

Commissioning and Maintenance of Electrical Distribution Equipment: Which Approach to Adopt?

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Executive Summary

A comprehensive commissioning and maintenance program for electrical distribution equipment identifies factors that can cause failures and provides the means to correct them.

Such a program can help identify risks that might lead to equipment failure or power outages and correct these risks at a time when their impact is minimal. Well-maintained equipment reduces production shutdowns while minimizing major failures, which in turn decreases overall operating costs.

To ensure electrical equipment and devices function properly, it is essential to set up an effective commissioning, maintenance and testing program through an in-house service or through subcontracting to a private company specialized in this practice.

What are the key factors to consider?

The optimal approach to commissioning and maintaining a specific system or equipment depends on a variety of factors, including:

- The impact of a failure on personnel safety
- The impact of equipment failure on business productivity and profitability
- The cost associated with commissioning and introducing a maintenance program
- Equipment failure rate and life expectancy
- The likelihood of causing damage to equipment or issues with the system during maintenance and equipment testing
- Technological evolution and the tools available to maintenance personnel
- The availability of information to support the maintenance program
- The addition of continuous monitoring devices for at-risk areas

The purpose of this document is to demonstrate the importance of performing electrical tests and preoperational verifications (POVs) on electrical distribution equipment and to choose the correct maintenance mode to use during its useful life. This document will



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also explain the process surrounding the commissioning and maintenance of an industrial electrical network and owner responsibilities.



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Business Challenge

The compliance of a device for various safety and reliability issues is an important factor throughout its lifecycle. Equipment manufacturers want to sell products that meet market standards. As for clients, they want to be sure that the equipment they buy is reliable and safe for their personnel and profitable for their operations.

The three most important factors when installing equipment in an industrial electrical installation are:

- Quality
- Reliability
- Safety

For the owner, the challenge is to invest in the tasks that have the greatest rate of return. A properly designed commissioning and maintenance program balances the cost of maintenance and equipment failure with associated production losses.

Overall equipment costs are calculated based on three factors: the purchase price, the service life and the maintenance cost. The maintenance cost is the sum of the cost for labour and equipment needed to repair the device, the cost of preventive maintenance to avoid repairs and the cost of lost production when the unit is shut down for repairs.

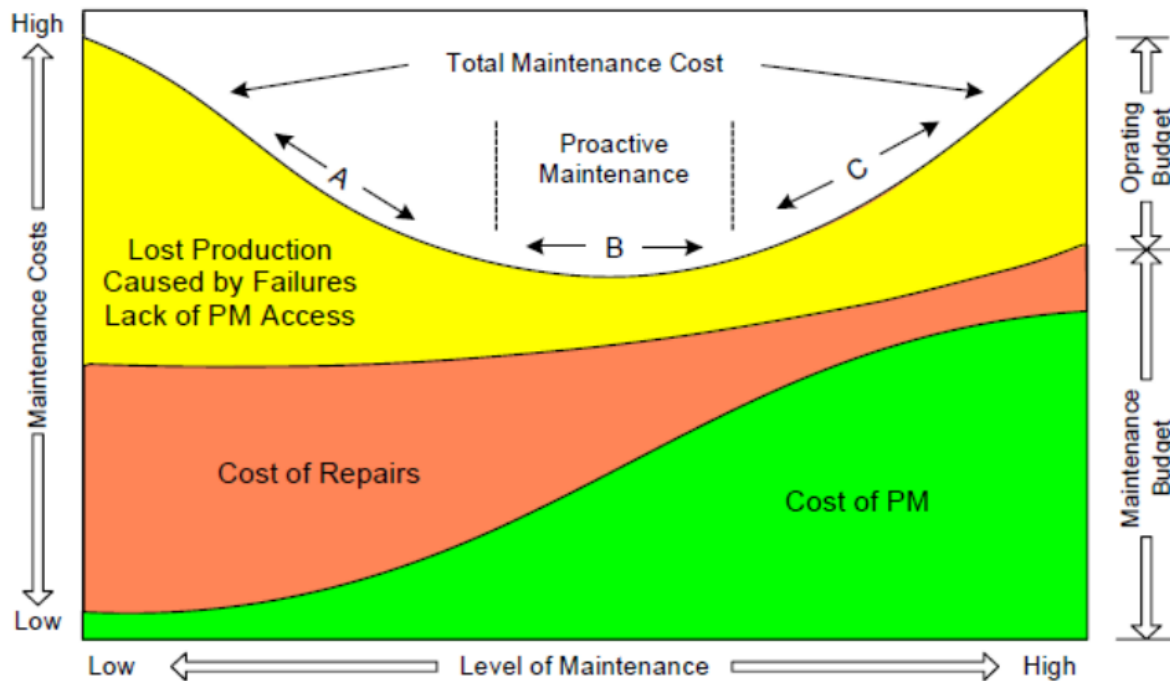
A predictive maintenance program includes actions that extend equipment life and prevent failures by substituting periodically scheduled tasks with tasks performed only when necessary.



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The maintenance challenge: Investment optimization [1]



Three distinct approaches

Most electrical equipment is vulnerable to certain degradation mechanisms, and most commissioning and preventive maintenance activities are designed to prevent, delay and mitigate the effects. There are three basic approaches, briefly summarized in the following paragraphs, in performing the inspection and preventive maintenance of electrical equipment. Most utilities and industrial clients use a combination of these. Deciding which approach to adopt is usually specific to a given equipment or system.



Reactive maintenance

Run-to-failure

In this approach, no particular activity is performed. Degraded equipment is only repaired or replaced when its deterioration becomes unacceptable. For most types of electrical equipment, this coincides with a catastrophic failure. No explicit effort is made to monitor performance or to prevent failures.

Risks associated with a major breakdown are accepted. Due to the generally high reliability of electrical equipment installed in a controlled environment, the run-to-failure approach often provides satisfactory reliability and power availability in non-critical applications. Small organizations that do not have enough staff often use this as a default approach, while larger organizations frequently apply it to equipment and systems that are not critical to their manufacturing process, provided the risk to personnel is properly controlled.

Inspection and maintenance where necessary

This approach requires a member of operations or maintenance personnel to perform a summary validation prior to commissioning equipment. This person then inspects the electrical equipment according to a more or less predetermined schedule, usually during a periodic tour of installations.

With this approach, problems are usually corrected before they become catastrophic, especially if their impact is considered unacceptable. Informal performance monitoring is carried out to predict future problems. Many industrial clients use this approach and find it satisfactory.

Preventive maintenance

With this approach, commissioning activities are adapted to each type of equipment. Electrical maintenance activities are established and performed at fixed intervals or based on the owner's schedule of operations (scheduled shutdowns), depending on the number of hours or cycles of operation. Procedures and schedules are usually based on manufacturers' recommendations or industry standards. While this approach provides periodic attention to equipment, it does not necessarily determine the priority of maintenance activities based on safety or productivity. It also does not consider optimizing the use of limited maintenance resources or lessons learned from other



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owners and industry. A planned preventive maintenance program is currently the predominant approach for owners where productivity and safety are serious concerns.

Predictive maintenance

Reliability-based commissioning and maintenance

This approach involves considering the activities based on an overall vision of the system and scheduling maintenance activities according to:

1. the statistical failure rate or the life expectancy of maintained equipment.
2. their criticality and productivity.
3. periodic updates of maintenance procedures and schedules to reflect the owner's actual maintenance experience.

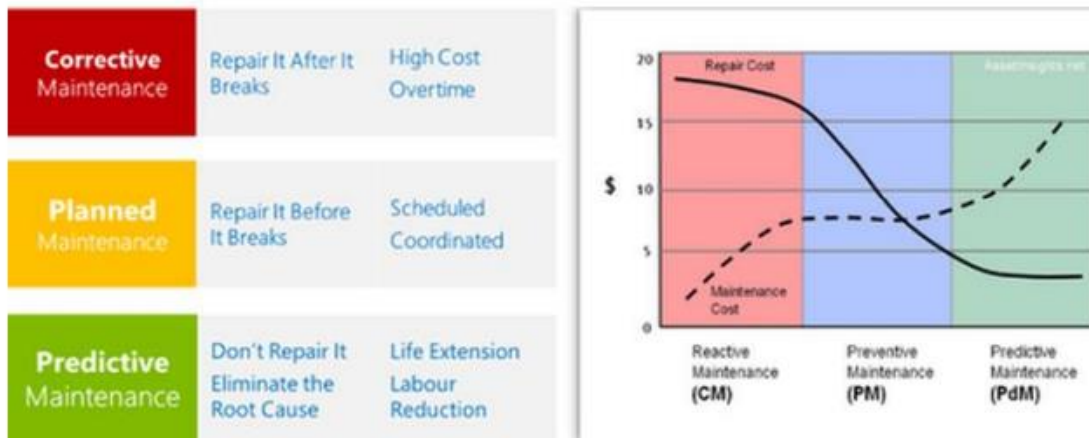
This is the most cost-effective solution because it improves installation safety, reliability and availability. It also reduces maintenance costs by concentrating limited resources on the most important or troubling elements and reducing or eliminating unnecessary tasks that are not very significant or are unreliable. A comprehensive reliability-centric maintenance program also incorporates structured provisions for investigation and correction of root causes of failure and for performance monitoring to predict future failures. This method is widely used in industry for those who have one or more critical processes and where productivity and safety are major concerns.



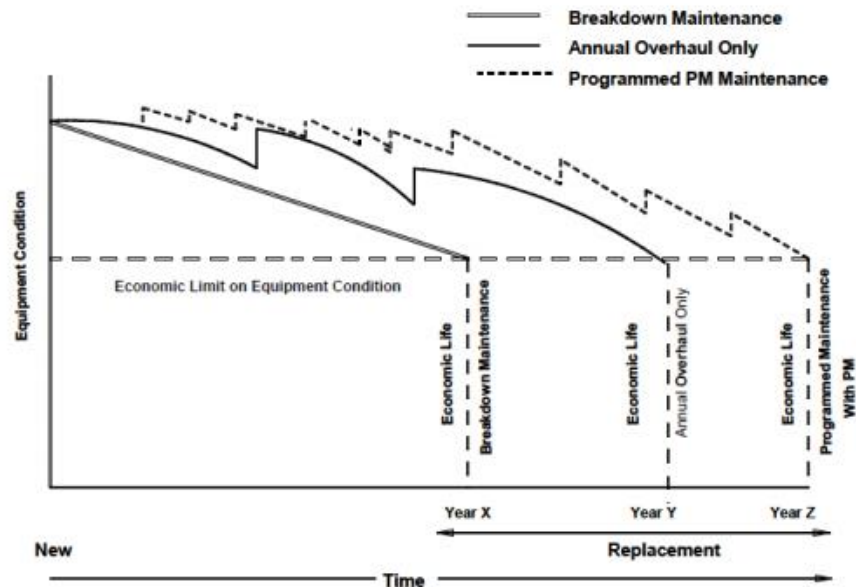
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Summary of the three approaches [2]



Impact of an optimized maintenance program [3]





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Owner responsibilities

It is essential for all stakeholders in the industrial electrical field to have a general understanding of safety and reliability requirements for associated equipment and operations. It is also necessary for stakeholders to have an overview of installation compliance and to know the specific steps in the process that can have a direct impact on their day-to-day responsibilities.

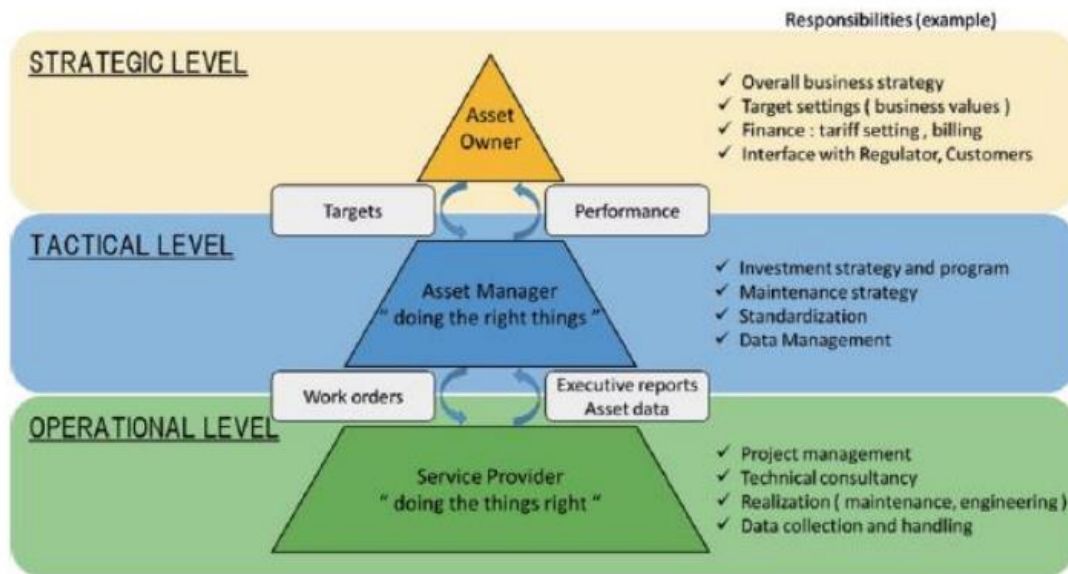
It is acceptable for non-specialists to perform superficial inspections and other low-level tasks when guided by well-defined procedures and acceptance criteria. However, rigorous and effective administrative controls should be implemented to ensure that critical tasks on major equipment and systems are performed only by persons specifically trained and experienced in the field or under the immediate supervision of those individuals.

The organization responsible for critical electrical work performed on major equipment and systems must:

- master relevant equipment and system design and operation.
- possess general aptitudes for equipment maintenance and testing.
- apply safe methods and practices for electrical work.
- have equipment and system test procedures.

For certain critical tasks, stakeholder experience must include performing similar work on identical or comparable equipment, preferably in an equivalent operating environment.

Role of the owner in managing its assets [4]



Description of the Solution

Optimization of commissioning activities

Deterioration of electrical distribution equipment is a normal phenomenon that begins as soon as it is installed and in service. If the deterioration is not addressed in a timely manner, it can lead to failure.

A commissioning program should include routine inspections as well as tests and functional verifications of electrical equipment and systems, such as: transformers, cables, circuit breakers, switchgear and related equipment (relays and protective devices, metering instruments and devices).

The best time to perform comprehensive tests is when installing equipment. At this stage, the owner's operations are not yet dependent on equipment performance, which may

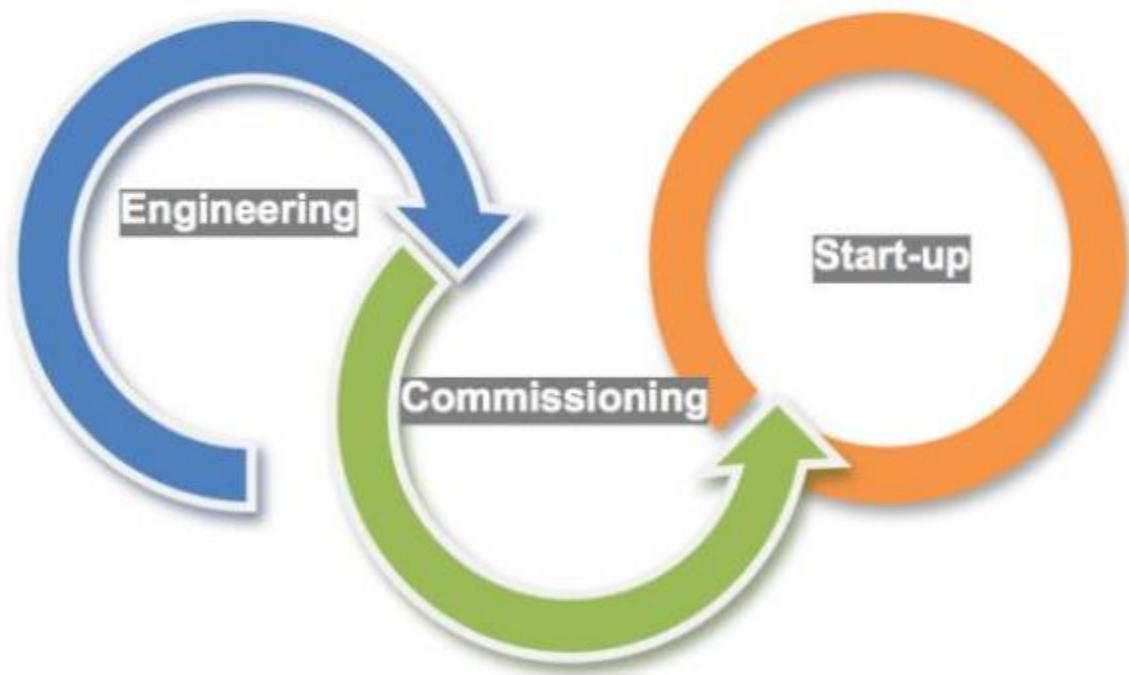


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not affect the company's profitability. The equipment is then fully available for a variety of tests and verifications without affecting adjacent systems. Such tests and verifications will hardly be possible after final equipment start-up, given the effect this equipment could have on adjacent systems.

Commissioning: A crucial step before start-up [5]



Why perform electrical tests?

Many governments and agencies have strict requirements regarding the design and performance of electrical distribution equipment sold around the world. In most markets, the equipment must comply with safety standards prescribed by safety and certification bodies – CSA, UL, ANSI, IEC and others.

To do so, it must pass a standard test at the manufacturer's facilities, which ensures the equipment meets market standards and specifications.



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The equipment is then transported to client installations where it is subject to various transport and storage conditions. During unloading and installation at the site, equipment is subjected to various hazards once again. These factors, if not properly controlled during all phases of transport and installation, can compromise equipment integrity and may no longer achieve the same performance levels as those recorded when it was submitted to factory testing at the manufacturer's site.

After the equipment installation is complete, POVs and electrical field tests are therefore essential to ensure the safe operation of any electrical equipment and to validate that it meets the manufacturer's specifications again, as an entire system. These tests take place during the initial commissioning of a device and can be repeated periodically throughout its lifetime to obtain an accurate picture of performance evolution.

Establishing a well-organized maintenance program and implementing it as soon as equipment commissioning activities are complete will:

- minimize accidents.
- prevent unexpected shutdowns.
- limit the average time between electrical equipment failures.



Benefits of the Solution

The complete commissioning of equipment or a system is intended to ensure expected operation and safe use for the owner's ongoing operations. In addition to individual verifications of all electrical equipment, the commissioning phase should include comprehensive performance tests, including full integration of all components of the newly installed system.

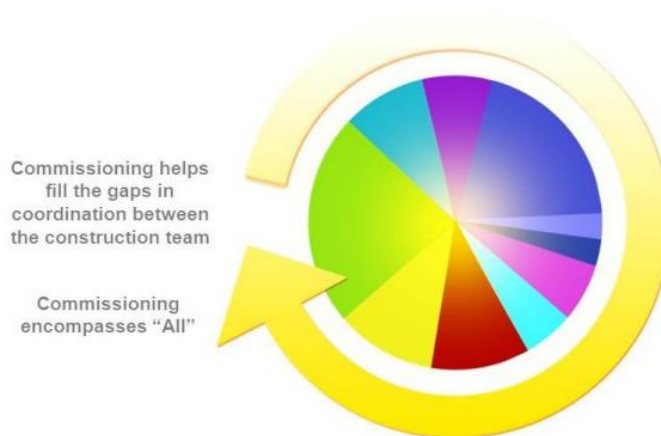
Direct benefits

- Reduced repair costs
- Decreased equipment downtime
- Improved personnel and equipment safety

Indirect benefits

- Improved employee morale
- Increased productivity and better work execution
- Discovery of system or equipment deficiencies

Benefits of a comprehensive commissioning [6]





Conclusion

Regardless of the project, there always comes a critical moment: one where you have to make sure that the installed equipment and systems function perfectly. Many operating philosophies can be explored when it comes to commissioning and maintenance of electrical equipment; these were presented in this document.

What to remember

- The established commissioning and maintenance approach for specific equipment or a system depends on the owner's concerns.
- For the owner, the challenge is to invest in the tasks that will provide the best rate of return.
- A predictive maintenance program includes actions that extend equipment life and prevent failures by replacing scheduled periodic tasks with tasks performed only when necessary.
- It is essential for owners to have an overview of their installation compliance and to define the specifications that have a direct impact on their day-to-day responsibilities.
- POVs performed prior to the permanent commissioning of an installation are crucial and can identify major deficiencies at a stage that reduces the impact on owner profitability.

In short, comprehensive and well-defined commissioning allows all components of the newly installed system to be integrated while reducing the risks associated with personnel safety and the costs associated with production losses. It is crucial that the system designer be involved and that testing is performed by personnel who are specially trained for these tasks.



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Dominic Dubreuil joined BBA in 2008 and has participated in coordinating and performing over thirty pre-operational verifications, and testing and commissioning electrical equipment projects. His work in medium- and high-voltage substations as well as in the industrial sector has allowed him to perfect his knowledge of electrical distribution equipment and to contribute effectively to each of his mandates, ranging from detailed engineering to commissioning.



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