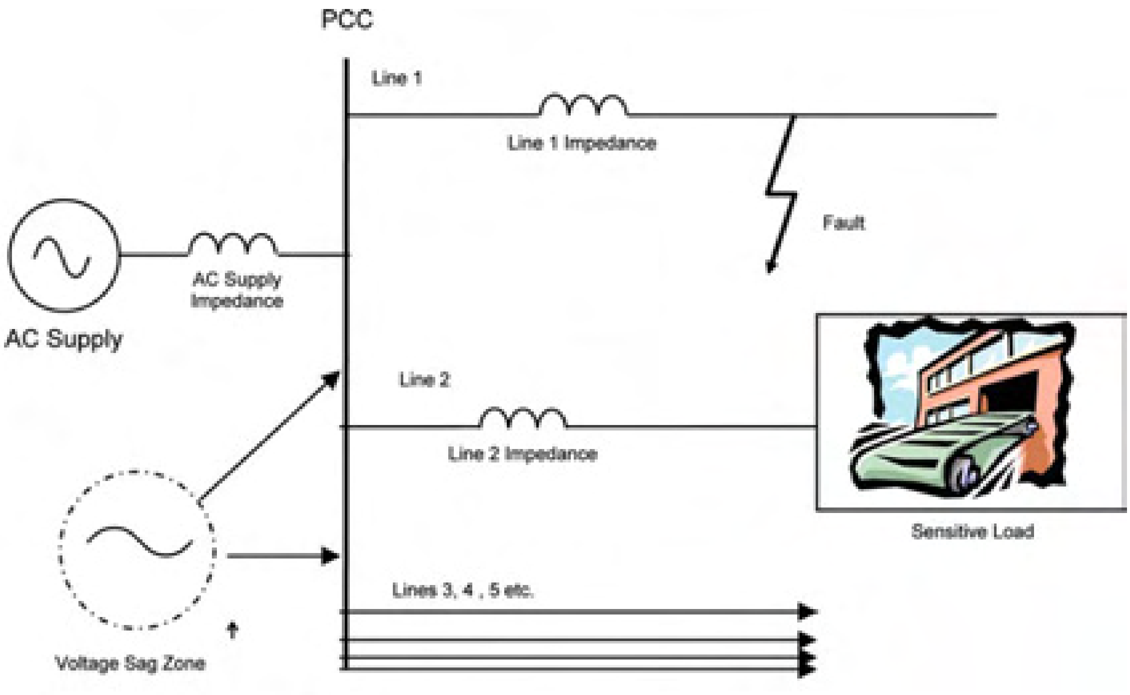


Figure 2

9.2 UPS Solutions

Uninterruptible Power Supplies (UPS) technology has been available for over 20 years and is ideally suited for those applications such as high speed data processing where continuous protection against any power variation and more importantly against any power interruption is essential.

Industrial UPS units are widely used to protect electronic process control equipment and to allow for an orderly shutdown of the process but it is rarely economic to install large UPS systems with their attendant large battery banks for high power electrical equipment such as high horsepower drives, extruders etc.

9.3 Electronic Voltage Regulators

There are several manufacturers of devices designed specifically for voltage sag correction in industrial applications. These devices use a combination of an inverter plus short term electrical storage or an inverter with a specially designed injection transformer to provide voltage correction against voltage sags as they arise.

Typical response times from initiation of a voltage sag to its correction are of the order of one half cycle or less.

Some devices offer limited ride through a zero voltage event for a short time, others do not.

These devices provide excellent protection against both 3 phase and single phase voltage sags.

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Some manufacturers offer small single-phase devices at low voltage 120V or 220V typically with small kVA ratings. Others provide only 3-phase devices at low voltage 208V – 600V and at medium voltage to 36kV.

The kVA ratings of 3 phase devices typically range from <20kVA -5 MVA at low voltage and from 1MVA to 50MVA for medium voltage applications.

A few manufacturers offer solutions in the 50MVA to 100+MVA range at medium voltage but demand for these occurs infrequently.

9.4 Pay back on Sag Correction Investment

Typically, pay back periods for actual savings achieved by businesses who have installed voltage sag correction equipment can be as little as few weeks, more commonly 12 months or less, but rarely exceed two years.

10. Summary

Voltage sags occur throughout North American utility networks. Some areas are more susceptible than others, as the frequency of events is related to weather and climate.

Electrical utilities are unable to eliminate the causes of voltage sags and this situation will not change in the foreseeable future.

Industry has invested heavily in high-speed and precision equipment, much of which is more sensitive to voltage variation than traditional machinery.

It is possible to establish a history of voltage sags in any given facility for a modest investment in one or more suitable meters and their associated software. The events from this history can be compared to the incidence of unplanned production stoppages, if adequate records are kept.

There a number of alternative solutions available for the correction of voltage sags, and typically the financial case for investment in these solutions will meet or exceed the investment criteria for many industries.