Maintenance Guidelines for Electrical Equipment

Introduction

Electric power is the lifeblood of any manufacturing plant or commercial operation. However, because of the general high reliability of electrical systems and the fact that deterioration in these systems is often silent and hidden, maintenance of electrical equipment is easily ignored. Some components such as circuit breakers may not be required to operate for years, but once a fault occurs, their proper operation is vital to minimizing plant damage and downtime.

Only periodic maintenance, inspection and testing will keep your electrical system operating at a high level of reliability. Through many years of working with our clients and investigating equipment breakdowns, Travelers Boiler and Machinery Division has developed electrical maintenance guidelines based on industry-accepted standards and our many years of experience. The industry standards used in the compilation of these guidelines are NETA MTS, NFPA 70B and a number of Institute of Electrical and Electronic Engineers (IEEE) standards. While it is difficult to address all types of equipment and take into account the wide variety of applications and operating conditions, these guidelines provide a baseline that can be used to develop an effective maintenance program. These guidelines, which begin on the following page, should not supplant maintenance recommendations supplied by the equipment manufacturer. Due to operating conditions and the process involved, more frequent and thorough inspections than recommended in these guidelines may be required. Longer intervals between inspections should only be considered after careful review of the system configuration and history of inspections and any past problems with the equipment. These issues should be discussed with your Travelers Risk Control consultant.

Note: The maintenance guidelines begin on the next page.

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Object	Evaluation frequency	Recommendations
Motors – AC	Annual	Check air gap clearances and adjust as needed Inspect foundations, base plates and mounting bolts Clean chamber and change oil on ring lubricated sleeve bearings Sample and test oil annually on forced lubrication sleeve bearings Inspect cooling system For motors with anti-friction bearings, lubricate to manufacturer's specifications Perform dielectric absorption ratio or polarization index testing using a megohm meter and compare to previously recorded test results. The testing results in megohms and recorded temperature should be corrected to 40 degrees Celsius. Minimum values should be: 1. IR 1 min. = kV +1 for most winding made before 1970 2. IR 1 min. = 100 megohms for most DC armature and AC windings built after 1970 (from wound coils) 3. IR 1 min. = 5 megohms for most machines and random wound stator coils and form wound coils rated below 1 kV Note: do not perform over potential, high potential or surge comparison tests on winding having values less than the above minimums
Generators AC	Annual	Check air gap clearances and adjust as needed Inspect foundations, base plates and mounting bolts Clean chamber and change oil on ring lubricated sleeve bearings Sample and test oil annually on forced lubrication sleeve bearings Inspect cooling system For all air cooled AC generators, follow the guidelines above for AC motors Hydrogen-cooled generators: At the time of dismantled inspection, the PI test must be made at the neutral, after breaking the connections. If the PI test is satisfactory, (ratio of 2.0 - 5.0) perform a DC high potential test according to the guidelines in IEEE standard
Motors and generators (DC)	Annual Monthly	Condition of insulation – perform insulation resistance tests following guidelines given above for AC motors Check brush wear and tension, rigging of brushes and condition of commutator
Circuit breakers (All)	2 years	Check mechanical operation by opening and closing several times
Molded case circuit breakers with adjustable trip settings	3 to 5 years	Re-calibrate trip settings using test instrument recommended by manufacturer for testing the electronics
Draw out (metal frame) air circuit breakers (< 600 V)	3 to 5 years	Test and recalibrate trip mechanism on: Electromechanical trip units; Load test by primary current injection, and Solid state trip units; Use test set supplied to test electronics Programmed microprocessor trip units operate trip mechanism, actual trip setting is programmed in

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Draw out type air magnetic circuit breakers 2.4 to 15 kV	3 to 5 years	Draw out and remove arc chutes, inspect, clean, lubricate and repair Check contacts for alignment and measure resistance Check arc chutes for cracking and metal spatter Trip test breaker with the DC trip circuit to check opening time. Should be either 5 or 8 cycles according to the particular model. Repair or correct any items not to manufacturer's specification
Oil circuit breakers outdoor type	Annual By operations counter	Take an oil sample and test for dielectric strength, minimum 25 kV Per manufacturer's specified number of operations as recorded on the counter, disassemble and inspect internal contacts and operate mechanism – repair as needed to restore to manufacturer's specifications.
Vacuum circuit breakers indoor and outdoor types	3 to 5 years for indoor metal clad types Number of operations on counter for outdoor – as specified by manufacturer	Inspect, clean and repair trip mechanism as needed Trip test circuit breaker with the DC trip circuit. Check breaker opening time against manufacturer's specifications – usually one-half cycle. Vacuum bottles should not be connected to voltage source when trip tested due to X-ray hazard Check contact wear as indicated by the external wear indicators Check open contact resistance with megohmmeter and compare to manufacturer's specifications. This is an indicator of remaining life
Circuit breaker relays on distribution system	2 to 5 years	Remove from housing if electromechanical type and clean, inspect and repair as necessary, then conduct operational test and recalibrate Electronic types – recalibrate to manufacturer's instructions
Circuit breaker relays for generators	1 to 3 years	Remove from housing if electromechanical type and clean, inspect and repair as necessary, then do operational test and recalibrate Electronic types – recalibrate to manufacturer's instructions
Storage batteries for switchgear and other applications – lead acid types	Weekly Monthly	Visual inspection – check for cracks, leaks, excessive sediment and corrosion Use selected pilot cells to check voltage and specific gravity and check against manufacturer's specifications As needed, run equalization charging as specified by manufacturer Discharge testing is performed to manufacturer's guidelines to determine true capacity. Perform this test if other test results show adverse results
Medium voltage conductors and cable	On installation, then for underground installations, after 6 months, then every 5 years	DC step voltage test as per manufacturer's recommendations or to guidelines in ANSI/IEEE For medium voltage cable not installed underground, test when installed and when condition is suspect

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Switchgear bolted connections, load centers, motor starters, transformer terminals	Annual	Thermographic survey to determine hot spots due to loose connections, overload, uneven loading of phases, etc.
Short circuit calculations and relay coordination	During original design process and when planning major changes in electrical system	The short circuit calculations determine the proper rated interrupter for the short circuit current available. The relays are set at the values specified so that the interrupting device nearest to the fault disconnects the fault from the system without affecting the rest of the system
Spare parts	Monitor continuously	As recommended by manufacturers and Travelers to maintain production
Preventive maintenance program	Monitor continuously	Consists of monitoring all equipment for periodic maintenance by using a simple system, such as card files with monthly work orders, or more sophisticated systems using computers with printouts
Plan of action	Annual	Complete file on spare parts, winding design data, vendor name, and/or replacement components for all major equipment

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