How often may a shutdown happen due to external disturbances?

To address this question, we should first examine what can potentially cause these unexpected shutdowns.
Voltage disturbances, as the most common cause of unexpected shutdowns, involve fluctuations in voltage quality that cannot be described using the same temporal patterns and statistical distributions typically used for steady-state voltage quality features. These variations occur randomly, and each occurrence may have an impact on customer facilities.

Many utilities worldwide report the reliability performance of their power systems, often using the System Average Interruption Frequency Index (SAIFI). For power systems in developed countries, the average SAIFI levels usually range from 0.5 to 5.0 interruptions per year. These levels depend on factors such as weather conditions, the functional condition of the feeders and upstream substations, the presence of underground or overhead systems, networked or radial systems, and more. SAIFI represents the number of times customers experience actual power interruptions each year, typically defined as interruptions lasting more than 5 minutes.

In the United States, the average SAIFI stands at approximately 1.3 interruptions per year. It's important to note that this index is often adjusted to exclude "major events" that impact a substantial portion of the system. The purpose of this adjustment is to assess the system's performance concerning events that could potentially be prevented through system investments and maintenance.

Voltage Sags & Momentary Interruptions

Facility operations can be impacted by more than just prolonged interruptions. Even momentary voltage sags, lasting less than 100 ms, can often disrupt susceptible equipment and operations. An example illustrating this is shown in Figure 1. Even though the impact of these disturbances can be similar to that of long-duration interruptions, they are more significant due to their higher frequency of occurrence. These disturbances typically result from faults on both distribution and transmission circuits. The interconnected nature of the system means that faults occurring far from a facility can still lead to a momentary voltage sag that might be significant enough to affect operations.
Many utilities are unable to provide customers with information regarding the expected number of voltage sags a customer is likely to encounter. EPRI conducted a comprehensive benchmarking project that yielded an estimate for the average number of voltage sags experienced by customers on distribution systems throughout the United States.

To convey the findings of this extensive benchmarking project, a new index was developed to describe voltage sag performance, known as the System Average RMS (Variation) Frequency Index (SARFI). This index quantifies the average number of voltage sags a customer experiences each year with a specific characteristic. For SARFIx, the index covers all voltage dips where the minimum voltage falls below x. For instance, SARFI70 represents the anticipated number of voltage sags where the minimum voltage is less than %70 of the nominal value.

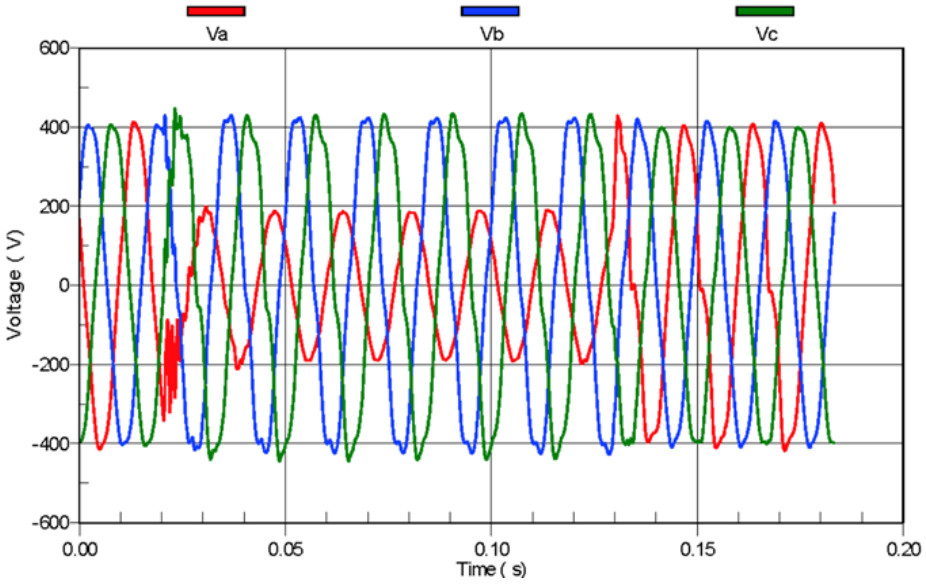

Figure 1: an actual disturbance that caused an outage in a plastics production company. [1]

The choice of an appropriate SARFI index for a facility depends on the sensitivity of the equipment within that facility to voltage variations. Gathering this information often requires extensive monitoring and evaluation of equipment responses to real disturbances.
For example, in the United States, the average number of voltage sags per year with a minimum voltage below %70 is approximately 18 events. However, if equipment can be affected by a voltage sag with a minimum voltage of %90 (considered a very minor voltage sag), then the number of events per year increases to about 50. Clearly, the sensitivity of the equipment is a crucial factor in determining the significance of these disturbances.

Our power conditioning solution can help your facility mitigate the impacts of these sags and significantly reduce the frequency of such occurrences. Please visit our website and feel free to contact us for further information.

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[1] IEEE Std 2011-1250 , IEEE Guide for Identifying and Improving Voltage Quality in Power Systems