The Importance of Upgrading Older Cap Banks!

As an inexpensive source of reactive power, capacitor banks bring many benefits to a facility. They are widely deployed to avoid penalties on utility bills, lower distribution losses, increase transformer/Genset capacity, maintain nominal voltage, and to reduce energy losses resulting in decreased carbon emissions. When coupled with reactors, capacitor banks can filter harmonics generated by Variable Frequency Drives (VFDs) and other non-linear loads that otherwise distort both voltage and current waveforms. This helps reduce the risks of premature insulation breakdown in motor windings and transformers, excessive heating, nuisance tripping of circuit breakers, and operational problems with sensitive equipment.

Capacitor banks often operate reliably for years and it is not uncommon for organizations to lose awareness of the equipment's age or condition, and experience unexpected and painful end-of-life failures. This note discusses the risks and mitigation strategies to promote reliable long-term operation.

Electrical network conditions and capacitor bank life expectancy

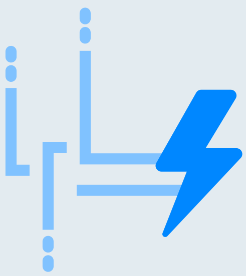
Capacitor banks typically have a design lifetime of 20+ years, but in-service deviations from the specified operation conditions can significantly reduce operational life and result in premature failures. Examples of such deviations include:

- High operating temperatures and harmonic levels which accelerate the aging of the capacitors and electronic components
- Resonance conditions which cause insulation breakdown inside the reactors and amplify harmonic currents
- Fluctuating loads which trigger frequent capacitor step switching and increase switch wear and electrical and thermal stress on the capacitor
- Neglect of maintenance and operation testing e.g. exhaust and intake air filters, wiring, terminal, and fuse integrity, contactor locking, and capacitor degradation

These adverse operating conditions often evolve over time and may provide no obvious early indication of problems until a surprise in-service failure. Operators should therefore take a proactive approach, scheduling annual or semi-annual maintenance to avoid unexpected failure.

Typical consequences of an unexpected end of life failure

Facilities managers and service providers should always be aware of the consequences for their operation if a capacitor bank fails. These can range from disrupted operations, expensive and unbudgeted repair or replacement costs, utility penalties, and other operational risks:



Operational Disruption

Capacitor bank failure can halt plant operations, or cause sensitive equipment to trip or fail, due to:

- Sustained or intermittent network voltage drop cause by reactive loads e.g. high-reactive current motor starts leading to tripping of VFDs and plant control systems
- Reactive power overload of network wiring, fuses, transformers, or gensets

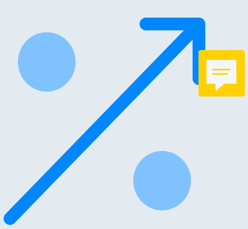
Extended Downtime

Surprise failure of unmaintained, aging equipment often results in extended downtime, even up to several months, due to:

- Long leader times for previous-generation replacement parts, or for specifying and integrating modern substitutes
- Potential need for system redesign or augmentation, with associated permitting, budgetary, manufacturing, installation and commissioning lead times to address the root cause of failure e.g. unplanned load growth
- Maintenance technician availability

Extended downtime may subject the operator to utility power factor or harmonic emission penalties until the situation is corrected

If still operational, the plant may be operating at sub-optimal voltage and excessive harmonic levels during the outage, with consequences for equipment efficiency and reliability, and for plant capacity, all or which mean increased operational costs for less productivity



Higher operational costs

Disrupted production and the typically unbudgeted equipment and labor costs of a surprise failure and recovery, often result in lower revenue and increased operating costs which are generally out of all proportion to the cost of mitigating these risks

CASE STUDY

18-year-old capacitor bank unexpectantly failing powering down the site, causes $50k a month in utility penalties.

A large food packager in the central US experienced dual reactor failures inside its 5 MVAR and 4 MVAR, 4.16 kV capacitor banks. Installed in 2003, these banks had operated reliably up to the point, maintaining power factor above the threshold demanded by the local utility.

When the unexpected failure occurred, personnel took immediate action to order replacement reactors. However, when the time came to perform the replacement, the additional failure of the main incoming switch led to major damage. Following the standard procedure, the contractor opened the incoming main switch to remove the feeding power and closed the ground switch as a safety precaution. Unfortunately, the incoming switch's spring mechanism failed to disconnect the power, resulting in a line-to-ground short circuit causing significant damage to the main switch (figure 1) and other components. The short circuit also triggered the feeder breaker to open at the utility substation, powering the site down and stopping production for 8 hours.


Figure 1 – Image of failed incoming switch

Given the extent of the damage, repairing the banks was no longer a viable long-term solution. The operator was forced to replace the two banks, which took six months during which the company incurred $50k per month in power factor penalties.

A proactive approach to replacing a capacitor bank is highly recommended

High quality capacitor banks are often the most cost-effective solution for power factor and harmonic-related technical issues and to avoid utility penalties. While the design lifetime is 20+ years, the actual and evolving operating environment and the lack of routine maintenance can accelerate aging and lead to premature failure. It is recommended that facility managers and service providers closely track capacitor bank performance, execute preventative maintenance regularly, and plan their upgrade or replacement proactively before an end-of-life failure brings disruptive and expensive consequences.