

Maintenance Definition

British Standard Glossary of terms (3811:1993) defined maintenance as:

the combination of all technical and administrative actions, including supervision actions, intended to retain an item in, or restore it to, a state in which it can perform a required function.

Maintenance Definition

maintenance is a set of organised activities that are carried out in order to keep an item in its best operational condition with minimum cost acquired.

Maintenance Activities

Activities of maintenance function could be either repair or replacement activities, which are necessary for an item to reach its acceptable productivity condition and these activities, should be carried out with a minimum possible cost.

Maintenance History

1. In the period of pre-World War II, people thought of maintenance as an added cost to the plant which did not increase the value of finished product.

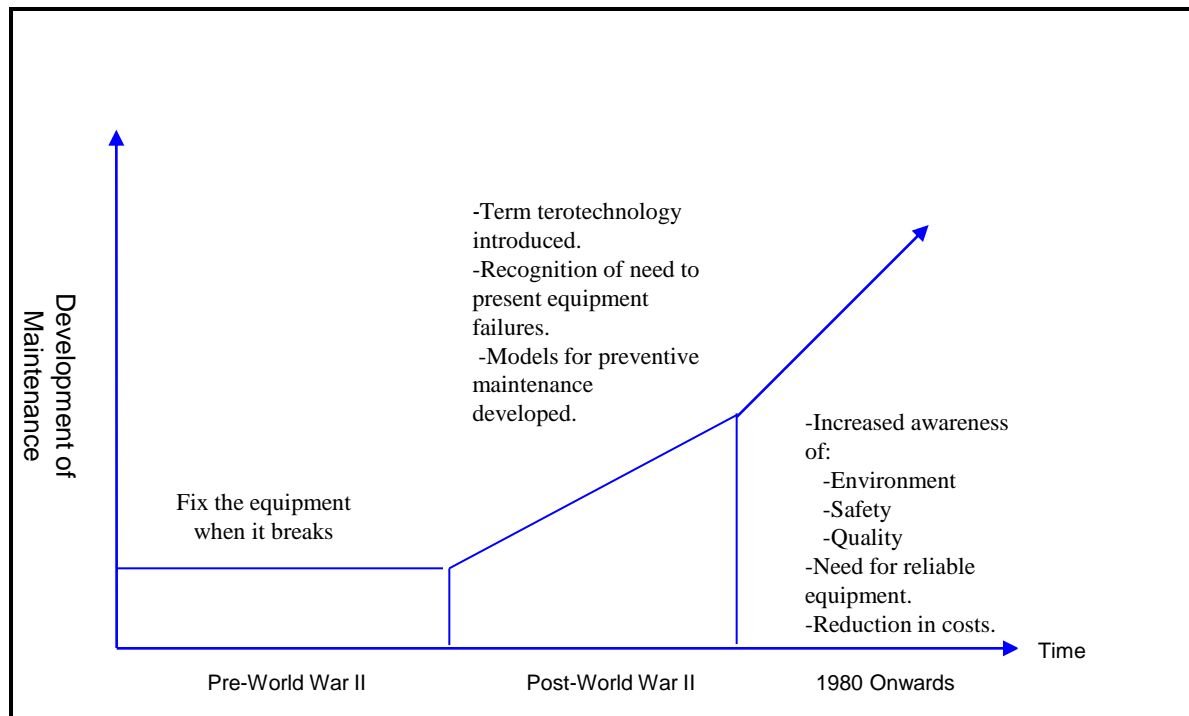
Therefore, the maintenance at that era was restricted to fixing the unit when it breaks because it was the cheapest alternative

Maintenance History

2. During and after World War II at the time when the advances of engineering and scientific technology developed, people developed other types of maintenance, which were much cheaper such as preventive maintenance.

In addition, people in this era classified maintenance as a function of the production system.

Maintenance History



**Figure 2.2 Maintenance History
(Adapted From Shenoy, Bhadury 1998)**

Maintenance History

3. Nowadays, increased awareness of such issues as environment safety, quality of product and services makes maintenance one of the most important functions that contribute to the success of the industry.

World-class companies are in continuous need of a very well organised maintenance programme to compete world-wide.

Maintenance Objectives

Maintenance objectives should be consistent with and subordinate to production goals.

The relation between maintenance objectives and production goals is reflected in the action of keeping production machines and facilities in the best possible condition.

Maintenance Objectives

- Maximising production or increasing facilities availability at the lowest cost and at the highest quality and safety standards.
- Reducing breakdowns and emergency shutdowns.
- Optimising resources utilisation.
- Reducing downtime.
- Improving spares stock control.

Maintenance Objectives

- Improving equipment efficiency and reducing scrap rate.
- Minimising energy usage.
- Optimising the useful life of equipment.
- Providing reliable cost and budgetary control.
- Identifying and implementing cost reductions.

Maintenance Objectives

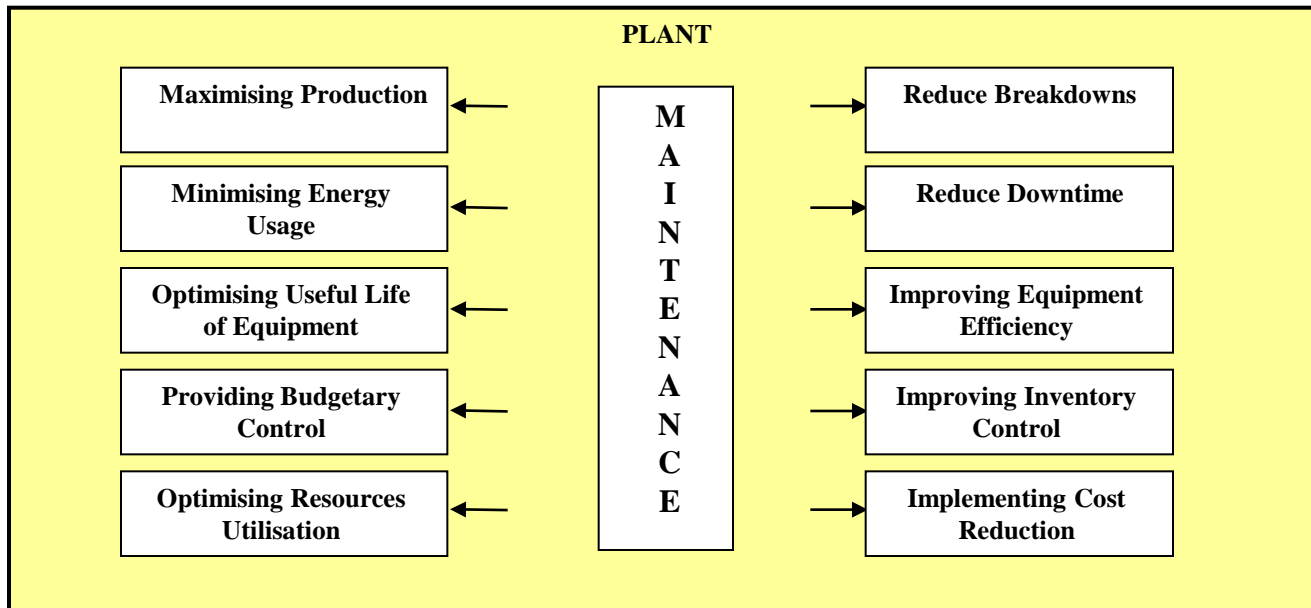


Figure 2.3 Maintenance Objectives

Types of Maintenance

- Run to Failure Maintenance (RTF)
- Preventive Maintenance (PM)
- Corrective Maintenance (CM)
- Improvement Maintenance (IM)
- Predictive Maintenance (PDM)

Run to Failure Maintenance (RTF)

- The required repair, replacement, or restore action performed on a machine or a facility after the occurrence of a failure in order to bring this machine or facility to at least its minimum acceptable condition.
- It is the oldest type of maintenance.

Run to Failure Maintenance (RTF)

- It is subdivided into two types:
 - *Emergency maintenance*: it is carried out as fast as possible in order to bring a failed machine or facility to a safe and operationally efficient condition.
 - *Breakdown maintenance*: it is performed after the occurrence of an advanced considered failure for which advanced provision has been made in the form of repair method, spares, materials, labour and equipment.

Run to Failure Maintenance (RTF)

- *Disadvantages:*
 1. Its activities are expensive in terms of both direct and indirect cost.
 2. Using this type of maintenance, the occurrence of a failure in a component can cause failures in other components in the same equipment, which leads to low production availability.
 3. Its activities are very difficult to plan and schedule in advance.

Run to Failure Maintenance (RTF)

- *This type of maintenance is useful in the following situations:*
 1. The failure of a component in a system is unpredictable.
 2. The cost of performing run to failure maintenance activities is lower than performing other activities of other types of maintenance.
 3. The equipment failure priority is too low in order to include the activities of preventing it within the planned maintenance budget.

Preventive Maintenance (PM)

It is a set of activities that are performed on plant equipment, machinery, and systems before the occurrence of a failure in order to protect them and to prevent or eliminate any degradation in their operating conditions.

Preventive Maintenance (PM)

British Standard 3811:1993 Glossary of terms defined preventive maintenance as:

the maintenance carried out at predetermined intervals or according to prescribed criteria and intended to reduce the probability of failure or the degradation of the functioning and the effects limited.

Preventive Maintenance (PM)

- *The advantage* of applying preventive maintenance activities is to satisfy most of maintenance objectives.

Preventive Maintenance (PM)

- *The factors that affect the efficiency* of this type of maintenance:
 1. The need for an adequate number of staff in the maintenance department in order to perform this type of maintenance.
 2. The right choice of production equipment and machinery that is suitable for the working environment and that can tolerate the workload of this environment.
 3. The required staff qualifications and skills, which can be gained through training.
 4. The support and commitment from executive management to the PM programme.
 5. The proper planning and scheduling of PM programme.
 6. The ability to properly apply the PM programme.

Preventive Maintenance (PM)

- It is good for those machines and facilities which their failure would cause serious production losses.
- Its aim is to maintain machines and facilities in such a condition that breakdowns and emergency repairs are minimised.
- Its activities include replacements, adjustments, major overhauls, inspections and lubrications.

Preventive Maintenance (PM)

- Researchers subdivided preventive maintenance into different kinds according to the nature of its activities:
- *Routine maintenance* which includes those maintenance activities that are repetitive and periodic in nature such as lubrication, cleaning, and small adjustment.
- *Running maintenance* which includes those maintenance activities that are carried out while the machine or equipment is running and they represent those activities that are performed before the actual preventive maintenance activities take place.

Preventive Maintenance (PM)

- *Opportunity maintenance* which is a set of maintenance activities that are performed on a machine or a facility when an unplanned opportunity exists during the period of performing planned maintenance activities to other machines or facilities.
- *Window maintenance* which is a set of activities that are carried out when a machine or equipment is not required for a definite period of time.
- *Shutdown preventive maintenance*, which is a set of preventive maintenance activities that are carried out when the production line is in total stoppage situation.

Corrective Maintenance (CM)

- In this type, actions such as repair, replacement, or restore will be carried out after the occurrence of a failure in order to eliminate the source of this failure or reduce the frequency of its occurrence.

In the British Standard 3811:1993 Glossary of terms, corrective maintenance is defined as:

the maintenance carried out after recognition and intended to put an item into a state in which it can perform a required function.

Corrective Maintenance (CM)

- This type of maintenance is subdivided into three types:
- *Remedial maintenance*, which is a set of activities that are performed to eliminate the source of failure without interrupting the continuity of the production process.

The way to carry out this type of corrective maintenance is by taking the item to be corrected out of the production line and replacing it with reconditioned item or transferring its workload to its redundancy.

Corrective Maintenance (CM)

- *Deferred maintenance*, which is a set of corrective maintenance activities that are not immediately initiated after the occurrence of a failure but are delayed in such a way that will not affect the production process.
- *Shutdown corrective maintenance*, which is a set of corrective maintenance activities that are performed when the production line is in total stoppage situation.

Corrective Maintenance (CM)

- *The main objectives of corrective maintenance* are the maximisation of the effectiveness of all critical plant systems, the elimination of breakdowns, the elimination of unnecessary repair, and the reduction of the deviations from optimum operating conditions.
- *The difference between corrective maintenance and preventive maintenance* is that for the corrective maintenance, the failure should occur before any corrective action is taken.
- *Corrective maintenance is different from run to failure maintenance* in that its activities are planned and regularly taken out to keep plant's machines and equipment in optimum operating condition.

Corrective Maintenance (CM)

- The way to perform corrective maintenance activities is by conducting four important steps:
 1. Fault detection.
 2. Fault isolation.
 3. Fault elimination.
 4. Verification of fault elimination.

In the fault elimination step several actions could be taken such as adjusting, aligning, calibrating, reworking, removing, replacing or renovation.

Corrective Maintenance (CM)

- Corrective maintenance has several prerequisites in order to be carried out effectively:
 1. Accurate identification of incipient problems.
 2. Effective planning which depends on the skills of the planners, the availability of well developed maintenance database about standard time to repair, a complete repair procedures, and the required labour skills, specific tools, parts and equipment.
 3. Proper repair procedures.
 4. Adequate time to repair.
 5. Verification of repair.

Improvement Maintenance (IM)

- It aims at reducing or eliminating entirely the need for maintenance.
- This type of maintenance is subdivided into three types as follows:

1. Design-out maintenance which is a set of activities that are used to eliminate the cause of maintenance, simplify maintenance tasks, or raise machine performance from the maintenance point of view by redesigning those machines and facilities which are vulnerable to frequent occurrence of failure and their long term repair or replacement cost is very expensive.

Improvement Maintenance (IM)

2. *Engineering services* which includes construction and construction modification, removal and installation, and rearrangement of facilities.

3. *Shutdown improvement maintenance*, which is a set of improvement maintenance activities that are performed while the production line is in a complete stoppage situation.

Predictive Maintenance (PDM)

- Predictive maintenance is a set of activities that detect changes in the physical condition of equipment (signs of failure) in order to carry out the appropriate maintenance work for maximising the service life of equipment without increasing the risk of failure.
- It is classified into two kinds according to the methods of detecting the signs of failure:
 - *Condition-based predictive maintenance*
 - *Statistical-based predictive maintenance*

Predictive Maintenance (PDM)

- *Condition-based predictive maintenance depends on* continuous or periodic condition monitoring equipment to detect the signs of failure.
- *Statistical-based predictive maintenance depends on* statistical data from the meticulous recording of the stoppages of the in-plant items and components in order to develop models for predicting failures.

Predictive Maintenance (PDM)

- The drawback of predictive maintenance is that it depends heavily on information and the correct interpretation of the information.
- Some researchers classified predictive maintenance as a type of preventive maintenance.
- The **main difference** between preventive maintenance and predictive maintenance is that *predictive maintenance uses monitoring the condition of machines or equipment to determine the actual mean time to failure* whereas *preventive maintenance depends on industrial average life statistics*.

Types of Maintenance

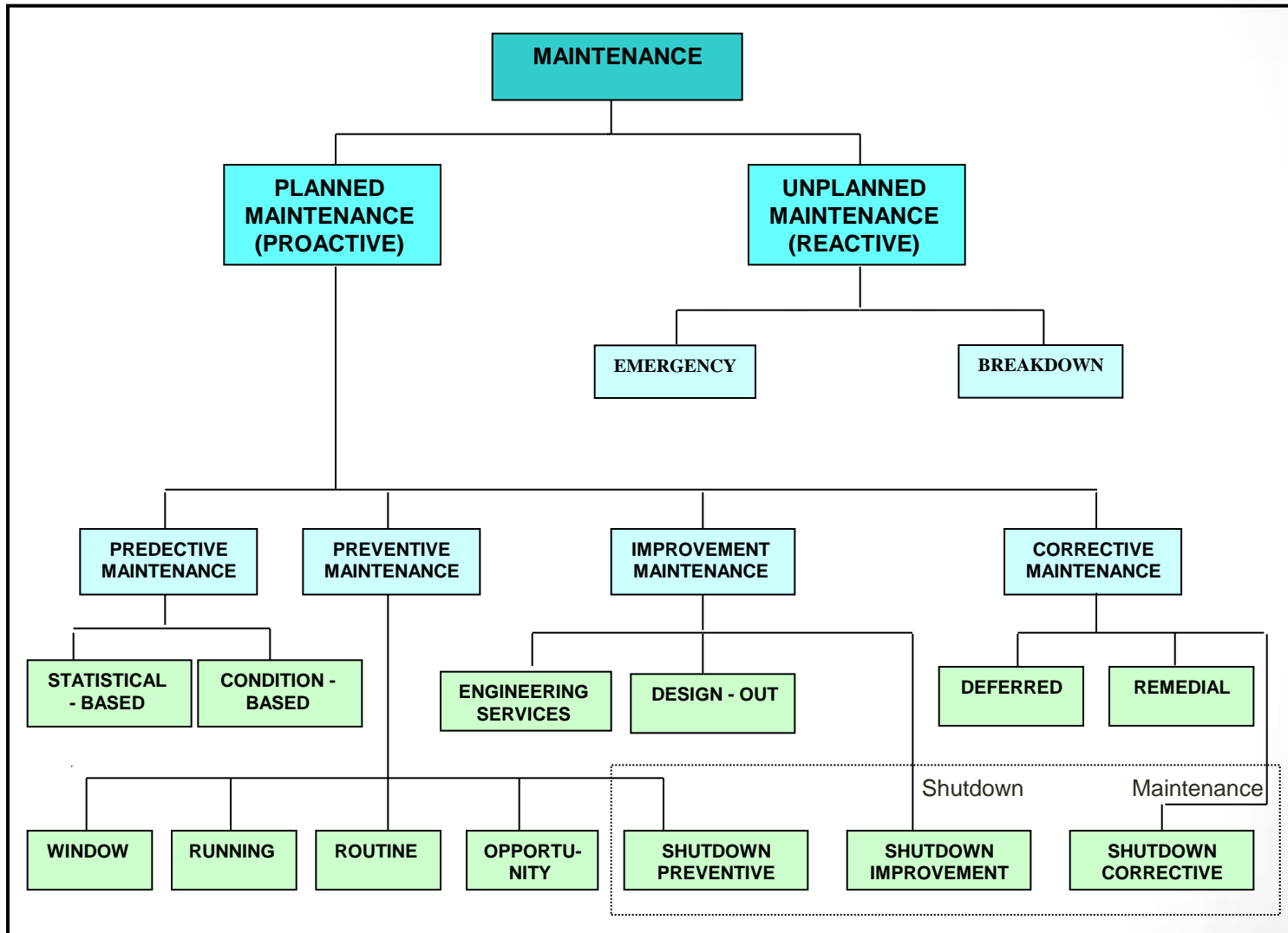


Figure 2.4 Maintenance Types