CHAPTER-9

COST OPTIMISATION IN MAINTENANCE MANAGEMENT

9.1 INTRODUCTION

No better introduction than the verse of holy *Quran* can be given for the maintenance that any thing found in this mortal world is whether natural or man made will decay or lose its utility with the passage of time but this decay can be delayed or useful life can be increased by proper maintenance. It is obvious from every day life by the centuries old saying 'a stitch at a time saves nine'. Though this thought is known to every one but is practiced in reality by very few who realize the importance of maintenance in terms of time, cost and the efforts involved.

Today because of complexity of equipment, material and cost involved the entire maintenance operation can be said as combination of managerial, financial, engineering, technology and other practices applied to physical assets, in pursuit of increasing economic life or reducing lifecycle cost, or in other word understanding the term ‘Terotechnology’ which encompasses everything like specification, reliability, maintainability of plant, machinery, equipment, building and structures with their installation, commissioning, maintenance, modification and replacement coupled with the feed back of information on design, performance and cost.

In fact the word ‘terotechnology’ itself stems from the Greek root ‘terein’ – ‘to look after’ or ‘to guard over’ or ‘to take care of’.

The study of maintenance has two major aspects. One is engineering aspect and another is managerial aspect as shown in Fig.9.1

![Diagram of Two Aspects of Maintenance Practice]

**Fig. 9.1 : TWO ASPECTS OF MAINTENANCE PRACTICE**
Unplanned maintenance is basically emergency maintenance which is defined as breakdown maintenance, for which it is necessary to put the things right at hand immediately to avoid serious consequences, for instance loss of production, extensive damage to assets or for safety reasons.

Planned maintenance can be split into two main activities, preventive and corrective. The major part of preventive maintenance involves, inspection on the basis of look, feel and listen and make minor adjustments at the predetermined intervals and discover the replacement needs as the result of such inspection.

Corrective maintenance involves minor repairs, usually of short term planning that may crop up between inspections, planned overhauls are also included such as yearly and two yearly overhauls, the extent of which would have been planned in detail on a long term basis as a result of preventive inspection. However, preventive maintenance not only reduces emergency maintenance but also the corrective maintenance.

Function of maintenance department may vary from company to company depending upon the size and the managements’ policies. In general the function of Maintenance Department can be grouped under primary and secondary functions.

9.2 PRIMARY FUNCTIONS

(1) Maintenance of existing plant, equipments, buildings and grounds.
(2) Lubricants and inspection of equipments.
(3) Maintenance of equipments for generation and distribution of power and other utilities.

9.2.1 MAINTENANCE OF EXISTING PLANT, EQUIPMENTS, BUILDINGS AND GROUNDS

It is the first and foremost function of a maintenance department. It includes the repairs of machinery and plant in efficient and economic way, taking preventive actions where necessary and minimizing the repair time.

Repair of building (roofing, glass replacement, painting), roads, sewers, water systems and electrical systems etc. constitute another major portion of the work. Quite often in larger plants a special organization takes care of maintenance of buildings and grounds and separate accounts are maintained for this type of work. Such arrangements greatly help, in controlling the costs and enforcing efficient functioning.
9.2.2 LUBRICATION AND INSPECTION OF EQUIPMENTS

Normally, operators handle lubrication of machinery and the duty of maintenance group is to provide them information on specifications and doses of lubricants and explain them procedures and practices of lubrication and inspection.

9.2.3 MAINTENANCE OF EQUIPMENTS FOR GENERATION AND DISTRIBUTION OF POWER AND OTHER UTILITIES

Equipments for generation of electricity and other utilities like water and compressed air are taken care of by Maintenance Department. The purchase and distribution of electrical power and water supply are also handled by Maintenance Department.

9.3 SECONDARY FUNCTIONS

(1) Keep-up of maintenance sub-stores.
(2) Fire protection.
(3) Accounting of property and insurance administration.
(4) Salvage and waste disposal (sometimes).
(5) Other services (such as janitorial, pollution control and safety).

9.3.1 FIRE PROTECTION

Normally fire protection is not under the Maintenance Department. In large projects, fire protection is the responsibility of security personnel, which is generally put directly under the Personnel Department, but in smaller projects, it is attached to Maintenance Department.

9.3.2 ACCOUNTING OF PROPERTY AND INSURANCE ADMINISTRATION

Property accounting deals with establishment and maintenance of records and reports of all the equipments, work-in-progress and of the completed works. This is essential for supplying the detailed and complete information to the Accounting Department.

Insurance administration covers inspection of heavy-equipment claims to be settled with insurance representatives. Depending on management policies these functions may be put under some other department as well.

9.3.3 SALVAGE AND WASTE DISPOSAL

The main job of salvage group is to make use of reclaimed materials. Maintenance Department is generally made responsible for providing sufficient waste pick-up force and to accumulate the pick-up material in special containers or locations, so as to eliminate dangerous and obnoxious surroundings.
9.3.4 OTHER SERVICES

These generally consist of services like pollution control & sewer maintenance and liaison with government agencies.

9.4 REQUIREMENT OF MANPOWER FOR MAINTENANCE

There are many factors, which must be considered in determining the number of workers and supervisors for the complete maintenance of the site. If company is using modern automatic machinery, may require higher number of maintenance crew if traditional equipments are being used then only, a limited number of persons are needed.

Thus to have an approximate estimate on the size of maintenance crew, it will be more realistic to choose estimated maintenance cost as a basis which itself has been taken as a percentage of investment on machinery. The annual cost of maintenance might run between 3 to 5 percent of investment in tools, plants and machinery. Yearly maintenance of building may run between 3 to 8 percent depending on type, size and use of the building. The labour cost may alone constitute 30 to 50 percent of total maintenance cost.

9.4.1 NUMBER OF CRAFTSMEN AND THEIR GROUPING UNDER DIFFERENT CRAFTS

The number of craftsmen should be well balanced between different crafts and as far as possible should be optimum, so that there remains no surplus in one craft and shortage in another craft. It is the amount of work and different functions assigned to the Maintenance Department, which become the prime considerations in deciding the number and kinds of shops. If skilled contractors are available, the number of shops and craftsmen can be reduced greatly. Quite often in smaller project, a few maintenance-men who are jacks-of-all-trades may be placed in one shop without any problem. While in larger project separate shops may be set-up for each craft.

Supervision is also an important part of the maintenance programme. For skilled craft man density should be higher and for unskilled labour it must be lower. Supervisors should always try to train the craftsmen and should save time for future planning and to improve the efficiency of the maintenance shop.

9.4.2 SELECTION OF MAINTENANCE PERSONNEL

To achieve low cost and high productivity at all levels of maintenance, competence of foreman and craft men plays a major role. Diversified experience and competence should be the main criteria for the selection of foreman and crafts men. In scholar’s opinion the foremost quality to be judged in any candidate ‘the desire to learn and has an attitude towards cost consciousness’.

258
9.5 OPTIMISING PREVENTIVE MAINTENANCE PRACTICES

The concept of preventive maintenance is applicable to any activity ranging from maintenance of car to maintenance of a big plant or heavy construction equipment at a project site. A well-planned preventive maintenance programme prevents breakdowns and cuts operating cost and at the same time it also improves the output and quality of the product.

The activities included in preventive maintenance are firstly to inspect tools, plants and equipments for detecting faults for purposes of minimising break down or accelerated depreciation and secondly the upkeep of the plant to eliminate such conditions before actual break down occurs. Number of breakdowns is a clear pointer of effectiveness of preventive maintenance programme.

It is well known that as an industry gets mechanized, the preventive maintenance becomes more and more advantageous to it. With the increasing complexity of modern equipments, the cost of maintenance is going up and that is equally true in relation to the cost of downtime as well.

Preventive maintenance must be interpreted with several other maintenance functions such as paper work systems, work planning and scheduling, training, work measurement, control reports, goods shop and tools. Major returns from preventive maintenance can be listed below:

1. More production and less production down-time,
2. Reduced overtime payments,
3. Lesser number of major repairs,
4. Cheaper costs of ordinary repairs,
5. Better quality output,
6. Elimination of cash outlays for earlier replacement of plant and equipment
7. Few standby equipments
8. Items with abnormal maintenance costs are brought to light
9. Change-over from inefficient break-down maintenance to the planned and economic maintenance
10. Smaller inventory levels of spare parts

In simple words, preventive maintenance can be considered as a function of minimising the number of breakdowns or accelerated depreciation of plant and equipment, through periodic inspections and corrections of such harmful conditions. This can be well achieved by creating the value “preventive maintenance is the duty of everybody”.

9.6 INSPECTION – ITS RESPONSIBILITIES AND REPORTS

The most important information, right from the beginning, is the preparation list, this must include all the items to be inspected. In fact such a list cannot be easily prepared. There are some general principles and certain do's and don'ts as guides and beacons. In general, most of the managers agree that the following items must be included.

(1) Motors
(2) Production machinery,
(3) Buildings,
(4) Materials handling equipment
(5) Process equipments
(6) Plant services
(7) Lighting
(8) Controls mechanisms
(9) Electrical panel boards

According to a process-plant management, the preventive maintenance items must cover piping, pumps, compressors, motors, instruments, vacuum and pressure relieving valves, flame arrestors, breathing and emergency-relief equipment, generators, supply storage and distribution systems for water, compressed-air pipelines, storage tanks, pipe lines, dikes, drains, gauges, measuring instruments, shipping and storage areas, transportation equipment such as tank-cars, fire-extinguishing installations (of foam, fog, gas, spray, or dry powder) first-aid extinguishers, alarm system etc.

Seasonal functions of equipment should also be taken care of. For example, a refrigeration system, which is generally not used in winter, should be pumped down or the plants and gardens may need to be given protection against scorching summer. Wherever necessary, special measures must be adopted for the preservation of machinery and ancillaries during shutdowns for off-season, vacations, and strikes or during natural catastrophes.

Following points should be kept in mind in deciding inspection policy.

(1) Whether the item is critical and going to cause major shut -down or damage?
(2) Whether the plant is having standby equipment and what is going to be the cost of breakdown maintenance?
(3) Is the cost of preventive maintenance going to exceed the down time cost plus the cost of repairs?
(4) Will preventive maintenance prolong the life of the equipment more than protection requirements, if so, preventive maintenance may be a waste?
(5) Do the poor working environments or unclean equipment conditions hamper production and expose employees to greater hazards?
9.6.1 EQUIPMENTS WHICH NEED INSPECTION

Immediately the next question arises, what physical parts on each piece of equipment must be inspected, unless an inspector is told, about the parts to be inspected he will be just wasting his time. Necessary inspection points can be singled out with the help of maintenance force only. The craftsmen who regularly maintain the equipment are many a time better inspectors than the manufacturers.

Service manuals received from the manufacturers must always be referred to. They are the best guides for maintaining the equipments. After a list of machines and inspection points has been prepared, it would be the best if checklists were also worked out. Most of the plants having preventive maintenance programme do make use of checklists. These include all the points to be checked on each piece of equipment or property. This checklist also has columns where the inspectors can put the dates and initials at the time of checking and this way nothing is left to the memory. This also helps in maintaining uniformity and complete inspection, irrespective of who does it. Preventive maintenance administrator must make sure that no items are omitted. But at the same time he must be careful that inspection costs do not get inflated through needless checks and tests.

An inspector may feel that the list gives everything and he need not inspect anything else. Often management feels that such thinking discourages his ability or imagination. It would be best if a column is provided on the form, asking from the inspector what additional should be included for the next inspection. Checklists need constant up-dating and experience shows that often a few items, which have been previously overlooked, need to be included. The number of check-lists vary from plant to plant. Generally a checklist for each piece of equipment is quite a common practice. Checklist may be used for several other purposes as well. For example, they can be combined with the inspection schedules and provided on checklists where the inspector marks the estimated future date of repairs. Such type of data provides details for long range planning and budgeting to the maintenance executive.

9.6.2 INSPECTION FREQUENCIES

The preventive maintenance administrator must also decide how often to inspect. Such a decision needs consideration of costs and savings from a preventive maintenance programme. Over-inspection is needless expense and may result in larger downtime even more than that in case of emergency breakdown. Under-inspection, leads to more breakdowns and quicker replacement. To maintain a good balance the major problem
and only longer experience with the equipment can solve it. For fixing the frequencies of
inspection, no formula is available. The criteria, which have a bearing on frequency, are
following.

(1) Age of equipment
(2) Type of equipment
(3) Environment
(4) Type of operation.

Many a time manufacturer's recommendations are very helpful but they also
clearly specify that their recommendations are applicable to normal conditions only and
recommend that each plant must modify their figures in the light of their own exposures
and the intensity of services. Certain professional bodies such as Electrical Machinery
Manufacturers' Association, Safety Council, Insurance Companies, etc. do issue certain
time-tables giving inspection frequencies for various types of equipments.

At this stage it must be made clear that any single piece of equipment may have
several inspection frequencies such as under.

(1) Once daily for cleaning
(2) Once weekly for adjustments
(3) Once monthly for functional inspection
(4) Once yearly for overhaul.

So all the types of maintenance inspections should be taken care of, and for ease
of operations may be categorised under lubrication, sanitation, painting, testing and the
like, excluding repairs.

Before deciding upon the frequency cycles we must make use of engineering
analysis of the equipment from the following view points.

(1) age, conditions, and value
(2) safety requirements
(3) Hours of operation
(4) Rate of wear
(5) Conditions leading to damage
(6) Conditions affecting adjustments
(7) Intensity of operations

While revising the manufacturer's recommendations the following data can be of
great help:

(1) Service records
(2) Maintenance work-orders
(3) Craftsmen
(4) Operating overheads of sections
(5) Quality control reports
(6) Records of other plants in the same industry.

It would be better to check the results continuously and then keep on modifying frequency cycles in accordance with production needs. It will be true for all the phases of preventive maintenance, viz. what to inspect and when to inspect and how to inspect. Cost of discarding good parts will definitely add to preventive maintenance costs. Experience has proved the fact that preventive maintenance fails only when its administrator fails to up-date the frequencies of inspection and repairs. Generally it takes about a year to stabilise inspection programmes.

To be sure about the validity of a cycle, the methods used are following.

(1) Trial and error
(2) Checking of new equipments more frequently till it is run-in
(3) Every time an inspection is made, the inspector must point out the needed modifications in frequency cycles.

For hitting at the optimum, it will be the best, if a ledger is maintained showing on one side the number and costs of inspections and repairs; and on the other side the number and costs of repairs and breakdowns. In case there are no repairs it is possible that the plant is being over-maintained, if too many inspections are needed it is possible that they are not getting at the root of the trouble. Success of Preventive Maintenance can be measured by comparing scheduled maintenance with the unscheduled maintenance. Too much unscheduled work, means lack of preventive maintenance. No unscheduled work means over-maintenance. Many managers feel the best would prevail if about 80% of the total man-hours of the maintenance crew are spent on scheduled work including the preventive maintenance and inspection and the rest 20% is being spent on emergency breakdown.

Analytically a schedule may be perfect but even then a small item may cause trouble. For example, failure to check-up an alarm may lead to great penalties if it does not function when it should. Scheduling means determination of calendar dates on which inspection should be held, so that the frequency requirements are accomplished in an efficient way. The most important criterion for setting-up schedules is that the maintenance activity keeps production going at lowest costs. The schedules must be arranged according to the needs of the production.

The major problems in scheduling are as under.

(1) Routine up-keep – this can be done at regular intervals and consists of adjustments, lubrication, cleaning, etc. while the equipment is operating or idle,
(2) Periodical inspections which can be accomplished while the equipment is running or shut down – those are visual inspections, tear-down inspections, over-hauls and scheduled replacements of parts

(3) Contingent work, which includes work done at definite intervals when equipment is down. The most of the preventive maintenance work can be squeezed within contingency category the less costly it will be. This can be achieved by preparing the priority list of inspection jobs to be taken up during periods of major downtime of various equipments.

9.7 IMPORTANT DATA

Any company having preventive maintenance programme must use five basic forms titled.

   (1) Equipment Record
   (2) Checklists
   (3) Inspection Schedules
   (4) Inspection Report
   (5) Maintenance Cost Record

   In spite of all complexities, preventive maintenance remains an effective tool of management. Experience and development of new procedures make preventive maintenance administration easier. The executive, administering preventive maintenance must be technically skilled to highest level and should be a good administrator as well.

REFERENCES

9. White, E.N (1973), Maintenance Planning-Control and Documentation, Gower Publisher Essex