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Service plans enhance the benefits of preventive maintenance programs

White Paper

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Executive summary

Companies are continually being tasked by management to increase revenue and reduce expenses. In many instances, operating expenses are targeted, which can actually have a negative financial impact on the bottom line.

This paper addresses:

1) The cost of ignoring maintenance and testing on electrical distribution equipment.
2) Recommendations for creating an effective preventive maintenance program.
3) How service agreements can optimize preventive maintenance programs.

Table of contents

The Cost of Ignoring Maintenance and Testing

According to NFPA 70B, Recommended Practice for Electrical Equipment Maintenance , "A well-administered Electrical Preventive Maintenance program reduces accidents, saves lives and minimizes costly breakdowns and unplanned outages. Impending troubles can be identified, and solutions applied, before they become major problems requiring more expensive, time-consuming solutions." (Section 4.2.1)

The ultimate goal of a preventive maintenance program is ensure that all electrical equipment and components operate safely and reliably as originally designed and intended. Studies of electrical equipment maintenance show a strong correlation between the level of maintenance and the reliability of the equipment.

Workplace Safety

Well-maintained equipment promotes workplace safety. One of the requirements to comply with NFPA 70E: Standard for Electrical Safety in the Workplace® is to maintain all electrical distribution system components.

Electrical injuries are the second most costly worker's compensation claim. (The Liberty Mutual Research Institute for Safety)

Breakdowns may put workers in harms way to repair equipment. Planned maintenance activities provide fewer opportunities for workers to improvise. Exxon-Mobil conducted a study on maintenance-related accidents. Findings revealed a higher incidence of accidents (five times greater) when working on equipment failures than on planned jobs.

Improved safety results in very real, though hard to measure, benefits. These include increased employee morale, due to the awareness of management's efforts to promote workplace safety; better workmanship; increased productivity; and reduced absenteeism. (NFPA 70B Section 4.2.2)

The Cost of Unplanned Outages

Without an EPM program, management assumes a greatly increased risk of a serious electrical failure and its consequences. (NFPA 70B, Section 4.1.3)

Facility managers should know what the monetary impact of an unplanned outage means to their respective operations. However, when an event happens, the focus is usually on restoring power as quickly as possible and at all costs. Often, the tangible and intangible costs are not accounted for during the event.

Investing in electrical preventive maintenance is sometimes resisted by management because, like insurance, there is no direct payback. However, the failure of electrical system components is three times higher without maintenance activities, and in some cases, more. (Source: IEEE) The best way to avoid this financial impact is to reduce the risk of an unplanned outage, which requires time, effort, planning and money.

The Cost of Ignoring Maintenance and Testing (continued)

Pay Now or Pay (More) Later

The generally-accepted industry 'rule of thumb' states that reactive maintenance is three to four times more costly than preventive maintenance. However, a 'rule of thumb' statistic can be hard to sell to management when budgets are tight.

In their book, Maintenance Excellence, Optimizing Equipment Life Cycle Decisions, John Campbell and Andrew Jardine address the 'rule of thumb' and quantify the cost saving potential. They proposed that maintenance work can be broken down into three categories, each with an assigned cost unit, as shown below.

Type of Maintenance Work	Cost Unit
- Planned Activities	$1.00
- Unplanned Activities	$1.50
- Breakdown or Emergency	$3.00

Suppose a company has an annual maintenance budget of $10 million. The work distribution for maintenance is 60% planned, 20% unplanned, and 20% emergency / breakdown. When broken down into '**work** units', we have:

Type of Maintenance Work		Cost Allocation
- Planned Activities (60%)	x 1.0 = 60 work units	60/150 x $10m = $4m
- Unplanned Activities (20%)	x 1.5 = 30 work units	30/150 x $10m = $2m
- Breakdown or Emergency (20%)	x 3.0 = 60 work units	60/150 x $10m = $4m
	Total : 150 work units	**Total: $10m**

What would the cost savings be to increase planned activities from 60% to 70%?

First, find the cost per individual work unit by dividing $10m (maintenance budget) by 150 (total work units) — $10m / 150 = $66,666 or **$0.067m** per work unit

Increasing planned maintenance activities by 10% and applying the per work unit cost in the calculation yields the following:

Type of Maintenance Work	
- Planned Activities (70%)	70 work units x 1.0 cost unit x 0.067m = $4.7m
- Unplanned Activities (15%)	15 work units x 1.5 cost unit x 0.067m = $1.5m
- Breakdown or Emergency (15%)	15 work units x 3.0 cost unit x 0.067m = $3.0m
	Total: $9.2m

Placing more resources into planned maintenance activities yields an **$800k** annual savings in the maintenance budget alone. Savings increase when you factor in the reduction of lost productivity and down time.

An interactive calculator is available - based upon Campbell's and Jardine's theory - to illustrate the savings potential of increasing planned (preventive) maintenance activities by only 10%.

To access, visit www.schneider-electric.us and click on the Pay Now or Pay (More) Later banner.

Creating an Electrical Preventive Maintenance Program

Step 1: Assess the Current State of the Electrical System

Prior to initiating a preventive maintenance program, have a short circuit analysis, a time-current coordination study, and an arc flash analysis of all of the power distribution systems to ensure equipment is properly rated, set and labeled. In addition, a licensed professional electrical engineer should be contracted and commissioned to create and maintain current electrical one-line diagrams and equipment name plate data.

An up-to-date one-line diagram of the electrical system provides clear and precise information concerning the exact interconnections of all electrical equipment

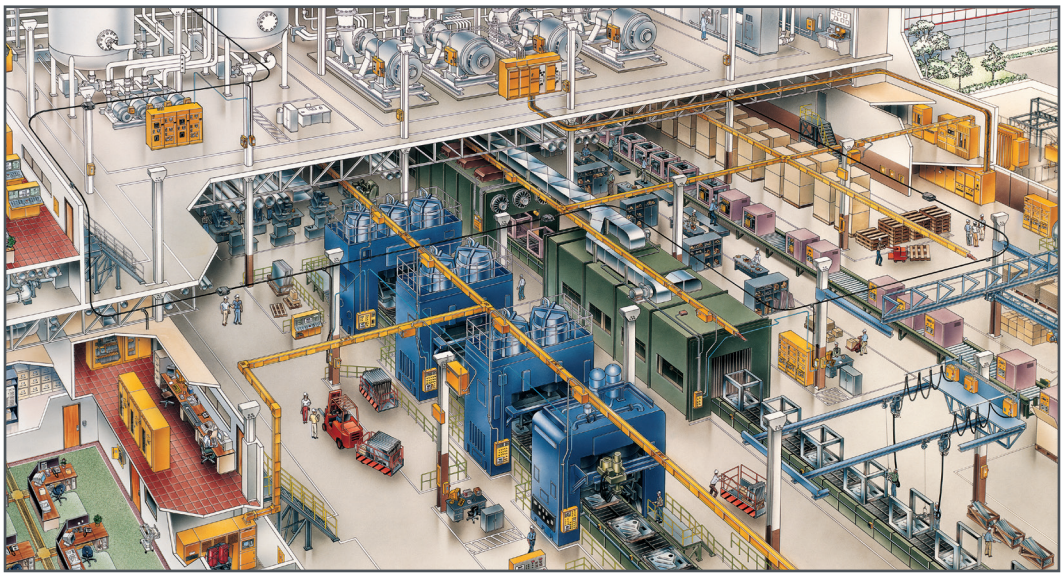
Step 2: Clearly Communicate Expectations to the Service Provider

A comprehensive preventive maintenance and testing program should incorporate detailed policies, procedures, and maintenance activities for the entire electrical power distribution system, regardless of the manufacturer.

- NETA-MTS, NFPA 70B and OEM operations and maintenance manuals can provide recommended guidelines for developing the work scopes as frequency for performing maintenance and testing.
  - If OEM manuals are unavailable, contact the manufacturer or check online.

The facility's management needs to clearly communicate to the service provider:

- Which equipment is included in the maintenance program.
- The specific order the electrical equipment should be removed from service for maintenance.
- The detailed scope of work for each piece of equipment or component, such as:
  - Electrical testing (insulation and current path)
  - Mechanical testing (functionality and sequencing)
  - Visual inspection to ensure proper set-up and function
  - Control and protection schemes to verify proper sequencing and automated operation



Creating an Electrical Preventive Maintenance Program (continued)

Following are recommended items or equipment to incorporate into a Preventive Maintenance Program:

- Monitoring equipment
- Protective relays
- Circuit breakers
- Panelboards
- Transformers
- UPS systems
- Optional stand-by generators
- Metering equipment
- Service-entrance switchgear
- Switchboards
- Motor control centers
- Automatic transfer switches
- Busway
- Bonding and grounding systems

Any specific maintenance of separate pieces of electrical equipment does not guarantee a completely coordinated and reliable power system.

Step 3: Qualify Service Provider(s): Considerations for Outsourcing

Due to the increasing complexity and interconnectivity of a facility's electrical infrastructure, very few companies have in-house staff with the experience to service all of the electrical equipment contained therein. Facility management needs to ensure that electrical workers are qualified, as defined by OSHA and NFPA 70E, to work on the specific equipment that is to be maintained. This applies to in-house staff as well as third-party contractors. Fundamental requirements include:

- Complete understanding of equipment, the required work scope and electrical hazards present.
- Proper use of personal protective equipment (PPE), tools, shielding and test equipment as well as precautionary techniques.
- Discipline and decision making skills to determine risk and ability to maintain a safe work environment.

If outsourcing the maintenance and testing activities, an in-depth interview is suggested and applicable references obtained. Ask questions up front relative to Field Personnel Competency Training to determine product knowledge. Find out about the service provider's safety training program. Ultimately, the company out- sourcing the work is responsible for workplace safety, whether the maintenance worker is an employee or a contractor.

Step 4: Planning for Outages

With FEW exceptions, electrical equipment should NOT be cleaned, inspected, maintained, serviced, or tested while it is energized.

- When planning for an outage, 'critical' equipment should be identified and scheduled.
- Arrangements for temporary electrical power should be made, if needed.
- Above all, it is management's responsibility for onsite personnel safety, whether for in-house or third-party electrical workers.

Creating an Electrical Preventive Maintenance Program (continued)

The recommended maintenance and testing interval for outages may need to be altered if any of these factors exist:

- Potential to safety of equipment failure
- High repair cost equipment
- Operating environment
- Equipment condition
- Operating load and ratings
- High repair cost equipment
- Cost of down time to production
- Performance history of equipment

Equipment must be in an electrically-safe condition during maintenance, testing and repair.

Service Plans Add Value to Preventive Maintenance Programs

All electrical power distribution systems will experience some type of electrical power interruption, whether it will be for scheduled maintenance or unscheduled downtime due to an electrical fault or inoperative equipment. It is important to remember that any specific maintenance of separate pieces of electrical equipment does not guarantee a completely coordinated and reliable electrical power distribution system.

Preventive maintenance programs are typically transaction based and equipment focused. They help ensure the (insert equipment type) operates as it was designed and intended according to the manufacturer's specifications and recommendations. As shown in the example on page 4, planned maintenance activities are more cost-effective than unplanned or emergency situations.

Service plans expand upon preventive maintenance programs and add value by focusing on the electrical system. By analyzing and trending data from the maintenance documents, a customized service plan can be developed to address a facility's operational risk. In addition to past operational performance, additional risk factors may include the type of business (data center, hospital, industrial), the cost of downtime, environmental conditions, lack of qualified personnel, etc.

Reliability: A Mathematical Probability

In general terms, "reliability" is a property of a power system that describes the likelihood that the same system will successfully operate or perform as designed, constructed, and intended. More exactly, reliability is the "statistical probability that the system will be able to perform its intended mission".

The "notion of reliability" is more of a mathematical probability than an actual physical condition and is determined from the combination of statistical dysfunctional or inoperative rates of individual components and the configuration of the power system to which they are applied.

Service Plans Add Value to Preventive Maintenance Programs (continued)

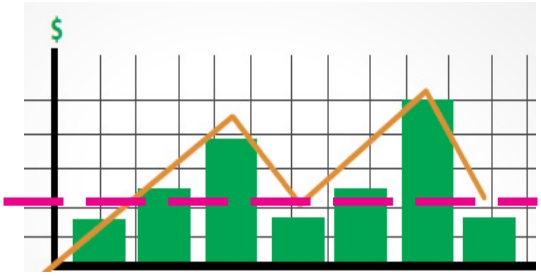
Example:

The simplest power distribution system consists of two protective devices connected in series (i.e., a main and feeder over current protective device) to supply power to a load. One might initially think that two 90%-reliable devices in series would yield a 90% reliable system. In fact, the system reliability is the product of the reliability of the two devices: 0.9 x 0.9 = .81 or 81%.

Drop the reliability of one device to 70% due to lack of maintenance and total system reliability plummets: 0.9 x 0.7 = .63 or 63%.

Another advantage of service plans is their fixed-rate nature. Maintenance budget fluctuations are eliminated since there are no hidden charges. Billing can be structured to provide a fixed payment schedule for the duration of the service plan and one plan can cover the entire electrical system.

Green bars indicate maintenance costs over time >



Basic-level service plans typically include a comprehensive preventive maintenance program along with access to 24/7 technical support. Additional options may include guaranteed on-site response times and spare or repair parts management, based upon a customer's specific requirements. In most cases, the term of the service plan is also flexible.

Conclusion

Studies of electrical equipment maintenance show a strong correlation between the level of maintenance and the reliability of the equipment. Lowered reliability, especially in the realm of electrical systems, increases the risk of both employee safety and of downtime-related lost business productivity.

Fixed-rate service plans are a growing trend to manage increasingly complex electrical power distribution systems or systems with multiple brands of equipment. In addition to meeting regulatory requirements, they offer the flexibility to customize a scope of work as well as the term, i.e., 36-month, 72-month, etc.

Having a single-source service provider helps ensure the uniformity and integrity of the test results year over year. It is important to select a qualified service provider who has the expertise to service multiple types of equipment and manufacturers.

Resources:

- Campbell, John and Jardine, Andrew. *Maintenance Excellence, Optimizing Equipment Life Cycle Decisions* (2001: Marcel Dekker, Inc.)
- NFPA 70B: Recommended Practice For Electrical Equipment Maintenance (2016)