TECH TALK
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ALLIANZ GLOBAL CORPORATE & SPECIALTY®

CAPACITOR BANKS

ALLIANZ RISK CONSULTING

This Tech Talk discusses potential fire and explosion hazards with capacitor banks and Allianz Risk Consulting (ARC) recommendations to prevent property damage and business interruption losses.

AT-A-GLANCE

- Capacitor banks can present fire and explosion hazards.
- Depending on their location, a significant business interruption (BI) exposure may exist.
- Several fire/explosion losses have occurred in the last few years with Allianz Global Corporate & Specialty clients.

INTRODUCTION

Capacitors improve the power quality and help to better manage the electrical power with cost optimization. They are used to generate or absorb reactive power. Capacitors accomplish this without important real-power losses or operating expense. The output of capacitors is proportional to the square of the voltage. For example, a capacitor bank rated at 1 megavolt amperes reactive (MVAR) will produce (or absorb) only 0.9 MVAR when the voltage sags/dips to 0.95, but it will produce (or absorb) 1.10 MVAR when the voltage rises to 1.05.

Reactive power management in an electrical power system is important for proper operation of electrical equipment to prevent damage, such as overheating of generators and motors. It is also important to reduce transmission losses and to maintain the ability of the system to withstand and prevent voltage collapse. A voltage collapse occurs when the system tries to serve much more load than the voltage can support.

Reactive power management is needed due to the type of electrical devices connected to the local electrical power network (i.e., motor, battery chargers, electronic ballasts, variable frequency drives, switching mode power supplies, etc.) and due to the electrical supply itself.

Capacitor banks are passive devices that are composed of individual capacitor cans, typically 200 kilovolt amperes reactive (KVAR), that are connected in series and/or parallel. The characteristics are the capacitor-bank voltage and the capacity rating.

FIRE & EXPLOSION HAZARDS

WHAT MAY CAUSE PROBLEMS FOR CAPACITOR BANKS?

- If the ventilation is not adequate to provide proper cooling, capacitor banks can overheat and fail.
- If the electrical connections are not properly secured, loose connections can increase electrical resistance causing overheating.
- If the equipment is used on a daily basis or if the installation has not been well designed, an anticipated aging may occur. The main consequences are that the capacitor banks lose their characteristics, which will increase the Joule Effect (also known as ohmic or resistive heating) and may cause overheating. This overheating will accelerate the aging of the equipment, which becomes a vicious circle.
- If the capacitor banks are not electrically controlled, the potential voltage difference increases, which may create an overvoltage when the load of the electrical power is reduced, for example, during nights or weekends when there is less demand.
- Some construction defects have been observed in recent years.
- It is common that the design or characteristics needed are not completed according to the best engineering practices, which may lead to one of the previous situations.

WHY DO CAPACITOR BANKS BURN OR EXPLODE?

- As with many electrical devices, capacitor banks are primarily made of plastic pieces that are combustible.
- Some capacitor banks are filled with a liquid impregnating agent. Some of these liquids may be combustible (classified as Class IIIB according to the National Fire Protection Association's Flammable and Combustible Liquids Code – NFPA 30). In case of improper design or use, the temperature will increase and flammable gases may be created by decomposition of the liquid. This could lead to an explosion or a leak of the combustible impregnating agent.

ARC RECOMMENDATIONS

The following recommendations are based on best engineering practices and should be considered after a hazard analysis is completed based on the potential loss. Please contact your local ARC representative to discuss your specific installation.

CAPACITOR BANK DESIGN

1. Dry capacitor banks are preferred over liquid-filled types to reduce the fire and explosion hazards of the equipment, even if there is an additional cost.
2. Provide controls to regulate the number of capacitor banks used to reduce the overvoltage hazard.
3. Take into account the harmonics when calculating the design. If needed, harmonic filters should be installed.
4. Install capacitor banks with adequate overload protection devices, such as fuses, circuit breakers, overload relays or contactors. An overcurrent may appear in case of overvoltage or high harmonic distortion. The installation of fuses will significantly reduce the explosion hazard, however, keep in mind that the energy stored can be enormous and the explosion hazard still exists.
5. Protect the capacitor banks with a circuit breaker or fuse with a rated current calibration between 165% and 250% in case of internal short-circuit.
6. Provide adequate automatic cool down of the equipment or adequate ventilation.
7. Provide adequate lightning protection.
8. Ensure that the residual voltage of the capacitor bank can be reduced to 50 V nominal or less within one minute after the disconnection of the electrical supply. The capacitors must have a means of draining the stored energy, such as through a suitable resistance.

INSTALLATION

9. Capacitor banks installed inside their own metal cabinet are preferable to reduce the risk of hazardous projectiles if there is an explosion of the equipment. If not installed inside metal cabinets, install wire fencing around the equipment.

10. Provide at least 2.4 m (8 ft.) separation distance between each capacitor bank to prevent abnormal operation of one bank from impacting another.
11. Locate the electrical equipment in a 2 hour fire-rated technical room located on the ground floor with safe access for emergency responders. Provide self-closing, 1½ hour fire-rated doors to protect room openings. An alternative to self-closing fire doors is to install a supervising alarm triggered when the door remains open.

MAINTENANCE

12. Conduct annual recorded thermographic inspections of capacitor banks using an infrared imaging system to detect abnormal operating temperatures. All deficiencies should be corrected promptly.
13. Replace the equipment before the mean time between failures (MTBF) communicated by the supplier due to the poor aging of this type of equipment.
14. Measure the temperature during the operation of the equipment (e.g., monthly if the equipment is operating 24/7). This may be accomplished by a temperature sensor placed near the equipment that transmits an alarm to a constantly attended location when the temperature is above 55°C (131°F). Another way could be to check the temperature with an infrared imaging system while the equipment is operating.

FIRE DETECTION AND PROTECTION

15. Install an automatic smoke detection system in the technical room with an alarm transmitted to a constantly attended location installed according to the latest edition of NFPA 72, *National Fire Alarm and Signaling Code*, or equivalent standard (i.e. VdS, APSAD, LPC, etc.).
16. Install an automatic fire sprinkler system in the technical room according to the latest edition of NFPA 13, *Standard for the Installation of Sprinkler Systems*, or an equivalent standard (i.e. VdS, APSAD, LPC, etc.).

Capacitor banks installed inside their own metal cabinet are preferable to reduce the risk of hazardous projectiles if there is an explosion of the equipment

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REFERENCES

NFPA Fire Protection Handbook, 20th Edition, Section 8, Chapter 13 – Electrical Systems and Appliances

NEMA Standards Publication CP 1-2000 (R2008), Shunt Capacitors

QUESTIONS OR COMMENTS?

PLEASE CONTACT:

Nicolas LOCHET
Regional Technical Manager
Allianz Risk Consulting
+33.607.798.412
nicolas.lochet@allianz.com
www.agcs.allianz.com

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Tech Talk is a technical document developed by ARC to assist our clients in property loss prevention. ARC has an extensive global network of more than 100 property risk engineers that offers tailor made, customer focused risk engineering solutions.

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