Risk Control Bulletin

Electrical Preventive Maintenance & Inspection

RISK CONTROL

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Statistics indicate that more fires start from electrical system failure than from any other cause. Electrical equipment is usually well designed and properly installed. However, the principal reason for electrical system breakdown is the failure to *maintain* the installation in its designed state.

As soon as electrical equipment is installed, normal deterioration begins. If left unchecked, the deterioration process can cause malfunction or complete failure. Performance and life expectancy of the equipment are decreased by factors such as environmental conditions, system overload or excessive duty cycles on equipment. These factors when combined with neglect can result in premature breakdown.

Instituting a preventive maintenance program which consists of routine inspections, tests and service of electrical equipment can significantly reduce the potential for breakdown. Without an electrical preventive maintenance program, your facility assumes a risk of serious electrical failure and the heightened potential consequences of fire and/ or production interruption.

Advantages of an Electrical Preventive Maintenance Program

Effective electrical maintenance program has specific advantages including, but not limited to the following:

- Reduces accidents and possibly even saves lives.
- Provides maximum freedom from breakdown during normal operation. If breakdown were to occur, downtime would be significantly reduced.
- Controls the cost of maintenance repairs and equipment replacement. Maintenance costs can be effectively budgeted versus large, intermittent expenditures.
- Maintains equipment at peak operating efficiency. This is often seen in reduced operating costs resulting from improved efficiency of electrical consumption.
- Improves employee morale since employees will be conscious of management's efforts to promote safety by reducing the likelihood of electrical equipment accidents which can result in injuries or even fatalities.

While the advantages resulting from improved safety are difficult to measure directly, the economic statistics can be tracked by reduced repair costs and equipment downtime. The investment in preventive maintenance is small compared to the cost of repairing equipment damage.

Instituting a Preventive Maintenance Program

Starting an electrical preventive maintenance program requires the support of top management. It is top management who must provide funds to initiate and maintain the program. It must be a conscious management decision to implement an effective electrical maintenance program since substantial commitment is necessary.

When considering the start up of an electrical preventive maintenance program, the basic planning begins with identifying some important factors - the "what if" questions:

- Personnel Safety - Should a failure of the electrical system or major electrical apparatus occur, will the safety of personnel be endangered? Has every precaution been taken to protect the worker from electrical injury?
- Equipment Breakdown - Is the electrical equipment complex and so unique that should a breakdown occur repairs would be expensive?
- Production Interruption - Should equipment become inoperable, will repair or replacement require extensive downtime? Consideration must be given to availability of spare parts (foreign versus domestic equipment). What effect would the loss of a vital piece of equipment have on overall production dollars?

These are key considerations in building an effective electrical preventive maintenance program. The degree to which the program is implemented and the frequency of maintenance will be dependent upon the answers to the foregoing questions.

The degree to which an electrical maintenance program is implemented is influenced by several factors:

- Location Size - 2,000 square ft. versus 250,000 sq. ft.
- Business Operation - mercantile versus industrial.
- Type of Plant Equipment in Use - Lighting fixtures versus large, rotating electrical apparatus.

- Consequences of electrical failure - relatively minor inconvenience versus substantial downtime or economic loss.

Based on these factors and the consideration of economic costs, management will select one of three types of electrical maintenance programs.

1. Unscheduled Maintenance - Repairs in response to breakdown, also known as "breakdown maintenance."
2. Ordinary Maintenance - Repairs, adjustments or replacement of parts shown to be necessary by visual inspections at irregular intervals.
3. Preventive Maintenance - Regularly scheduled inspections and periodic dismantling of equipment to check every detail likely to cause trouble. This is the preferred method.

Obviously, unscheduled maintenance is least preferred, but is most common and widely practiced. It must be understood that implementing an electrical preventive maintenance program is not an easy task to accomplish. There are production scheduling considerations, budget requirements and the need to have the electrical systems inspected, tested and maintained by personnel specifically trained in electrical maintenance.

The lack of maintenance or periodic system inspections can increase the potential for unneeded nuisance interruptions or critical breakdowns during peak operation which can result in lost production and lost profit. The implementation of an effective electrical maintenance program will satisfy an important part of management's responsibility; keeping costs down and production up.

Value of an Effective Electrical Maintenance Program

The cost of preventive maintenance is small compared to the cost of repairing extensive damage. Expensive time consuming repairs are often the result when unexpected trouble develops in electrical equipment which is important to business operations and plant production. Major electrical changes found necessary by periodic inspections can usually be planned to have the least impact on the overall operation. Equipment can be shut down when its effect on output is minimal. Unscheduled maintenance, however, is necessary when an electrical apparatus fails unexpectedly and can seriously affect operations.

A regularly scheduled, effective electrical preventive maintenance program is the most important factor in correcting electrical defects, reducing equipment failure and the resulting breakdown costs, and protecting personnel against injury.

Essential Components of an Electrical Preventive Maintenance Program

1. Assign qualified personnel. Where appropriate, provide maintenance personnel with formal training, preferably by the equipment manufacturer or authorized service provider. For many metal finishers, contract maintenance makes good economic sense with the prime factors being the lack of competent, qualified personnel, extent and frequency of maintenance, or the complexity of the equipment. This is particularly true when performing thermal scanning of apparatus since a certain degree of interpretation of the results is necessary.
2. Establish the necessary maintenance requirements and priorities. Equipment should be analyzed to determine the extent of the required maintenance and where the program should begin. As a minimum, all immersion heaters, rectifiers, motors, transformers, circuit breakers, controllers, and protective devices should receive a thorough inspection and evaluation. Upon conclusion, a qualified judgment can be rendered as to how, where and when each piece of equipment can be worked into the program.
3. Initiate routine inspections and tests. Manufacturer's recommendations should be followed as a minimum with frequency increased for critical components or severe service conditions. Some testing may have to be performed during operational shutdowns. Generally, for continued reliable operation, switchgear components should be cleaned, inspected and checked for tightness of electrical connections on an annual basis. Electrical testing of insulation for indications of deterioration or faults should also be performed on an annual basis. At the same time, protective relays and controller can be tested for proper operation and recalibrated, if necessary, by a qualified contract service.
4. Analyze inspection test reports so that proper corrective measures can be implemented. Evaluate the data to determine equipment condition which will reveal repair work needed. It will also help determine the frequency of required inspections and tests as well as the cost estimates. Whatever frequency of inspection and maintenance is established, it should be adhered to for several maintenance cycles and modified subject to experience. Equipment that consistently goes through two maintenance cycles without requiring service may have the interval between inspections

increased by 50%. Equipment subject to frequent breakdowns between inspections should have the interval decreased by 50%. As the frequency of inspection and maintenance is increased, it is anticipated that breakdown or unscheduled maintenance will decrease until an optimal level of preventive maintenance is reached. At this point, overall costs including breakdown maintenance and loss of production will be at their lowest levels.

5. Perform the required work. Follow through with appropriate corrective action after the inspections are completed and the test reports analyzed. Performing necessary repair work, replacement and adjustment is the end result of an effective preventive maintenance program. Keep a sufficient supply of replacement parts recommended by the equipment manufacturer to avoid downtime and extended lead time. Remember, the worst time to perform maintenance is when it is unscheduled. Do not procrastinate.
6. Maintain complete and accurate records. Maintaining records is an invaluable tool in planning, budgeting and in evaluating the overall effectiveness of the program. As a minimum, it is suggested that nameplate data, purchase information, test and/ or start-up (acceptance) specifications and any applicable information from the manufacturer be kept for comparison purposes. Also, document emergency contacts and phone numbers of repair companies and equipment suppliers as well as lead times for replacement parts. Care should be taken to avoid excessive record keeping since that may hamper the program.
7. Periodically re-evaluate the preventive maintenance program. Annually review the inspection and test reports as well as the replacements and failures to determine if the program is meeting its objectives and to verify that all information is current.

Inspection Frequency

Those pieces of equipment identified as critical to business operations should require the most frequent inspection and testing to assure continued reliability. Other equipment should be inspected and tested but it can usually be with much lower frequency.

Most electrical equipment manufacturers provide a recommended frequency of inspection within their service manuals. The frequency listed is normally based on "standard or common" operating conditions and environments. The manufacturers cannot provide accurate frequencies for equipment exposed to unusual combinations of environment and operating conditions. Those specifications, however, are a good basis from which to begin considering the frequency of inspection and testing.

Frequency, of course, can be varied depending on operating conditions. For example, electrical switchgear located in a room which is clean and operating at ambient conditions would be tested based on manufacturer's recommendations.

If that same switchgear were exposed to dust or corrosive vapors, the test frequency may be doubled.

Whatever frequency of inspection is established, it should be adhered to for several maintenance cycles unless failures occur. For equipment subjected to failures the interval between inspections could be reduced by 50 percent. If equipment consistently goes through two maintenance cycles without requiring service, the period in between inspections may be increased up to 50 percent.

As the frequency of inspection and maintenance increased, it is anticipated that breakdown or unscheduled maintenance will decrease until an optimal level of preventive maintenance is reached. When this occurs, overall costs, including breakdown maintenance and loss of production, will be at their lowest levels.

Fundamentals of Electrical Preventive Maintenance

Most effort has been directed toward initiating an effective electrical preventive maintenance program to reduce the potential for a serious electrical interruption. The basic rule applying to all electrical apparatus is to keep it clean, keep it dry, keep it tight, and prevent friction.

- Clean
  Dirt is a common cause of electrical failure. Dirt is the day-to-day accumulation of particulate matter from the atmosphere consisting of dust, lint, chemical, metallic particles, oil mists, spray residues, etc. if allowed to accumulate, it can contaminate electrical equipment causing overheating and increased electrical resistance. In some applications heavy contamination cannot be avoided. This is typical of foundries, mills, quarries, cement plants, grain elevators, etc. in these applications, special apparatus designs are appropriate. Every effort, however, should be made to keep equipment free to particulate matter. This includes activities such as weekly cleaning of motor casings and keeping electrical cabinets free of dust by vacuuming. Every maintenance opportunity should include a thorough cleaning of apparatus.

- Dry
  Electrical equipment operates best in dry and corrosive-free atmospheres. Humidity accelerates the oxidation of metals used in the electrical gear. Oxide build-up increases resistance thus reducing effective contact and the resulting heat can lead to eventual failure. High moisture levels can lead to direct short circuiting and immediate failure. Humidity should be controlled if possible and guarded against by using equipment designed for use in damp or wet conditions. Some typical example of high moisture areas or where there is an exposure to moisture or corrosion included: dairies, laundries, canneries, tanneries, meat packing plants, locations near seashores, swimming pools, metal plating, and areas where acids and alkali chemicals are used, handled or stored.
- Tight
  Many electrical components operate with high speed movement while other electrical equipment may not move at all. Motion of operating equipment will eventually cause wear and imbalance. Appreciable imbalance tends to create vibrations in equipment and loosen vital connecting parts. Routine maintenance is necessary to detect wear and loosening of parts and connections. This should include a check for tightness of accessible hardware and bolted parts as a simple precautionary measure. Tightening a screw or connection takes but a moment. It can prevent hours of searching for intermittent trouble.
- Friction Free
  Electrical equipment that is operating properly has minimum of friction, however, there is always the potential for mechanical breakdown as a result of increased friction. Friction can result from numerous causes. Some of the most common reasons include misalignment of equipment, excessive wear and the failure to properly lubricate. Some electrical apparatus does not require lubrication nor should it be performed unless specified by the manufacturer. Over-lubrication is a dangerous practice because excessive oil can collect dust and abrasive materials and even oxidize into difficult to remove deposits on the machinery. Lack of required lubrication will significantly add to overheating of the unit and may eventually lead to failure. Machinery must be properly lubricated at recommended frequencies. Alignment of machinery components is critical to help reduce friction. Machinery which is squeaking may be the first indication that friction problems are developing. Equipment operators should be instructed to be alert for signs of faulty operation or unusual equipment sounds. The key element is *maintenance.*