Electrical Switchgear and Switchboards

Electrical distribution equipment plays a critical role in continued business operations. Switchgear, switchboards, and subpanels contain essential components which provide control, isolation, and protective functions. Failure to monitor and maintain this equipment may result in equipment damage, unscheduled downtime and possibly personnel injury.

Safeguards and Controls

The following controls, protective devices and features are commonly found on electrical distribution equipment:

- **Overcurrent Protection**: Properly designed and installed overcurrent protection is a safeguard against excessive currents or current beyond the acceptable current rating of the equipment. Overcurrent conditions may cause overheating or arcing damage to electrical equipment. Magnetic circuit breakers, fuses, and overcurrent relays are commonly used to provide overcurrent protection.
- **Ground Fault Protection**: Ground fault protection devices are designed to provide equipment protection from the effects of a phase-to-ground fault. Electrical arcing events frequently start as ground faults, especially those caused by moisture. When the ground fault current magnitude and time reach the ground fault relay pick-up setting, the device signals the circuit disconnect to open and electrically isolate the equipment. In a properly coordinated protection system, ground fault protection will isolate the circuit before an overcurrent condition can occur.
- **Phase Unbalance Protection:** Phase unbalance protection devices are used to detect and protect equipment from a voltage mismatch between the phases in a three-phase system. These devices inherently may offer overvoltage and undervoltage protection features as well. Single phasing has the potential to adversely affect rotating electrical equipment by causing overheating, arcing, burning out of motor windings, or a chain reaction of electrical failures.
- **Transient Voltage Protection:** Transient voltage protection, otherwise known as “surge protection”, is used to safeguard sensitive electronic components, such as programmable logic control (PLC) cards and computers, which could be damaged when subjected to a sudden voltage rise.
- **Short circuit and coordination studies**: Are critical for the safe, efficient, and economical operation of any electrical distribution system. A short circuit study can determine the theoretical maximum current value should a worst-case scenario electrical fault occur. The results of this study can help to ensure that equipment is protected by establishing proper circuit interrupting ratings. A coordination study maximizes power system flexibility by isolating faults to the nearest protective device, helping to avoid unnecessary service interruptions. These studies should be updated whenever changes are made to the electrical systems that may impact the validity of the previous studies.

Other electrical protective devices such as undervoltage, overvoltage and reverse power relays and trips can be installed in switchgear to reduce the risk of electrical breakdown from power quality issues or for specific applications. A qualified electrical engineer experienced with electrical distribution system protective systems should be consulted to determine the appropriate devices for each specific application.

Maintenance Guidelines

Establishing a formal preventative and predictive maintenance program can assist with identifying potential problem areas and associated risks while minimizing downtime. It is recommended that the following practices be incorporated into your regular maintenance program. The following maintenance activities should be performed by a qualified operator or technician. Additional guidance may be obtained from the original equipment manufacturer (OEM).

Preventative Maintenance:

- **Insulated case and molded case circuit breakers:** The following activities should be performed annually:
  - Breakers should be exercised by opening and closing them several times.
  - Enclosures should be opened for cleaning and general inspection.
  - Bolted connections should be checked for tightness and re-torque as needed.

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  - Trip settings, including long-time, intermediate, short-time, instantaneous, and ground fault, should be tested according to manufacturer's instructions (where adjustable trip settings are installed).

- **Fused switches / fused disconnects:** Every three years the switch or switchboard should be de-energized and the following actions completed:
  - Manually exercise each switch two or more times to check operation; visually inspect to check contact or blade alignment, condition of the phase barriers, and indicating devices.
  - Clean and inspect the equipment and lubricate applicable components according to the manufacturer's instructions.
  - Check bolted connections for tightness and re-torque as needed.
  - Check fuse holders for corrosion and tightness.
- **Draw-out circuit breakers**: The following maintenance and testing should be performed every three years:
  - Draw out breakers for cleaning, inspection, and lubrication according to the manufacturer's instructions.
  - Check contacts for excessive wear, corrosion and alignment.
  - Check arc chutes for damage or cracking.
  - Exercise breakers by trip testing while the main contacts are de-energized.
  - Test the trip functions according to the manufacturer's instructions for long time, short time, instantaneous and ground fault trips.
- **Electromechanical and electronic relays**: Relay calibration may degrade over time and may not function as intended when needed to provide a protective action. Protective relays and associated circuits should be properly maintained, tested, and calibrated to help ensure proper protection of switching equipment and distribution systems. Protective relays should be tested on the following frequencies:
  - Bench test and re-calibrate protective electronic relays on electrical distribution systems and generators every 7-10 years depending on the manufacturer's guidelines.
  - Bench test and re-calibrate protective electromechanical relays on electrical distribution systems every 2 to 5 years.
  - Bench test and re-calibrate protective electromechanical relays on generators every 1 to 3 years.

For all maintenance activities, refer to the OEM's instructions and guidance, and contact the manufacturer with any questions. Keep a detailed record of equipment tests to help identifying potential issues that can develop over the life the equipment.

Predictive Maintenance

Thermographic inspections may detect incipient electrical faults that can be corrected before the fault becomes catastrophic. Switchgear, switchboards, and other critical electrical devices should be scanned using an infrared thermographic imager at least annually. This inspection should be conducted by a technician qualified to interpret the results. It is important to note that switchgear covers may need to be removed to properly perform a thermographic survey. Certified technicians or personnel should perform these tasks.

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