

1. OBJECTIVES, FUNCTIONS, TYPES AND ECONOMICS OF MAINTENANCE

MAINTENANCE OBJECTIVES:

The objectives of maintenance are to ensure the desired plant availability at an optimum cost within the safety prescription. In other words, it may be mentioned that the objective of maintenance is to minimise the total cost of unavailability and resources.

Whenever the plant is not available either due to breakdowns or due to planned stoppages, the following costs are incurred.

- 1) Loss of earnings due to stoppage of equipment
- 2) Loss of in service materials.

In addition the following costs are incurred on resources:

- 1) Labour of overhead expenses
- 2) Materials in spares and consumables
- 3) Cost of storage of spares and facilities.

Hence, maintenance functions are so, organised as to minimise the total cost of unavailability and resources.

MAINTENANCE FUNCTIONS:

The above mentioned objectives are attained by taking certain action illustrated below:

<u>Action</u>	<u>Purpose</u>
a. Lubrication	
b. Cleaning	
c. Adjustments	Return or slow down the process of deterioration or wear
d. Application of Protective coatings	
e. Examination of the state of the components	Assess the extent of wear and determine, on that basis, the action required to check a break-down and the time when such action should be taken
f. Analysis of history of behaviour of the machine and its components	
g. Replacement of worn out component	

h. Repair of cracks or other repairable damages	Restore the original operational capacity of the machine and prevent further damage
i. Modification of design of the components or location of the equipment.	Affect improvements to reduce the frequency of attention or to reduce cost of maintaining the equipment
j. Capital replacement	Replacement of the machine when the age of the existing machine requirements of quality and quantity of output and emergence of better machines make it economical to dislodge the present and install a new machine.

In these, the first four steps are taken with the sole purpose of reducing friction, wear and effects of environment on the individual parts of a machine. For example, lubrication reduces friction; cleaning prevents corrosion and abrasion due to dust; adjustment of level or alignments or by tightening the loose bolts and nuts eliminates undue stresses; and preventive coatings guard against rust and corrosion. These action increase the useful life of parts and therefore, constitute an intrinsic part of Preventive Maintenance.

The next two steps, inspection of parts and analysis of history, are meant to assess the condition of the part, the extent of wear, the action required to remedy the defect and the time when such action should be undertaken. These activities are undertaken essentially to be able to plan the remedial measures.

Inspection can be external for abnormal sound or temperature which does not require a stoppage of the machine. It could even be internal, requiring a machine to be stopped either purely for inspection or at the time of some other repair or during overhauling of the machine. Historical data on the other hand, is a chronological record of repairs and replacements carried out on a machine during its life in the company. Analysis of such a record helps to estimate the life span of various components and establish the frequency of inspections, repairs, and replacements.

Replacement and repair of components can be undertaken on the basis of inspection reports, analysis of history or complaints of operating personnel.

Another important part of maintenance is the change in some characteristics of the components which gives frequent trouble, to avoid re-occurrence of that trouble with that frequency. Such an action is taken on the basis of history of the equipment and evaluation of costs involved. This

step can be defined as "Maintenance Prevention". Cost of maintenance of the machine rises with the increase in its age. Moreover, passage of time also affects the operational efficiency of the machine. Requirements of quality and quantity of production go through a change making an old machine more or less obsolete in relationship to the new demands.

New and better machines emerge in the market. All these factors make it necessary to replace the existing machines at some stage in their lives by new machines. Maintenance is vitally linked with such action. Analysis to determine the economics in replacement of machines and their physical installation, therefore, becomes a responsibility of the maintenance personnel.

MAINTENANCE TYPES:

1. BREAKDOWN MAINTENANCE:

Characteristics of Break-down Maintenance System:

- * No services except occasional lubrication unless failure occurs
- * No maintenance men on regular basis
- * Maintenance done by sub-contractors
- * No organised efforts to find out reasons
- * No stock of spares
- * No budget
- * No records
- * Initially it looks economical
- * Problems in case of B/D
 - Who is to do repair?
 - From where to get parts?
 - How do we pay for them?
 - Who is to go to buy parts?

Results of Breakdown Maintenance System:

- * Increased Down Time
- * Increased costs & Pressures

2. ROUTINE MAINTENANCE

A procedure followed regularly i.e.,, A cyclic operation recurring periodically.

Advantages

1. Simple to establish & follow
2. Little or no clerical work
3. High degree of prevention by intercepting developing faults.

A more advanced stage of routine maintenance calls for 'service instructions on a pre-printed schedule and checklists'.

Examples:

- * Check all compressors first on Mondays.
- * Lubricate completely two machines daily.

Disadvantages

- * Routine maintenance may not provide the service specified by the manufacturer
- * We may ignore information regarding preceding breakdowns
- * Service required for a machine at different frequencies may be ignored
- * All similar machines may be serviced at same frequency irrespective of working hours.

3. PLANNED MAINTENANCE

In this type of service, the emphasis is placed on the machines.

- What does the manufacturer prescribe?
- Is the unit utilised for two, or three shifts per day?
- Is it working under normal load?
- Are the conditions as good as those envisaged by the manufacturer?
- Do we allow for extra attention owing to corrosion-including conditions?

Characteristics of Planned Maintenance

- * Instructions are more detailed than in routine maintenance

- * Calls for differently timed service for the same unit
- * Schedule is drawn with dates
- * Need for establishing the work-load for the crew
- * Entails considerable planning effort, faithful implementation and recording
- * Initial list of planned maintenance will be in detail and

Advantages of Planned Maintenance

- * Will take into consideration the changes in conditions of use and increased wear of parts
- * Inspections, replacement of parts and adjustments are included in the overall plan
- * Detailed instructions reduce the chance of missing any activity. Unforeseen work is greatly reduced
- * Provides as much attention as the equipment requires - to the best judgement and ability of the planner

4. PREVENTIVE MAINTENANCE

System which strives to reduce the likelihood of failures.

To achieve prevention of break-downs Planned service is carried out with the explicit additional objective of detecting wear points and ensuring perfect functioning by replacing parts which could still be used were it not for the assurance that is required.

Occasional use of statistical analysis/methods for determining life expectancies of parts.

The system employs Measuring & Inspection Devices. This phase is Predictive maintenance.

Preventive Maintenance System is more expensive due to more of planning and replacement of parts before failing.

- PM increases reliability
- PM reduces total work-load
- PM reduces total down time
- PM reduces unplanned work
- PM reduces total maintenance cost

Routine maintenance & Planned maintenance also include Preventive maintenance action.

Preventive maintenance could be grouped as under:

- Fixed-time Maintenance
- Condition-based Maintenance
- Opportunity Maintenance

Corrective Maintenance:

Services carried out to restore an item to an acceptable working condition.

Services arising out of

- Break-downs
- Malfunctioning &
- Deteriorating conditions

Productive Maintenance

An effort to set up the function on a planned and measured production pattern. The output relates to the number of servicing tasks completed, e.g., lubrication, inspection, overhaul, etc. Originally used in USA.

Total Productive Maintenance (TPM)

Efforts with the total participation of employees.

Used in Japan.

ECONOMICS OF MAINTENANCE:

Concept of preventive Maintenance is presently accepted in most of the industries in order to achieve their planned production. Both production and maintenance have the same objective - to produce a quality product at maximum efficiency and minimum cost.

Theoretically maintenance should aim at keeping the machines and other facilities in a condition that allows them to be used without any interruption and at their maximum profit making capacity. Such a situation can be assured in practice only if machines are replaced frequently or if a stand-by machine is maintained which can be put into operation as and when the original unit is stopped for checks, repairs and component replacements.

But, no industrial unit can possibly afford to throw away its capital resources by replacing machines frequently, nor can a company block its money in equipment that will be only partially utilised by having stand-bys.

An organisation has, under such circumstances, to accept a certain loss in productive capacity of its investments to enable maintenance, to examine the various equipment, repair if not in order, and put them back in a condition as required by the users.

Analysis of Maintenance Cost

Downtime of an equipment costs money to the company, which is made up of maintenance labour spent, materials and spares consumed, and supervision exercised. Loss of revenue due to downtime because of maintenance, however, provides a saving to the organisation through

extension of the useful life of plant and facilities and through maintaining them at the optimum standards of operation. This saving consists of reduction in wastage and scrapping of materials, higher level of employee morale and their safety, minimisation of process time and postponement of the necessity of investment for capital replacement.

Management of maintenance has, therefore, to concern itself with the balancing of costs against gains so as to evolve the most suitable policies and determine the maintenance effort required, which as said earlier, is a function of cost and it can vary from Industry to Industry. In establishing a systematic maintenance system, the following stages are normally gone through.

- 0 stage - Only break-down maintenance
- 1st stage - Breakdown maintenance + certain amount of cleaning and lubrication
- 2nd stage - Breakdown maintenance + planned lubrication and inspection
- 3rd stage - In addition to degree 2, preventive replacement of spares (renewal) is carried out
- 4th stage - In addition to degree 3, there are periodic maintenance schedules including overhauls
- 5th stage - In addition to degree 4, predictive maintenance techniques are adopted.

From above it is assumed that as the degree of maintenance effort increases the number of breakdown decreases, while on the other hand maintenance cost increases. Hence, there must be some compromise in order to achieve the optimum maintenance effort.

With the increase in maintenance effort the variation of breakdown cost, Preventive maintenance cost, cost of sub standard performance, cost of spares and the total cost can be graphically represented as shown in Fig.1.

Cost Elements:

The cost elements involved in the above mentioned costs are

- (i) Breakdown (B/D) cost = labour + downtime
- (ii) Preventive Maintenance (PM) cost = labour + downtime due to planned shutdown
- (iii) Cost of sub-standard performance = loss of in-process material + scrapping of material + wastage
- (iv) Cost of spares = cost of spares + other materials.

The optimum maintenance effort required varies from Industry to Industry. Hence, the maintenance whose objective as said earlier, is to produce a quality product at maximum efficiency and minimum cost, should concern itself to evolve the most suitable maintenance effort required.

FIGURE-1