Another Tool for the Toolbox
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While the screwdriver may still be one of the best tools for troubleshooting power quality related problems, there is a tool available that is very useful to have in the tool box for helping to determine the susceptibility of the equipment to the quality of the electrical supply. In the grand scheme of things, that is what really matters --- can the equipment operate properly with the electricity that is supplied to it? IEEE Std 1346 Electrical Power System Compatibility with Electronic Process Equipment is just such tool.

The document provides a standard methodology for the technical and economic analysis of compatibility of process equipment with the electric power system. It doesn't try to set hard limits for the different power quality phenomena, such as IEEE 519 does for harmonics. In the real world, there are too many factors involved to say that if the quality is above value X, then the process will run smoothly. Different equipment has different susceptibilities. Different building wiring results in different disturbance levels from the same event.

As with most things in life, it is the weakest link in the chain that can break the process flow. IEEE 1346 shows how to correlate performance data of the equipment to the voltage, especially as it relates to voltage sags. Voltage sags are the most common power quality phenomena in most facilities, and result in process problems ranging from decreased quality of the product to a complete shutdown with a lengthy restart time.

The key to using this method is in two charts that are developed and then overlaid on top of each other. Figures 1, 2, and 3 show how this method is carried out. The first step is monitor a site for typically a month or longer. It would be useful to conduct the survey over different seasonal periods if applicable in your area, since lightning and ice storms can contribute significantly to the data. A histogram of number of occurances of voltage sags, along with their durations, needs to be generated next. Some of the power quality analysis software programs provide this feature, else it would need to be done by manually looking through the data and generating a table of such. The contour lines can be in whatever increments that are desired. The example here is in steps of 5 events per year. Dots are placed on the graph corresponding with the data collected and connected with contour lines, like a topographical map that civil engineers use when designing roads. In the example shown, this site is likely to experience 0-5 events per year of a voltage sag to 40% or less of nominal lasting 50 cycles or longer. Or, there is likely to be 5-10 events per year of a sag to 60% or less of nominal lasting 10 cycles or longer. Or, sags to 80% of nominal lasting 3 cycles are likely to occur 10-15 times per year.

The next step is to obtain data from the equipment manufacturer on the susceptibility of the equipment in similar terms. For example, the relay shown in Figure 2 will drop out if there is a sag below 75% of nominal lasting 2 cycles or longer, whereas the PLC will drop out or mis-operate with a sag below 47% of nominal for 37 cycles or longer. This clearly shows that the PLC is far more tolerant of sags that the relay (contrary to some people's intuition). Note that the photo-eye, often used as an emergency safety shut-off in stamping presses or cutting machines, will drop out with just a 1 cycle sag to 87% of nominal. Hence, the PLC and other equipment has no problem running during such an event, yet the safety stop would malfunction, shutting down the process.

The final step is to overlay the two graphs, as in Figure 3. This shows the probability of the specific equipment having a problem in this particular electrical environment. The relay is likely to experience problems 25-30 times per year, whereas the PLC is only likely to see sags that would affect it 0-5 times per year. The photo-eye may be shutting down the process more than 70 times a year.

If the cost of the downtime is calculated, now there is a method to assign the economic impact of such, and justification for taking steps to prevent such needless losses in productivity and profit. It is as easy as 1 - 2 - 3, with IEEE 1346 in your toolbox.

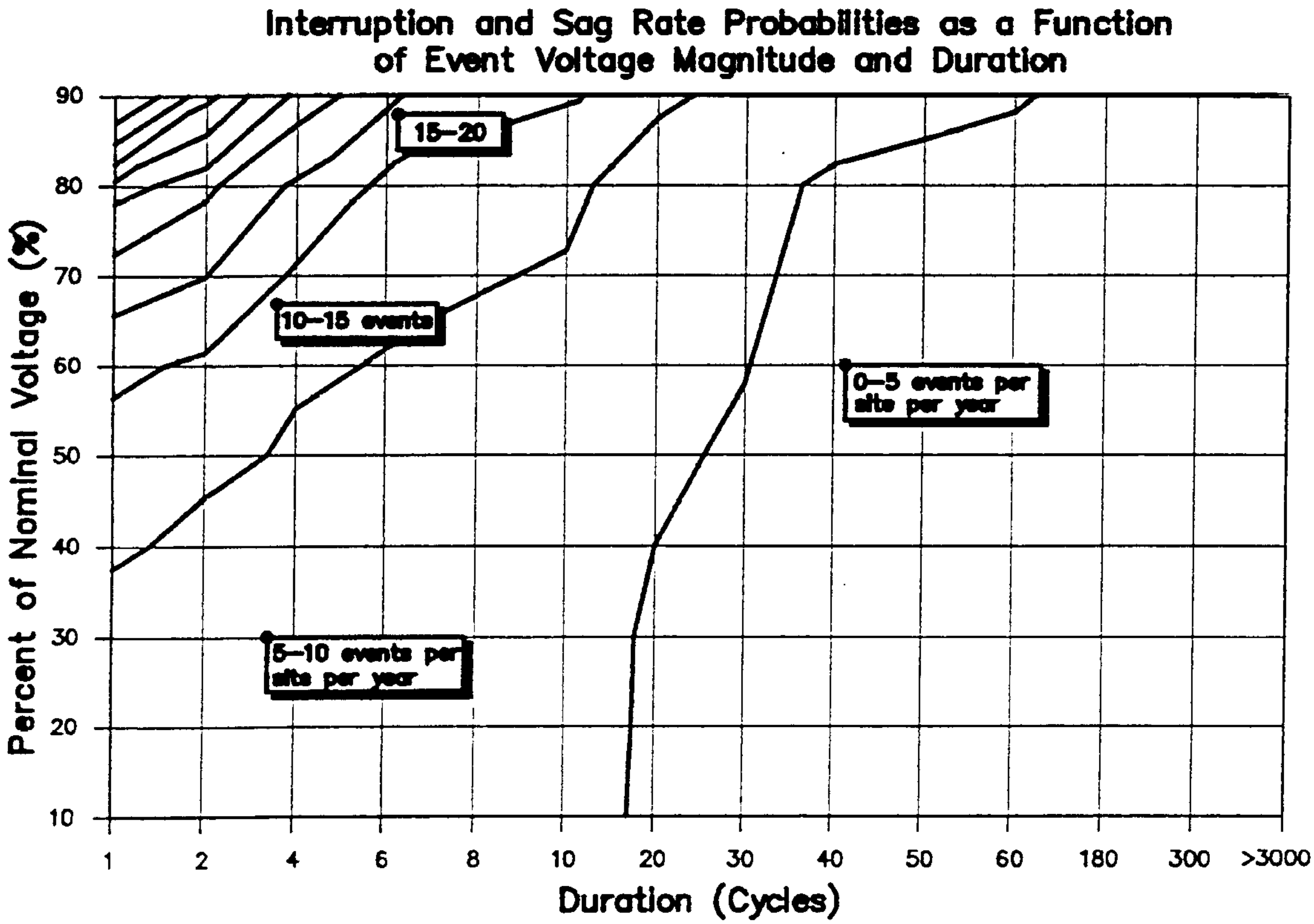

Figure 1. Probability of Voltage Sags (and Interruptions) by Magnitude and Duration

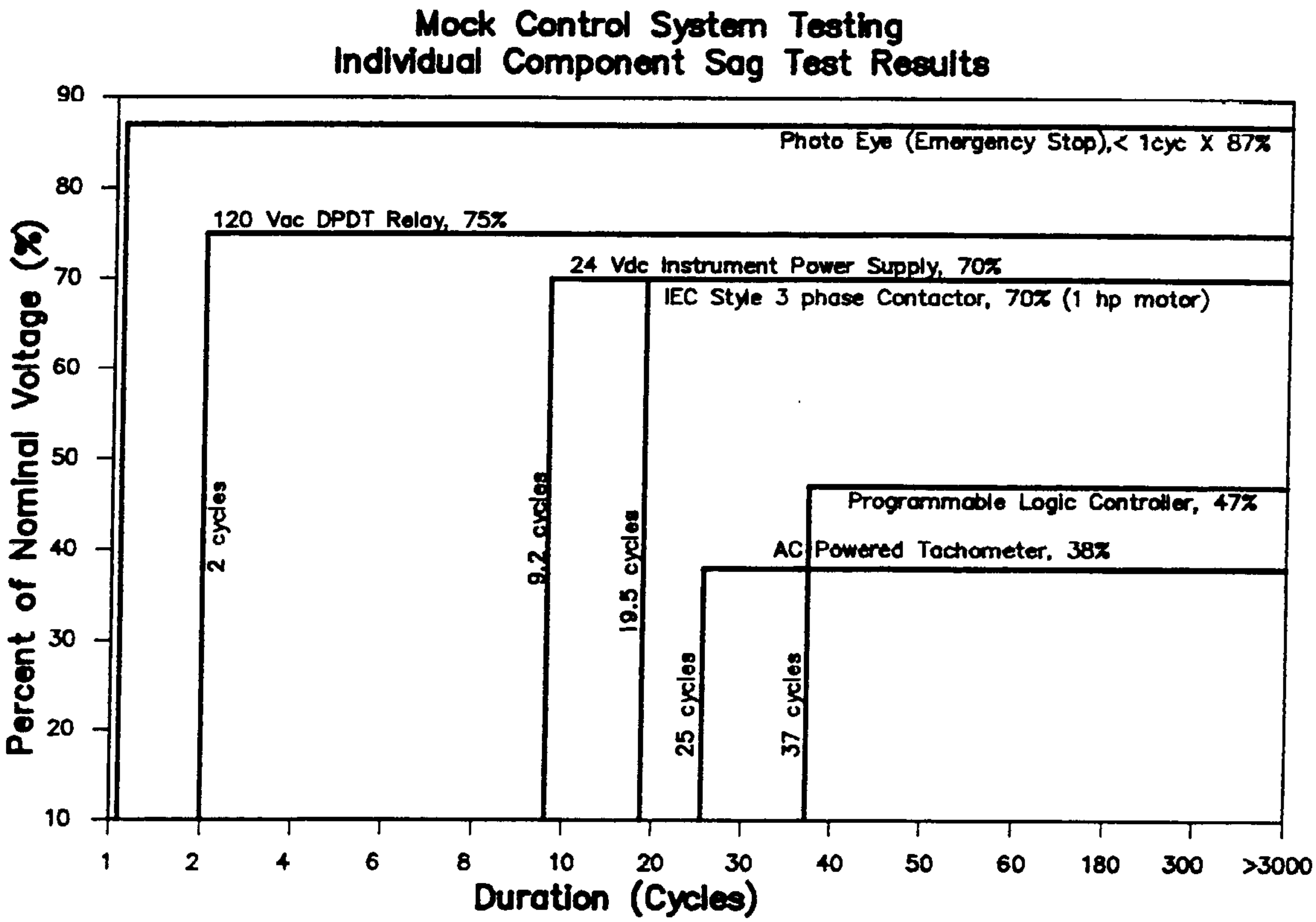

Figure 2. Different Equipment's Susceptibility vrs Magnitude and Duration of Voltage Sags

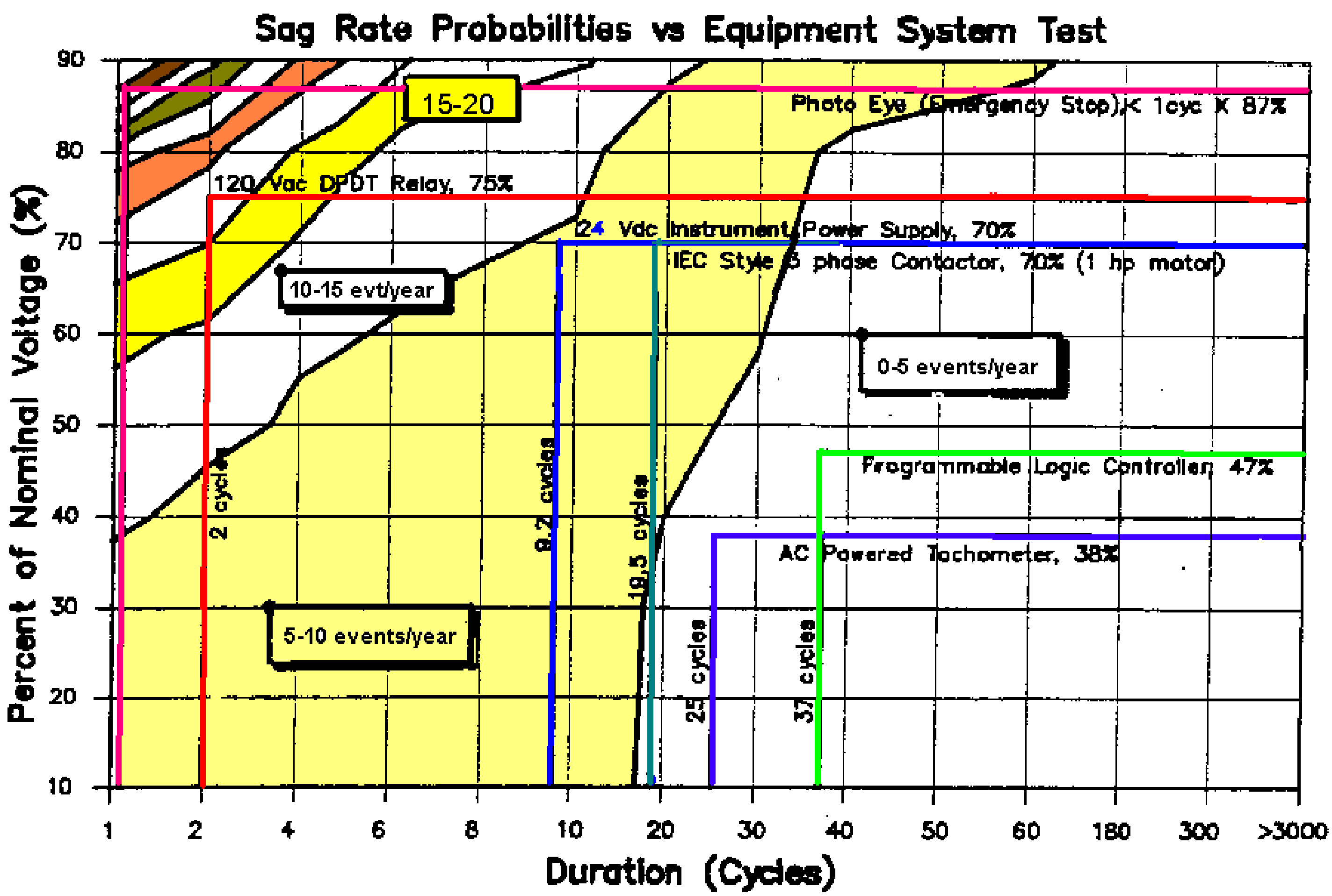

Figure 3. Overlay of Equipment Susceptibility with Voltage Sag Probability.