

INDUSTRIAL SAFETY

UNIT 2: MAINTENANCE

Unit-II:

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Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

Fundamentals of Maintenance Engineering

Definition:

Maintenance is defined as the action taken by the user to maintain an existing facility in operating condition.

“Maintenance is a routine and recurring activity of keeping a particular machine or facility at its normal operating condition so that it can deliver its expected performance or service without causing any loss of time on account of accidental damage or breakdown”.

Objectives of maintenance

The objectives of maintenance should be formulated within the framework of the overall organizational setup so that finally the goals of the organization are accomplished. For this, the maintenance division needs to ensure that:

- (a) The machinery and/or facilities are always in an optimum working condition at the lowest possible cost
- (b) The time schedule of delivering to the customers is not affected because of non -availability of machinery /service in working condition
- (c) The performance of the machinery /facility is dependable and reliable.
- (d) The performance of the machinery /facility is kept to minimum to the event of the breakdown.
- (e) The maintenance cost is properly monitored to control overhead costs.
- (f) The life of equipment is prolonged while maintaining the acceptable level of performance to avoid unnecessary replacements.

The main aim of equipment maintenance is to maintain the functionality of the equipment and to minimize its breakdowns.

For mechanical equipment, the maintenance management will involve repair, replacement, and servicing of tools. It also ensures the proper working and to intercept fluctuations that occur in the duration of the production process.

The fact remains that, any kind of change even a minor downtime could reduce the overall efficiency of machines which would lead to major production losses.

Therefore, it is important for organizations today to get and implement a good maintenance management strategy.

Without or in the absence of equipment management, it might be possible to face some consequences in revert of careless decisions. Some of them are:

- Production loss
- Rescheduling of whole projects
- Material wastage from resources that have not been used yet
- Over time of labor because of downtime
- Disposal of machinery and equipment before the end of its useful life

There are two main categories of maintenance:

1. Primary functions

- Equipment inspection, cleaning, and lubrication
- Alterations to existing types of equipment and buildings
- Maintenance of existing buildings and grounds
- Maintenance of existing plant and equipment
- New installations of equipment and buildings
- Generation and distribution of utilities

2. Secondary Functions

- Property accounting
- Insurance administration against theft and fire etc.
- Store keeping for maintenance purposes
- Plant protection against fire etc.
- Pollution and noise control
- Waste disposal
- Salvage
- Providing caretaker services
- Any other services concerning maintenance as delegated by plant management

RESPONSIBILITY OF MAINTENANCE DEPARTMENT

The most important part of a maintenance department's responsibility, however, is performing routine planned maintenance. This provides regular servicing of equipment, checks for correct operation and identifies potential faults – which can be corrected before they interrupt production.

The responsibilities of a maintenance department involve the coordination and supervision of the plant or facility's maintenance. The maintenance department ensures that everything runs smoothly and at optimal performance.

The responsibilities of a maintenance department involve, but is not limited to:

- Make sure machines are operating properly to prevent the machines from potentially breaking
- Maximize the availability and reliability of all operating systems
- Maintaining operating systems and machines or equipment prevents safety issues and performance capability
- Work with a team to make sure production goals are met while also supporting the efforts of other departments
- Provide efficient maintenance and repair services

- Provide the previously listed tasks while staying within a designated budget

The different types of maintenance strategies include:

Preventive Maintenance, – includes regular and **periodic (time-based)** schedules.

Predetermined Maintenance, – follows a factory schedule

Predictive Maintenance – is data-driven and impacted by preset parameters.

Corrective Maintenance, – occurs when an issue is noticed

Condition-based Maintenance, – occurs when a situation or condition indicates maintenance is needed.
and

Reactive Maintenance. – occurs when a total breakdown or failure appears

PREVENTIVE MAINTENANCE

This type, preventive maintenance, seeks out and repairs more minor issues and decreases the occurrence of major repairs. Preventive maintenance may take on aspects of all other maintenance types.

For example, maintenance inspections may change based on the age of the equipment. When it is new, the procedure may be more of a predetermined maintenance style, but as it ages, more frequent inspections, both physical and through data, may prevent more minor performance issues from becoming extensive and costlier repairs.

Example of Preventative Maintenance

An excellent example of preventative maintenance is **the seasonal cleaning of an HVAC unit**. In spring, you schedule maintenance to ensure that grit and sand are not inside the casing or leaves are not blocking the air intake in the fall. There is no specific issue, but we know that leaves can accumulate and cause problems later in the fall. Removing the grit or leaves now prevents a later difficulty, such as poor performance, increased energy usage, etc.

Preventive maintenance is easily described as regular and routine inspections that look for wear before symptoms appear.

Costs of Preventative Maintenance

Expect to pay more for labour under preventative maintenance, so equipment inspections occur as scheduled. However, those added labour costs may be offset by preventing major repairs and the increase in energy consumption from machines that do not operate at peak performance. In addition, service can be outsourced, which can help reduce the cost of labour.

Benefits of Preventative Maintenance

- Prevention of major repairs.
- Keeps businesses open by preventing most emergency repairs.
- Adds to the **product's lifecycle** by reducing wear.
- Keeps energy costs at their lowest possible rates.

PREDETERMINED MAINTENANCE

Predetermined maintenance **follows a plan of action created by the manufacture of equipment**, rather than scheduled maintenance laid out by a maintenance team.

Examples of Predetermined Maintenance

An excellent example of predetermined maintenance is **when machinery maintenance is scheduled at time intervals based on the manufacture's recommendations**.

For example, oil changes will be every fourth month.

Transmission service will occur at X number of hours of run time. After one year of use, Parts X, Y, and Z are checked for wear. Engine replacement occurs after X number of years.

Even if the machine has sat idle for four months, the oil is changed. The list of maintenance is scheduled based on time or usage rather than functionality.

Another example is **when smart data indicates a decrease in productivity**. The drop in performance signals a need for maintenance. Predetermined maintenance crosses over into predictive maintenance, where data reporting for issues occurs.

Cost of Predetermined Maintenance

The cost of predetermined maintenance programs is **generally low**. Because everything is scheduled, you can plan for part or service items for maintenance. Costs do vary based on the machinery and parts associated, but even those are known costs.

Predetermined Maintenance Benefits

- Much easier to schedule and manage, including labor.
- The manufacturer outlines the maintenance plan.
- You can schedule technicians rather than hire maintenance personnel.

PREDICTIVE MAINTENANCE

One of the more advanced ways that maintenance occurs, predictive maintenance, **is data-driven**. Data supplied by the equipment indicates when maintenance occurs. Data also is a means to map when the failure of the machine may occur.

Examples of Predictive Maintenance

Technology is all around us, and many businesses put it to work for them. The examples of predictive maintenance would include:

- Alarms that sound when the temperature on a machine or in an environment begin to move outside the safe parameters set up per the manufacturer's guidelines. The enteral temperature in a data center's server room becomes too hot, and sensors in that room alter maintenance.
- A sensor in an engine monitors misfires and alerts maintenance that engine service is needed.
- A sensor on a refrigeration truck monitors the enteral temperatures of the truck and alerts the driver when the internal temperature falls outside acceptable parameters.

These alerts do not necessarily mean a complete failure occurs, but that condition is approaching a range where catastrophic failure can occur.

Benefits of Predictive Maintenance

There is a **higher cost at set up for predictive infrastructure**, but overall, predictive maintenance can save money by:

- Improving product quality.
- Reducing catastrophic failures.
- Improved equipment performance.
- Higher customer satisfaction.

CORRECTIVE MAINTENANCE

Maintenance teams activate after the uncovering of a problem. The goal of corrective maintenance is **to bring systems back to regular operation as quickly as possible**. With corrective maintenance, there is no program for regular maintenance. A problem must be present before maintenance occurs.

Examples of corrective maintenance include:

- Repairing a broken HVAC unit rather than maintaining it.
- Repairing an HVAC unit after data from the unit shows it is not functioning at peak performance.

Cost of Corrective Maintenance

Because there is not a regular maintenance program that prevents breakdown, **maintenance occurs only when an issue is noticed**. The cost of repairs may be slightly more expensive but far cheaper than paying maintenance to maintain equipment. The driving force is fixed just in time, but that can backfire if a catastrophic event happens. In the above example, the HVAC is not repairable, and replacement is the only option. Even then, some costs for replacement may be covered by a warranty.

Benefits of Corrective Maintenance

- Decreased monthly maintenance costs.
- Decrease in time for managing maintenance.
- Focuses on non-critical elements.
- A more straightforward maintenance process.

CONDITION-BASED MAINTENANCE

As the name implies, condition-based maintenance **focuses on outcomes through measurement or observation**. Machines have a range of normal operating conditions. Within that range, the operation is acceptable. Near the edges of that range, maintenance may be required.

Examples of Condition-Based Maintenance

An excellent example of condition-based maintenance is that **pesky check engine light in your car**. When it comes to the car's system has indicated that something is out of the normal range and maintenance is scheduled. The exact process may occur with machines that self-monitor through smart technology or physical inspections in a business.

Another example of condition-based maintenance might be **when a machine begins to use more energy to function**. That may be that a tank of fuel does not last as long or that there is a sudden spike in electrical usage. Again, that level of condition requires maintenance.

Cost of Condition-Based Maintenance

The overall cost of condition-based maintenance is **low**. It is a function of the condition of equipment over time and before a failure occurs. It is also known as a P-F curve. Because maintenance is scheduled when

anomalies begin, the cost to correct them is less than repairing a complete failure of the machine. The benefits of Conditional-based maintenance show us more.

Benefits of Condition-Based Maintenance

- Less downtime.
- Decreased energy consumption.
- Greater productivity — the equipment runs in the range of peak performance for longer.
- Fewer complete failures as equipment maintenance occurs as the performance drops.

There can also be a reduction in maintenance labor since automation can also become part of the predictive process.

REACTIVE (RUN-TO-FAILURE) MAINTENANCE

Reactive maintenance is a maintenance system that responds when a failure of machinery or systems occurs. The repairs may be handled in-house or by the manufacturer, or through a combination of in-house maintenance and the manufacturer's technicians.

Unlike preventive maintenance, reaction maintenance occurs when a breakdown happens.

Examples of Reactive Maintenance

The car washing at the local gas station breaks, and the maintenance team is notified.

The printing press that handles varnish applications fails, and maintenance or the factory service team is notified, and repairs are scheduled.

Costs of Reactive Maintenance

The costs of reactive maintenance **can range from minor repairs to total replacement of machinery**. Therefore, it becomes difficult to predict the cost of reactive maintenance, though occasionally the cost is offset by a warranty or service contract.

Benefits of Reactive Maintenance

It may seem like a waste of money to not have any other type of maintenance in place before machinery or equipment fails. However, there are some cost savings associated with Reactive Maintenance. Those include:

- Less maintenance staff, fewer employees, fewer wages paid out regularly, etc.
- Fewer costs to implementation – No regular maintenance means no labor or part costs until failure occurs.
- Fewer management hours are needed for maintenance planning.