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High Technology Solutions for the Producers, Distributors and Users of Electric Power

Cadick Corporation

The Eight Step Preventive Maintenance Program
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INTRODUCTION

This technical bulletin outlines eight simple steps that should be at the heart of an electrical preventive maintenance. These key steps are plan, inspect, clean, tighten, lubricate, test, record, and evaluate. The following paragraphs briefly describe each step and illustrate the part that they play in a good preventive maintenance program.

STEP 1– PLAN

Before working on anything, take time to think about what you are going to do and how you are going to do it. A few minutes of thought before the job is started results in a safer and more efficient job. This step is especially important when you are performing emergency repair work.

Start by identifying the specific task or tasks that you intend to perform. In this initial stage you do not need to go into too much detail, rather, concentrate on the broad goals that you to accomplish. List each goal, the personnel that you will use, the equipment that you will need and the amount of time that will be required.

Be certain that you obtain and use the proper instruction manuals and design drawings before you start. The joke of "getting the manual after smoke is present" has too much basis in fact to be very funny for experienced electricians. Trouble shooting without accurate and correct schematics and wiring diagrams is close to impossible in all but the simplest circuits.

Develop detailed plans and procedures from the preliminary plans discussed above. Steps should be detailed as much as required by the complexity of the job and the experience of your personnel.

STEP 2 – INSPECT

Periodic inspections should be set up on a routine basis. Inspection can be done with the senses that nature gave us, called unaided inspection, or with instruments such as infrared viewers, ultra sound transducers, etc.

Unaided Inspection

Your eyes are your most important inspection tools. They can detect dirt, note current readings, determine levels, discover discolored, overheated insulation, determine the presence of insects and rodents, and find a whole host of other problems. The more experienced you become, the more information your eyes can provide; however, even the most inexperienced electrician can detect spider

webs in a circuit breaker operating mechanism. Always observe what you are working on and look for any abnormalities that can give you an idea of any thing that can cause these problems.

Your ears can also be useful inspection tools. Overloaded transformers are normally noisier than lightly loaded ones, corona has a distinctive hissing sound, and motors with unbalanced voltages or bad bearings vibrate. Any change in sound should be investigated.

Nothing in electrical systems is more distinctive than the odor of overheated or burning insulation. Your nose can detect such problems long before your other senses. Again, the most useful indicator of problems is a change in odor.

Touch may also be employed to inspect electrical equipment. Feeling for excessive vibration or heating is a time tested technique. Of course, you should be extremely cautious before touching any piece of equipment. If the equipment is not de-energized, contact should be made only when wearing appropriate insulating PPE such as rubber gloves.

Inspection with Tools or Instruments

Except for your own senses, infrared viewers are the most cost effective maintenance tool in existence. Annual infrared scans of your power system *invariably* discover problems which, if allowed to continue, could result in severe problems. Whether this service is done "in house" or contracted to an outside service, you ***should*** perform an annual (minimum) infrared scan of your system.

Ultra sound transducers are normally used on major overhauls to evaluate the condition of metals which are subjected to constant vibration.

Many other such tools and instruments are available to help in the performance of maintenance tasks. Such tools should be used as required by qualified personnel trained in their proper and safe use.

STEP 3 – CLEAN

Dirt and electricity don't mix. After you have completed the inspection of your electrical equipment, the next step is to clean all components.

The first step is general cleanliness. Dust, dirt, and foreign material must be cleaned from motors, switchgear, transformers, and other such electrical equipment. For such cleaning we recommend the use of high suction, insulated hose shop vacuum, clean, lint free wiping cloth, and general purpose solvents. A citrus based, general purpose solvent is effective and biodegradable.

Each insulator or conductor has its own way to be cleaned. Porcelain, for example, can be cleaned with soap, water and appropriate cleaning brushes or pads. Plastic insulation, on the other hand, cannot take any abrasion. Always refer to the manufacturer's recommendations for specific techniques. Also, always avoid using steel wool or other conductive abrasives in any area where contact with energized conductors is possible.

Conductor connecting surfaces need special attention. Contact surfaces of copper conductors should be cleaned to a bright finish where they are connected together. Aluminum must not only be cleaned to a bright finish so that the protective oxide coating is not damaged. A special material should

be used to penetrate the aluminum oxide that forms almost immediately after cleaning. (See the section on lubrication below.)

Refer to the manufacturer's instruction books sometimes specify the cleaning material to be used for their equipment. Be sure to consult this literature before attempting to clean electrical components.

STEP 4 – TIGHTEN

Tightening fasteners on electrical equipment takes special care and should be done to the torque recommended by the equipment manufacturer. Electrical connections are especially critical. Recommendations for recommended torque values can be found in the maintenance and acceptance testing specifications published by the InterNational Electrical Testing Association. Be certain to torque connections per this table and/or manufacturer's recommendations.

STEP 5 – LUBRICATE

Lubrication of electrical system components is an often overlooked or improperly performed procedure. Too much lubricant can be worse than no lubricant at all. This is especially true of devices such as protective relays and circuit breakers which may go for years without operating. Be especially careful of conductive lubricants to make sure they do not cause a short circuit. Always use the lubricants recommended by the equipment manufacturer or one that has the same characteristics. Lubrication falls into two important areas:

1. Non-conductors

   Non-conductive joints or moving members should be lubricated using an appropriate material. In some cases grease, oil, or some synthetic lubricant may be recommended. Motor bearings, mechanism pivots, and other such equipment fall into this category. Remember that some pieces of equipment, such as protective relays, do not require any lubricant at all.
2. Conductors

   Most manufacturers make and/or recommend a lubricant to be used on conductors, stabs, and other such equipment. The ubiquitous "black grease" has been and continues to be a good lubricant when used properly. The correct approach to lubrication of electrical conductors is to apply a small amount and then wipe the contact surface clean with a clean, lint free cloth. Do not *scrub* the surface however. You wish to leave a fine film of lubricant in place.

REMEMBER

Use the proper lubricants in the proper amounts.

STEP 6 - TEST

Electrical equipment should be tested periodically. Insulation resistance should be measured, breaker trip times should be checked, relays should be calibrated, and a variety of other procedures should be performed. The only exercise that many protective devices get is during the test interval.

A detailed review of all procedures is beyond the scope of this course; however, the recommendations made by the InterNational Electrical Testing Association (NETA) in their publication entitled *Maintenance Testing Specifications* should be reviewed an applied as appropriate.

STEP 7– RECORD

Doing work without keeping records is almost useless. Recording test and other data can help set maintenance intervals, isolate troublesome equipment (or manufacturers), and provide a baseline that helps to know when insulation or other components are starting to fail. Besides test results records should always include the date, equipment identification, and all pertinent data on any problems discovered. System conditions like load current, voltage, temperature and, other such information can help determine how close components are to being overloaded.

Test and record forms should be developed and tailored to your company's specific needs. Examples of such forms may be found in the back of the NFPA 70B Electrical Equipment Maintenance, Review that document for ideas and examples.

STEP 7 – EVALUATE

Evaluation of the test results is, possibly, the single most important step in the entire process. Since 1990, significant progress has been made in the statistical analysis of small population data such as that gathered during maintenance intervals. Whether the analysis is done using sophisticated mathematical techniques or simple field rules of thumb, no program is complete without it. Analysis if records will allow the company to determine what, if any, additional maintenance needs to be performed and to pinpoint problems which might otherwise go un-observed.

FREQUENCY OF MAINTENANCE

How often should a power system be maintained? Unfortunately their is no simple answer to this question. The following should help in determining frequency of maintenance in a power system. The steps listed in this procedure are valid for all of the testing and maintenance information given in this text.

DETERMINING TESTING INTERVALS

1. Start initially with a once per year test program. Continue this procedure for the first two (2) times.
2. Review the test records from your maintenance intervals.
3. If frequent and/or severe problems are evident, decrease the maintenance intervals.
4. If no major or frequent problems are evident, increase the maintenance intervals.
5. Repeat steps 2 through 5 throughout the life of your maintenance program.

The average maintenance interval in industrial systems is about two years. This means that every two years, most industrial plants completely maintain their electrical system. Electrical utilities

have similar intervals although their average is probably closer to 1½ years. Recent advances in statistical analysis have enabled maintenance programs based on technology rather than "estimate." Such *Condition Based Maintenance* programs will be the way maintenance is done in the 21st century.

SUMMARY

The organization of an electrical preventive maintenance program may be greatly enhanced by adhering to the simple, eight step program outlined in this chapter. These steps contain all of the elements required for a comprehensive program. If you *plan, inspect, clean, tighten, lubricate, test, and record,* you will be well on your way to a safe, efficient, and profitable preventive maintenance program.