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5.8.1 Power Systems Analysis

Analysis of electrical power systems may uncover energy waste, fire hazards, and impending equipment failure. A well-executed analysis requires planning and lays the foundation for ongoing reliability-based maintenance.

Opportunities

The best time to initiate preventive maintenance on electrical systems is before failures occur. Regular maintenance will help uncover hidden problems, allow timely repair, and avoid the unexpected disruption of system failure. In a new facility, maintenance should begin from the outset. In existing facilities, it is never too late to start a regular electrical system maintenance program.

Technical Information

"Tune-ups" for electrical power systems yield both direct and indirect efficiency improvements, and they can increase the reliability of equipment. Direct improvements result from correcting leaks to ground and cutting resistive (I^2R) losses in the distribution components. Indirect improvements result from improving the efficiency of equipment that previously operated with poor quality input power, such as three-phase motors operating with phase-to-phase voltage imbalances.

Establish a preventive maintenance program that includes good recordkeeping. The following procedures should be followed when possible:

- Document system components and electrical loads. Start with available drawings and other documentation. Update this documentation to "as-built" and keep files current.
- Inspect components, noting discoloration, deformation, damage, hot odors, noise, or vibration.
- Manually operate all switches and disconnects on a monthly schedule to help eliminate corrosion.
- Conduct a regime of electrical tests designed to identify actual and potential problems. This may include contact condition assessment with a voltage-drop survey, infrared thermography, power factor assessment, or voltage assessment to determine imbalances and deviations from target voltages.
- Consider a proactive maintenance program with the predictive elements discussed in *Section 5.8 – Electrical Power Systems*.

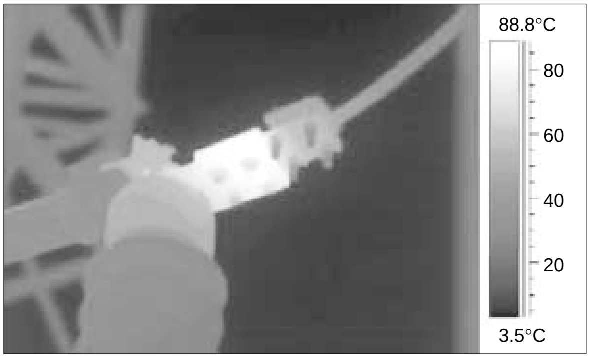
When conducting electrical assessments, be aware of varying conditions. Power quality may change greatly at night or at other times because of changes in loads.

$ Facility managers increasingly find that reliability-centered maintenance can save money, reduce energy consumption, and reduce downtime. A lumber/plywood facility in Oregon projected $125,000 in potential savings by instituting an electrical system preventive maintenance program. Estimating *actual* savings is difficult, however, because of the uncertainty about when failures will occur, what equipment will be damaged, and how long problems will last.

References

IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (ANSI/IEEE Standard 242-1986), Institute of Electrical and Electronics Engineers, 1986; Publications Office, Los Alamitos, CA: (800) 272-6657; www.ieee.org.

Keeping the Spark in Your Electrical System: An Industrial Electrical Distribution Maintenance Guidebook (WSEO 93-15), Washington State Energy Office, Olympia, WA, 1995.



Source: FLIR Systems

Infrared thermography can quickly identify electrical power system problems and should be included in a proactive maintenance program. Apart from the costly inefficiency of wasted power, this faulty electrical connection would eventually have resulted in total failure once the melting point was reached.

TROUBLESHOOTING FOR POWER SYSTEMS

PROBLEM	COMMON CAUSES	POSSIBLE EFFECTS	SOLUTIONS
Voltage imbalances or differences between relative voltage levels among the three phases in all or part of a facility	Improper transformer tap settings, one single-phase transformer on a polyphase system, single-phase loads not balanced among phases, poor connections, bad conductors, transformer grounds or faults	Motor vibration, premature motor failure, energy waste (a 5% imbalance causes a 40% increase in motor losses)	Balance loads among phases.
Voltage deviations (voltages too low or high)	Improper transformer settings, incorrect selection of motors, e.g., a 230/208 motor (which is actually 230-volt rated) on a 208-volt circuit	Reduced efficiency, power factor, and equipment life; increased temperature	Check and correct transformer settings, motor ratings, and motor input voltages.
Poor connections (may be in distribution or at connected loads)	Loose bus bar connections, loose cable connections, corroded connections, poor crimps, loose or worn contactors, corrosion or dirt in disconnects	Energy waste, heat generation, failure at connection site, voltage drops or imbalances	Use IR camera to locate hot-spots and correct.
Undersized conductors	Facilities expanding beyond original designs, poor power factor	Voltage drop, energy waste	Reduce the load through conservation load scheduling.
Insulation leakage	Degradation over time due to extreme temperatures, abrasion, moisture, chemicals, or use of conductor insulation inappropriate for conditions	Breaker trip failure, current leakage to ground or to another phase, variable energy waste	Replace conductors, insulators.
Low power factor	Inductive loads such as motors, transformers, and lighting ballasts; nonlinear loads such as most electronic equipment loads	Reduction in current-carrying capacity of wiring, voltage regulation effectiveness, and equipment life; increase in utility costs	Add capacitors to counteract reactive loads (see *Section 5.7.3 – Power Factor Correction*).
Harmonics (nonsinusoidal voltage and/or current wave forms)	Office electronics, telephone PBXs, uninterruptible power supplies, variable-frequency drives, high-intensity discharge lighting, and electronic and core-coil ballasts	Overheating of neutral conductors, motors, transformers, switch gear; voltage drop, low power factors, reduced capacity	Choose equipment carefully. Isolate sensitive electronics from noisy circuits.