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| OPERATION, MAINTENANCE AND MANAGEMENT OF ELECTRICAL EQUIPMENT FOR SUSTAINABLE DEVELOPMENT.  YAKUBU NATHAN BALA  17/ENGO4/076  ENG384 |

INTRODUCTION

Electrical systems need regular maintenance to ensure optimum performance, such maintenance will prevent system and equipment failures and ensure maximum safety and efficiency in the utilization of the facilities. At each installation, establish a program for proper maintenance and effectively follow it. Include in this program the scope of work, intervals of performance, and methods of application including safety requirements, practices and procedures, and operations and maintenance (O&M) of electrical power and distribution systems. The information provided applies to the plans and procedures to operate and maintain installation electrical distribution systems. Specific installation conditions may dictate the need for procedures that exceed these minimum requirements. These systems include substations, overhead and underground electrical distribution systems, exterior lighting systems, and electrical apparatus and components. The importance of discussed topic comes from the fact that electricity companies must handle a large number of electrical equipment (circuit breakers, transformers, cables etc.). Most of them have been in exploitation for years and are close to the end of their useful lifetime and then, they are more likely to fail, being necessary an assistance in making an appropriate and timely decisions about their assets. Based on the information acquired from asset management activities (monitoring and diagnosis, maintenance strategies and risk management), the decision-making process is designed to maintain electrical equipment in operating state, in safe condition and economical efficiency for electricity companies. In the context of energy market deregulation for any company in the electricity field either generation, transmission and distribution, its overall objective is to reduce costs while increasing equipment reliability, extending equipment lifetime and ensuring high levels of health and safety for operation and maintenance personnel, for the public, and for the environment. Due to this fact, proper operation and maintenance of major electrical equipment (transformer, circuit breakers, and overhead lines) becomes significant because:

* they belong to the expensive equipment category;
* the costs for maintenance of these equipment represent a large percentage of maintenance budgets;
* failure adversely affect the system reliability and the existing monitoring technologies within the power station.

Overall objective of the electricity companies is now, more than ever, to minimize operational costs of the electrical equipment and also to ensure that the system is working more economically. An important operational cost is the maintenance cost. Maintenance optimization is one possible technique to reduce life cycle costs while improving reliability. The electricity company needs to implement new strategies for more effective maintenance techniques. Thus, making decisions about the equipment maintenance activities must have a clear idea about what the maintenance can perform, what maintenance strategies are available, what assets to perform maintenance on, what level of maintenance to perform, what specific maintenance steps to perform, and when to perform the selected maintenance.

OPERATION OF ELECTRICAL EQUIPMENT

The newest version of NFPA 70E (2015) discusses normal operation of electrical equipment and covers five key elements of what normal means. One of those key elements is that the **equipment must be properly installed and maintained (NFPA 70E 130.2(A)(4)).** So what exactly does properly installed and maintained mean?  How does a company ensure that electrical equipment is in fact safe to operate under normal conditions? The informational note in this same section mentions manufacturer’s instructions and applicable codes and standards as guides. Two of these guides are **NFPA 70B Electrical Equipment Maintenance** and the **MTS/NETA Standard for Maintenance Testing Specifications for Electrical Power Equipment and Systems**.

Both of these references have their strengths in making sure your organization has a thorough electrical maintenance program. The key to such a program is that all **equipment is being properly maintained in accordance with the equipment manufacturer’s instructions.** Well-maintained equipment has a direct effect on the safety of personnel who are tasked to operate electrical equipment. A big piece of the electrical safety pie is an accurate arc flash study, based on the engineering department’s [arc-flash studies](http://www.e-hazard.com/arc-flash-studies), which are in turn based upon reliable and appropriately-set protective device tripping times. And do not forget, proper electrical maintenance is imperative for ensuring personnel are in proper PPE when working on or around electrical equipment.

**NFPA 70B (2013 edition)** does a great job covering the topic of grounding in Chapter 14. Section 14.1 defines the myriad of words used when discussing grounding and/or bonding, such as “counterpoise,” “down conductor,” and “grounded” vs “grounding” conductor. Anyone familiar with the National Electrical Code’s Article 250 should be very familiar with these often confused terms. The chapter continues in 14.2 to provide symptoms and even causes of inadequate grounding.  Section 14.3 addresses grounding system inspections, testing, and monitoring, and finally Section 14.4 ends with “Solutions to Inadequate Grounding.” In the final section, 14.4.1 provides four basic ideas for improving grounding at a jobsite, covering basic tasks such as cleaning, tightening, and testing connections, replacing or repairing damaged parts, using the correct size grounding conductor(s), and even using soil enhancement material if necessary, which is often applied at cell antenna sites for lightning protection.

In comparison, the **NETA/MTS 2015** guide on grounding starts in section 7 – Inspection and Test Procedures. This section includes visual and mechanical testing of grounds, and provides specific guidance on which tests to follow. The section goes on to recommend using the manufacturer’s torque requirements or the provided torque requirement table in the latter section of the NETA standard. It continues by addressing a series of electrical tests to perform, with guidelines of when to dig deeper when questionable results arise. One specific test shows when it is necessary to investigate point-to-point resistance values during bolted connection resistance testing.

Similar comparisons can be made in the breaker testing procedures in each manual. For example, the **NETA-MTS** book gives a step-by-step reference for molded-case breakers. First on the testing list is bolted connection impedance testing, followed by insulation-resistance testing; long-time, short-time, and ground-fault pickup testing; and time delay testing via current injection. The procedure continues with a comprehensive circuit breaker program, including reference charts to follow for specifications that may be missing from manufacturers who may have gone out of business. The end result of the NETA testing method is a well-maintained and documented molded-case breaker maintenance program.

Section 11.10 of **NFPA 70B** addresses Low Voltage circuit breakers, both molded-case and power circuit breakers. 70B gives excellent documentation of the testing program, referencing many industry standards that are commonly accepted as Best-Practice. The references include NEMA AB4 Guidelines for Inspection and Preventive Maintenance of Molded-Case Circuit Breakers Used in Commercial and Industrial Applications, as well as ANSI/IEEE C37.13, ANSI/NETA ATS, and ANSI/NETA MTS.  NFPA 70B gives detailed guidance on trip test times, coil pickup tolerances, and more, but one may get lost in the manual’s wordy guidelines, unlike the step-by-step approach of NETA/MTS-2015. If you are one who needs an education on what all is involved in a typical circuit breaker testing program, NFPA 70B is definitely the book to provide this knowledge. It covers almost four full pages in small print of the Low Voltage Circuit Breaker testing process.

MAINTENANCE OF ELECTRICAL EQUIPMENT

## Purpose of Maintenance

Apart from safety, maintenance is needed **to keep plant in an acceptable condition**. Maintenance of this kind must be reviewed on an economic and energy efficiency basis. While it is appreciated that breakdown of plant may result in costly interruption of normal building operation, it must also be borne in mind **that stopping plant for maintenance can also cause a loss in production**.

Equipment on continuous and arduous duty, e.g. switchboards, [motor control centres (MCCs)](https://electrical-engineering-portal.com/download-center/books-and-guides/siemens-basics-of-energy/motor-control-centers), air-handling units, chiller plant etc., require more attention than that which is lightly loaded and rarely used.

## Initial Steps For Economic and Energy Efficiency

Apart from the above considerations there will be the question of whether to repair or replace faulty equipment. This requires analysis of the past and future maintenance costs and the benefits of new equipment. However, some simple initial steps can be taken as far as the economic and energy efficiency is concerned for maintenance of electrical equipment in buildings.

**1. Standardisation of Equipment**

The use as far as possible of standard items such as switchgear will help both in buying, stockholding and replacement of components on the most economic and convenient basis.

## 2. Establishment of Records on Breakdown

Initially this may be on a **simple log book** or **card system**. This information should give some idea of which plant requires attention and at what intervals. It may also lead to improvements to the plant itself which will reduce the frequency of future failures.

## 3. Frequency of Maintenance

This requires careful organisation to ensure that it fits in with operational requirements. All [planned maintenance](https://electrical-engineering-portal.com/maintenance-management-of-electrical-equipment-condition-monitoring-based-part-6) should therefore have been agreed with the relevant operation.

## 4. Economic of Routine Maintenance

It may not be economic or practical to include some equipment in a scheduled routine although safety inspections will still need to be carried out. Examples of low priority maintenance are **equipment that is not subject to breakdown**, e.g. electric heater, and equipment that would cause little or no interference with operational routine and could be repair or replaced at any time.

## 5. Upgrading to More Efficient Plant

**Energy saving can be achieved by changing the type of equipment in use, for example:**

Replacement of **less efficient lamps** with more energy efficient lamps.

Replacing **electro-mechanical control device**s to electronic systems.

Installing new high efficiency motors [to replace old motors](https://electrical-engineering-portal.com/8-energy-efficiency-improvement-opportunities-in-electric-motors) particularly where extended duty operations prevail.

Retrofitting VSDs for flow control of fans or pumps.

The economics of changing inefficient existing systems, which are continuing to provide a satisfactory operational performance, obviously requires careful consideration. Not only the costs of new equipment need to be understood, but also **equipment life** can have a significant impact on the overall financial viability of any proposed changes.

## Emergency Maintenance

The emergency maintenance can hardly be regarded as maintenance in the sense that, in many cases, it consists of an urgent repair to, or replacement of, electrical equipment that has ceased to function effectively.

## Planned Maintenance

In the use of electrical plant and equipment there are obviously **sources of danger** recognised in the Electricity (Wiring) Regulations.

These regulations are mandatory and serve to ensure that all electrical plants and equipment areadequately maintained and tested to prevent any dangerous situation arising that could harm the users of such equipment or the building occupants.

Normally, maintenance carried out solely for safety reasons will be covered by standard procedures, which in some instances will have to fulfil **the relevant Code of Practice** for the Electricity (Wiring) Regulations.

**Planned maintenance** can be carried out on the basis of the operation of the piece of electrical equipment itself. For example, it is worth considering whether all electric motors should be periodically cleaned and inspected, making sure that dirt and dust has not interfered with the self cooling of the motor and that there is no oil leakage into the motor’ s windings.

Bearing should also be checked for wear and tear to prevent contact between the rotor and stator. Maintenance can also be based on the complete item of plant, or auxiliary plant, such as the central air conditioning plant of a tall building.

MANAGEMENT OF ELECTRICAL EQUIPMENT

## The cost of maintenance

In today’s competitive market scenario, all types of industries are under tremendous pressure **to cut down their maintenance costs**, as they form a significant portion of the operation costs.

The industries are forced to look for different types of maintenance of the electrical equipment rather than usual [preventive maintenance](https://electrical-engineering-portal.com/electrical-preventive-maintenance-of-air-circuit-breakers) being carried out at a fixed interval of time.

Over the past twenty years or so, the concept of maintenance has been assuming different dimensions and changing a lot, perhaps more so than any other management discipline. The changes are due to a huge increase in the number and variety of plant equipment in the industries, which must be properly maintained.

The electrical equipment with much more complex designs require new maintenance techniques and changing views on maintenance organization and responsibilities.

Maintenance activities are also responding to changing expectations as follows:

* Rapidly growing awareness of the extent to which electrical equipment failure affects safety of plant and personnel and the environment.
* Growing awareness of the connection between maintenance and product quality.
* Increasing pressure to achieve high plant availability remaining cost-effective.

The changes are testing attitudes and skills in all branches of industry to the limit. Maintenance people are required to adopt completely new ways of thinking and acting, as the plant engineers and as the plant managers. At the same time, the limitations of maintenance systems are becoming increasingly apparent, no matter how much they are computerized.

## Failures of electrical equipment

Failure of any electrical equipment or rather any equipment should be taken up seriously. Detailed analysis of each failure should be carried out, which will help in significant reduction of repeated failures of same nature.

It is true that in spite of carrying out regular maintenance, failure of the equipment cannot be totally eliminated. Failures of different types of electrical equipment are reported by all the industries and some of the failures are quite serious resulting in substantial production losses besides causing consequential damage to the adjoining equipment as well.

For example, when the equipment like [surge arrestors operating at extra high voltage](https://electrical-engineering-portal.com/complete-overview-of-lightning-arresters-part-1) fail, they explode like a bomb many a times resulting in scattering of solid porcelain pieces to a larger distance causing damage to the adjoining equipment. Similar situation is also observed during incident of fire in electrical switchboards due to heavy short circuit.

## Breakdown Maintenance Management (BMM)

The heading itself implies simple and straightforward logic – **“When a machine breaks down, fix it”**. This is **a reactive maintenance management technique** that waits for machine or equipment failure before any maintenance action is taken; however, it is actually a “no-maintenance” approach of the management.

No expenditure is made on maintenance until a machine or system fails to operate.

Few plants adopt a true run-to-failure management philosophy, as in almost all instances, the industries carry out basic preventive maintenance tasks such as lubrication, monitoring of operating parameters and other machine adjustments.

In this type of maintenance, however, the electrical machines and other plant equipment are neither rebuilt, nor are any major repairs made until the machine fails to operate.

## High equipment downtime and high cost of maintenance

This reactive method of maintenance results into rather high equipment downtime in most of the incidents of breakdown.

Many times, **all the spare parts required to set right the breakdown are not available** and the vendor is approached to purchase the spares. Even if immediate delivery of required spares is affected, substantial time would always be lost before the equipment is repaired and put back into service.

Moreover, **the vendor would charge premiums for expedited delivery**, which would substantially increase the costs of spare parts besides higher downtime required to correct machine failures. This happens due to the fact that it is not feasible to maintain all the spare parts for all the machines installed in the plant.

CONCLUSION

In conclusion, electrical systems need regular maintenance to ensure optimum performance, such maintenance will prevent system and equipment failures and ensure maximum safety and efficiency in the utilization of the facilities. At each installation, establish a program for proper maintenance and effectively follow it. Include in this program the scope of work, intervals of performance, and methods of application including safety requirements, practices and procedures, and operations and maintenance (O&M) of electrical power and distribution systems. The information provided applies to the plans and procedures to operate and maintain installation electrical distribution systems. Specific installation conditions may dictate the need for procedures that exceed these minimum requirements. These systems include substations, overhead and underground electrical distribution systems, exterior lighting systems, and electrical apparatus and components. The importance of discussed topic comes from the fact that electricity companies must handle a large number of electrical equipment (circuit breakers, transformers, cables etc.). Apart from safety, maintenance is needed **to keep plant in an acceptable condition**. Maintenance of this kind must be reviewed on an economic and energy efficiency basis. While it is appreciated that breakdown of plant may result in costly interruption of normal building operation, it must also be borne in mind that stopping plant for maintenance can also cause a loss in production.

Hence, it is important to properly operate, maintain and manage electrical equipment in order for there to be sustainable development.

REFERENCES

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