Equipment reliability doesn't equal system reliability

The future of your electrical system's health rests in maintenance. A pragmatic approach is best to avoid potential shutdowns while ensuring everything runs smoothly.

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10/13/2016

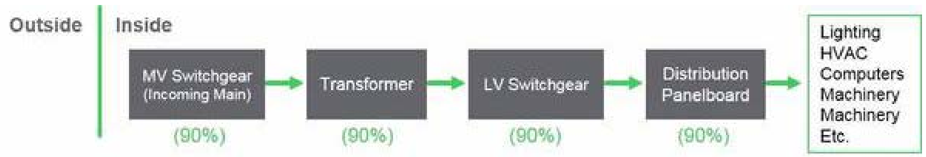
The reliability of power systems varies greatly from site to site and from business to business. Operations teams work with dissimilar quantities and qualities of electrical equipment, support different mission critical processes, and pursue diverse maintenance strategies. Nevertheless, it is prudent to take into account the specific power issues of a site and determine how reliable the system is and how reliable it needs to be.

When determining system reliability, it is important to not confuse the reliability of individual electrical components with the reliability of the electrical system as a whole. Overall *system* reliability is only as good as its weakest link. Operations personnel can easily be misled if they focus on the reliability statistics of individual components. This false sense of security increases the risk of unplanned downtime.

Consider the following examples:

- Assume a simple electrical system configuration consisting of a transformer that is 90% reliable and switchgear that is 90% reliable. The reliability of this mini "system" is actually 81% (0.9 x 0.9).
- Or assume a system consisting of a transformer at 90% reliability, switchgear that is 90% reliable and a distribution panel at 90% reliability. This system's reliability is only 73%.
- Or, even more alarming, a transformer at 90%, switchgear at 70% and a distribution panel at 70%. Such a system would equate to 44% reliability.

Why is the system reliability always significantly lower than the individual component reliability?



Reliability is a property of an electrical power system that describes the likelihood that the system will operate or perform as designed, constructed and intended. Reliability is determined from the combination of failure rates of individual components and the configuration of the power system to which they are applied.

The notion of reliability is more of a mathematical probability than an actual physical condition. Electrical reliability is measured by its trouble-free time. For example, if a piece of equipment is designed and intended to continuously operate "X" years and it does, it is 100% reliable to "X" years. After that point in time, if there is an occasional breakdown, the reliability beyond the stated time is less than 100%.

Lowered reliability, especially in the realm of electrical systems, increases the risk of both employee safety and of downtime-related lost business productivity.

Therefore, it is prudent to build reliability enhancement investments into the annual operational expense (OPEX) budget. Such a budgetary line item should include three essential elements: electrical infrastructure assessment (evaluating the state of affairs), recalibration of maintenance strategy (last year's strategy may not be relevant to this year's requirements) and upgrade of low reliability or aging/obsolete assets (upgrading equipment that may be on the verge of failing).

Power assessment of existing infrastructure

Facility managers may be unaware of the current reliability state of their electrical power sub-systems unless maintenance and test inventory data on all equipment is complete and readily available throughout the equipment's service life.

If documentation is unavailable or outdated, management may consider having a power system assessment performed by a professional engineer. This assessment determines the present state of electrical system, its associated equipment, its functionality and its reliability relative to the present needs of a facility's functions and operations.

The assessment should be performed by a registered professional engineer with in-depth experience surrounding the design, operation, maintenance, safety and reliability of AC and DC power systems and equipment. During an assessment, a facility's risk is determined by a combination of the following four factors:

1. The impact of a power event on critical business processes
2. The safety hazard threat to electrical workers
3. The probability of a power event occurring
4. The ability of the organization (or supporting vendors or partners) to quickly correct the negative effects of the power event.

Re-examination of the maintenance strategy

Over time, electrical equipment can break down for several reasons. One is mechanical failure. Another is the environmental conditions of the site. Human error also plays a factor (the less humans have to touch the equipment, the better). But in deciding on how to formulate an up-to-date maintenance strategy, how much maintenance is enough? And what type of maintenance should be performed?

Look for the optimal blend of maintenance strategies that meet reliability and availability requirements at the lowest cost. Here are some of the common options:

Reactive maintenance

In a reactive or corrective-based maintenance approach support is only brought in to address an unanticipated problem or emergency. If a component breaks down, a technician is called in to service it. This approach is not advisable for any components that are linked in any way to critical systems and is the most expensive of all maintenance strategies.

Proactive maintenance

Preventive or "scheduled" maintenance is a very common proactive maintenance method. This type of maintenance approach is characterized by routinely performed maintenance (regardless of the equipment's condition). In some cases, maintenance may be unnecessary but is nevertheless performed on a regular time schedule. Preventive maintenance is a less expensive option than reactive maintenance but more costly than predictive maintenance.

Predictive or condition-based maintenance is another proactive maintenance approach that is scheduled. But that schedule is not based not on time intervals. Instead, the results of diagnostic evaluation drive the maintenance. Elements such as equipment age, environmental stresses, criticality of equipment and utilization are the determining factors.

These maintenance strategies, however, are often associated with maintenance of individual components. As we have seen, system reliability is more important than component reliability.

Reliability-centered maintenance

This brings us to the most advanced approach to maintenance: reliability-centered maintenance (RCM). Properly designed and executed, RCM takes a systems view as opposed to an equipment or a component view. This approach prioritizes the maintenance expense on critical vs. noncritical functions and integrates preventive maintenance, predictive testing and inspection and run-to-fail maintenance strategies to meet business objectives.

An ongoing process, RCM gathers performance data to improve equipment design and enables management to make more informed future maintenance decisions.

Take a pragmatic approach

A common rule of thumb for electrical infrastructure equipment is to consider upgrading if the equipment in question is over 15 years old. For equipment under 15 years old, select the most appropriate maintenance approach.

However, upgrade planning should not be random. Shutdowns should be avoided if possible, and the upgrade plan should be developed around equipment performance data. Are the components in question supporting critical or noncritical functions? If critical, the reliability and integrity of that equipment should be preserved at all costs.

Often, equipment upgrades are a cost-effective alternative to purchasing new equipment. In the case of low- and medium-voltage switchgear, aging or obsolete circuit breakers can be directly replaced with new circuit breakers, leaving the existing switchgear structure and footprint intact. The new direct replacement circuit breakers are designed to fit into the existing cubicle with little to no downtime since there is minimal (if any) outage to the equipment bus.

Another switchgear upgrade option, a retrofill solution, involves modification of the internal circuit breaker cell to accept the new circuit breaker. In these cases, a bus outage is required for the modifications to take place. The retrofill approach is often used in lieu of the direct replacement option for larger devices, such as main circuit breakers and tie circuit breakers.

In both cases, the line-up is brought to current technology utilizing OPEX funds.

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