Theory and Practice of Maintenance

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ABSTRACT

Maintenance is an essential activity of any manufacturing unit. It is possible with good skilled. and trained labour force. Any forward looking management shall work with good strategy for improved financial performance, strive for best systems and processes, plan to enhance the employee skills with good corporate governance. Each of these factors has a role to play in the process of value creation and positive growth of the company. The best managed companies use clear distribution of responsibilities and powers in the organization. Due consideration should be given to periodic reports from different sections for predictive and preventive maintenance for zero loss in production time. Adequate budget provisions should be made for spares, contracting labour and regular maintenance staff. The mill should strive for zero break down maintenance and zero defect in product quality.

KEYWORDS: Financial Performance, Proper strategy, Productivity, Spares, Skilled labor

INTRODUCTION

In today's competitive market place, companies must achieve high productivity while decreasing and controlling total costs. Maintenance must be a partner in this endeavor and not merely a "Cost of doing business". The effectiveness of the maintenance function largely determines the availability and performance of production equipment. This has a large impact on efficiency (1). Maintenance therefore plays an increasingly significant role in determining the efficiency and perhaps survival of companies.

Maintenance is not merely preventive maintenance (2), although this aspect is an important ingredient. Maintenance is also not merely lubrication, although lubrication is one of its functions. Nor is maintenance simply a frenetic rush to repair a broken machine part or building segment, although this can sometimes be a dominant maintenance activity.

In a more positive vein, maintenance is a science since its execution relies, sooner or later, on most or all of the sciences. It is an art because seemingly identical problems regularly demand and receive varying approaches and actions. It is above all a philosophy because it is a discipline that can be applied intensively, modestly, or not at all, depending upon a wide range of variables that frequently transcend more immediate and obvious solutions. Moreover, maintenance is a philosophy because it must be as carefully fitted to the operation or organization it serves. Proper and reliable maintenance helps in avoiding major failures and maintaining zero defect production as desired for Total Quality Maintenance (TQM) and Total Productivity Maintenance (TPM) as per the new quality standards.

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The operational techniques and activities that are used to fulfil requirements for quality include terms when referring to a sub-set of quality control, such as" manufacturing quality control", or when referring to a broader concept, such as "company-wide quality control".

Quality control involves operational techniques and activities aimed both at monitoring a process and at eliminating causes of unsatisfactory performance at relevant stages of the quality loop (quality spiral) in order to result in economic effectiveness.

Quality assurance: All those planned and systematic actions necessary to provide adequate confidence that a product or service will satisfy given requirements for quality.

1. Unless given requirements fully reflect the needs of the user, quality assurance will not be complete.

2. For effectiveness, quality assurance usually requires a continuing evaluation of factors that affect the adequacy of the design or specification for intended applications as well as verifications and audits of production, installation and inspection operations. Providing confidence may involve producing evidence.

3. Within an organization, quality assurance Serves as a management tool. In contractual situations, quality assurance also serves to provide confidence in the supplier.

Quality system documentation: All the quality system elements, requirements and provisions should be clearly documented in a systematic and orderly manner.

PRIMARY FUNCTIONS :

Maintenance of Existing Plant Equipments.

This activity represents the physical reason for the existence of the maintenance group in that section. Responsibility here is simply to make necessary repairs to production machinery quickly and economically and to anticipate these repairs and employ preventive maintenance where possible. For this, a staff of skilled technicians capable of performing the work must be retained and adequate records for proper distribution of expense must be kept. Some mills have listed the various tasks to be performed daily, weekly or monthly as per specific needs of that equipment, machine or section. Performa available in respective sections are completed and reported back to the competent authorities at the desired intervals. This helps in avoiding major failures and maintaining zero defect production as

desired in new quality systems for Total Quality Maintenance (TQM) and Total Productivity Maintenance (TPM).

Maintenance of Existing Plant Buildings and Grounds.

The repairs to buildings and to the external property of any plant-roads, railroad tracks, in-plant sewer systems, and water supply facilities- are among the duties generally assigned to the maintenance engineering group. Additional aspects of buildings and grounds maintenance may be included in this area of responsibility. A plant with an extensive office facility and a major building-maintenance program may assign this coverage. to a special team/ section. Repairs and minor alterations to buildings-roofing, painting, glass replacement-or the unique repair skills required to service electrical or plumbing systems or the like are most logically the purview of maintenance engineering personnel. Road repairs and the maintenance of tracks and switches, fences, or outlying structures may also be so assigned. In the new ISO 9000 specifications great emphasis is being given to Environmental consideration along with TQM and TPM.

Equipment Inspection and Lubrication.

Although many mills persist in assigning these functions to production department personnel, it is an ill-advised practice in light of the increasingly technical aspects of both inspection and lubrication, and lubricants. In medium and large mills, these activities are almost invariably delegated to the maintenance engineering group, resulting in greater standardization and a more impartial follow-up.

Utilities Generation and Distribution.

In any plant with co-generation system, normally the powerhouse has an operating department of its own to look after the production of steam and power, their distribution and recycle/ reuse of condensates.

ORGANIZATION

Maintenance, as noted, must be carefully tailored to suit existing technical, geographical, and personnel situations. Basic organizational rules do exist, however. Moreover, there are some general rules covering specific conditions that govern how the maintenance engineering department is to be structured. It is essential that this structure does not contain within itself the seeds of bureaucratic restriction nor permit empire building within the plant organization.

Establish reasonably clear division of authority with minimal overlap.

Authority can be divided functionally, geographically, or on the basis of expediency; or it can rest on some combination of all three. But there must always be a clear definition of the line of demarcation to avoid the confusion and conflict that can result from overlapping authority, especially in the case of staff assistants.

Keep vertical lines of authority and responsibility as short as possible.

Stacking layers of the intermediate supervision, or the over application of specialized functional staff aides, must be minimized. When such practices are felt to be essential, it is imperative that especially clear divisions of duties are established.

Maintain an optimum number of people reporting to one individual.

Good organizations limit the number of people reporting to a single supervisor to between three and six. There are, of course, many factors which can affect this limitation and which depends upon how much actual supervision is required, one man can direct the activities of twelve or more individuals.

FIT THE ORGANIZATION TO THE PERSONALITIES INVOLVED

In theory at least, smooth organizational flow occurs when allowance is included for the feelings and capabilities of the people involved. This implies some built in flexibility to fit changing personnel and conditions.

The foregoing basic concepts apply across the board in any type of organization. Especially in maintenance, local factors can play an important role in the organization and in how it can be expected to function.

Type of operation.

Maintenance may be predominant in a single area building, machine tools, process equipment, piping or electrical elements and this will affect the character of the organization and the supervision required.

Continuity of operations.

Whether an operation is a 6-day, single shift one or, say, a 7-day, three shift one makes a considerable difference in how the maintenance engineering department is to be structured and in the number of personnel to be included.

Geographical situation

The maintenance that works in a compact plant will vary from that in one that is dispersed through several buildings and over a large area. The latter often leads to area shop and additional layers of intermediate supervision at local centers.

Size of plant.

As with the geographical considerations above, the actual size will dictate the number of maintenance employees needed and the amount of supervision for this number. Many more subdivisions in both line and staff can be justified, since this overhead can be distributed over more departments.

Work force level of training and reliability.

This highly variable characteristic has a strong impact on maintenance organization because it dictates how much work can be done and how well it can be performed. In industries where sophisticated equipments predominate, with high wear or failure incidence, more mechanics and more supervisors are going to be required.

These factors are essential in developing a sound maintenance department in an organization. It is often necessary to compromise in some areas so that the results will yield an orderly operation at the beginning yet retain sufficient flexibility for future modification as need indicates.

SPECIALIZED PERSONNEL IN MAINTENANCE ORGANIZATION

Some believe that engineers should be utilized only where the maximum advantage is to be taken of the professional training and experience and that these individuals should not be asked to handle supervisory duties. Others feel that technical personnel must be developed from the line in order to be effective and that the functions of professional engineering and craft supervision must somehow be combined. Both views are valid.

Mr. Joe Miller and Mr. Ed Fuller (3) of Beloit Corporation feel that the mills cannot afford to let their people fall behind the trend towards more advanced technology. Each time a new equipment is installed, there is not only a equipment to operate, there is also a new type of technology to master. It is essential that people should first feel comfortable with the technology before they can even begin to learn its operation. According to them not everyone learns and retains the information in the same way. Research has identified three types of learners: auditory, visual and kinaesthetic. They can be identified as follows:

***Auditory (Hearing*):** Learns best in formal class or lecture settings.

***Visual (Seeing*):** Learns best in presentation settings with visual aids.

Kinaesthetic (Touching): Learns best in demonstration or hands on settings.

Most people are combination learners, but have one dominant form through which they most readily learn and retain information. On the mill floor, maintenance personnel and operators face the three types of learning everyday. If there is a problem, the operator will first explain it to the maintenance personnel *Auditory.* Then they will inspect the machine or component *Visual.* And finally, the maintenance crew may begin disassembling the machine to locate the problem - *Kinaesthetic.* In view of the above the training programmes should be so formulated that all the skills can be enhanced as per specific needs.

MAINTENANCE CATEGORIES

Maintenance incorporates the following types (5):

Breakdown On the basis of importance of loss of production and quality, increase in environmental pollution, nature of accident etc, may need appropriate immediate attention due to equipment failure.

Preventive Can be planned or periodic. Visual inspections, condition monitoring, or repair/ replacement tasks are accordingly under taken.

Predictive: Usually planned based on the specific requirement of the machine, component life.

According to world class, the performance of Planning and Scheduling are:

Daily:
- Planned and scheduled 75%
- Opportunistic Maintenance 20%
- Break in jobs 5%

Shut down:
- Planned and scheduled 90%
- Opportunistic Maintenance 10%
- .Break in jobs 0%

In addition to corrective and preventive maintenance, excessive maintenance may be caused by improper equipment design, poor quality manufacturing, misapplied equipment, or process changes that cause improper operation. Long term solutions often require major system and/ or equipment modifications with heavy financial implications. Improper or no periodic checking even lead to serious accidents like bursting of digesters and dryers causing even spot deaths, in some cases. Improper design of a low capacity turbine had even lead to a virtual closure of a good running mill due to the severe financial crisis caused by the purchase of that turbine and related infrastructure.

Predictive maintenance can minimize the need for disassembly and inspection of internal parts. Just as important, through periodic measurement or monitoring, it is possible to identify conditions that require correction before a major problem develops. Predictive maintenance takes advantage of the fact that commercial equipment is available that can be used such as portable vibration analyzers and amplitude meters, vibration amplitude and axial-displacement monitors, ultrasonic equipment for wallthickness measurement, and other non-destructive testing or measuring devices, optical tooling and non-contacting displacement sensor for a monitoring alignment, and conventional pressure, vacuum, flow, temperature, and load measuring devices. With such equipments, conditions can be measured and recorded periodically or, when justified, continuously monitored with alarms or cut offs set at pre stabilized levels. In many conditions this approach can assure maximum service life without increasing the risk of failure.

PREDICTIVE MAINTENANCE VERSUS PERIODIC INSPECTION MAINTENANCE

The term "predictive maintenance" is used to identify the maintenance philosophy described previously. To sum up this philosophy in slightly different words, predictive maintenance evolved from two basic facts:

1. Certain vital parts last longer and operate better if not frequently taken apart.

2. Operation until complete destruction is not only foolish but costly.

These facts represent the extremes of the situation. From an economic viewpoint, it is definitely poor policy to be constantly tearing an engine down for inspection. On the other hand, for both safety and economic reasons, we cannot go to complete destruction before exercising some form of maintenance or adjustment. The answer lies in the fact that thousands upon thousands of operating hours have proven that 99% of all failures are preceded by certain signs. conditions, or indications that these parts were going to fail. This being true, it would be ideal to use these indicators or signs in determining just when an engine should be overhauled or when some urgent repairs are to be undertaken. They could also be used to ward off serious premature casualties subject to the limitations mentioned above.

Case Study 1-

In one of the paper mills in Kashipur, spherical digester had burst open during operation, resulting in death and serious injury of a few persons.

The mill has installed pressure regulating valve / safety valve at the steam supply headers for each digester separately, which is taking due care for

the maximum pressure of the steam supplied in the digesters.

The digesters are operated at around 5 to 7 kg/cm^2 steam pressure or 140 to 170 ^{o} C. At a time during the operation, it may be carrying 25 to 30 tons of hot material and obviously the accidental opening of the lid cover led to the sudden exit of several tons of high temperature material in the surroundings; resulting in the severe injuries and death of some of the persons present over there. It appears that the bolts responsible to keep the lid cover closed had broken down first during rotation of the digester which led to the disengagement of the lid from clamps due to slight rotation of the free cover. The failure of sudden opening of the digester cover is thus only mechanical in nature, which was caused due to improper care by the operating and maintenance personnel.

It is expected that continuous monitoring by the maintenance staff and proper reporting by the operating staff about the status of the lid cover, thickness of the digester plates, nuts and bolts could have helped in avoiding such accidents. Continuous checking of the safety valves for their reliable operation is also to be carried out at regular intervals. Proper safe operation training of the maintenance and operating personnel may also help in avoiding future accidents.

It was also noted that the lids were opening outside and the mill was advised to change the design of the lid cover so that they can open inside and with proper clamping arrangements, they shall be relatively safer in operation.

Case study 2-

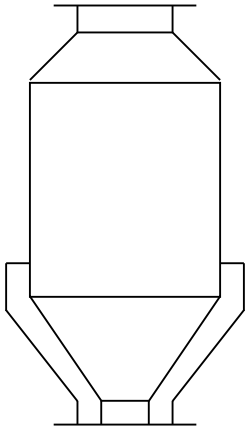
In another paper mill (Now closed) Digester had burst resulting in death of 4 persons on the spot. In this case the periodic checking of wall thickness was not carried out and the joints became week due to chemicals.

This shows that periodic checking of wall thickness and weldings is necessary for safe operation.

Case Study 3-

Some times in new plants, extrapolations are carried out in the absence of proven data for scale variations. One of the good running paper mill decided to go for small capacity extraction turbine, of the scale which had not been tried before. Even a high pressure boiler was installed for this purpose. Unfortunately the turbine

Case study 4-



did not perform as per specifications. This huge expenditure virtually led to closure of the good running mill due to the severe financial crisis caused by the purchase of that turbine and related infrastructure.

As per IS 2825, Code for unfired pressure vessels, the wall thickness in the digester in the lower section has to be higher than the upper section, The lower section has higher corrosion and erosion effect in comparison to the upper section. The bottom thickness should be continuously monitored. In one paper mill the bottom portion had to be replaced when it was observed that the thickness has gone lower than the minimum design thickness due to continuous operation.

CONCLUSIONS

Maintenance is an essential activity of any manufacturing unit. It is possible with good skilled and trained labor force. Distribution of responsibilities and powers should be clearly defined. A senior executive should be responsible for quality, productivity and maintenance activities. Due consideration should be given to periodic reports from different sections for predictive and preventive maintenance. Adequate budget provisions should be made for spares, contracting labors and maintenance staff, for zero break down maintenance and zero defect in product quality.

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REFERENCES

1. Anja Klarin "*Concept of maintenance in the pulp and paper industry*" Materials, Corrosion Prevention and Maintenance. "*Paper making Science and Technology*" Finnish Paper Engineer's Association and TAPPI Press.

2. Lindley R. Higgins. "*Maintenance Engineering Handbook*" Fifth Edition.

3. "*Inpaper International*" vol.3 Issue 1, Oct-Dec (1998).

4. Asokkumar. K. and Parameswaran N.S., " *Trends and ideas on maintenance strategies and practies*" IPPTA JournalVol. 15,No.3 July-Sept. 65(2003).

5. Heinz P. Bloch. "*Improving Machinery Reliability*" (Practical machinery management for Process Plant) Vol. 1, Second Edition.

6. Jha. Mohan, "*Maintenance in Pulp and Paper industry*" IPPTA Journal Vol. 15,No.3 July-Sept. 65(2003).