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## **INTEGRATION OF MAINTENANCE SYSTEMS**

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### **ABSTRACT**

In this paper, an integration of maintenance systems such as CBM, RCM and TPM is proposed for a continuously monitored system subject to degradation due to the imperfect maintenance, where a hybrid hazard rate based on the concept of age reduction factor and hazard rate increase factor is used to predict the evolution of the system reliability in different maintenance cycles. A maintenance policy is suggested for an integrated maintenance system.

**Keywords:** maintenance, TPM, RCM, CBM.

### **INTRODUCTION**

Excellence in maintenance is imperative in highly competitive market because it resulted into minimum maintenance cost, high equipment effectiveness, maximum reliability of the system, high quality of the products, low delivery time, high flexibility, safety etc. Any maintenance system such as Total Productive Maintenance (TPM) or Reliability Centered Maintenance (RCM) or Condition Based Maintenance (CBM) alone cannot achieve the excellence in maintenance but its integration may do.

TPM is an innovative approach to maintenance that optimizes equipment effectiveness, eliminates breakdowns, and promotes autonomous operator maintenance through day-to-day activities involving the total workforce [1]. RCM is a systematic approach to determine the maintenance requirements of plant and equipment in its operation. It is used to optimize preventive maintenance strategies. The developed PM programs minimize equipment failures and provide industrial plants with effective equipment [2]. CBM or predictive preventive maintenance methods are an extension of preventive maintenance and have been proved to minimize the cost of maintenance, improve operational safety and reduce the frequency and severity of in-service machine failures. The basic theory of condition monitoring is to know the deteriorating condition of a machine component, well in advance of a breakdown, for proactive maintenance [3].

Many investigations have been carried out on individual maintenance system which determined the optimum cost of maintenance threshold value, where preventive maintenance must be carried out, optimum inspection schedule etc., but very few references are reported in the area of integration of various maintenance systems.

In this paper, an integration of maintenance systems such as CBM, RCM and TPM is proposed for a continuously monitored system subject to degradation due to the imperfect maintenance, where a hybrid hazard rate based on the concept of age reduction factor and hazard rate increase factor is used to predict the evolution of the system reliability in different maintenance cycles. A maintenance policy is suggested for an integrated maintenance system.

## RESULTS AND CONCLUSION

All the above defined systems are comprehensive and self-sufficient in their approach but their benefits are different from each other. To obtain the benefits such as minimum cost of maintenance, equipment effectiveness, reliability, quality, delivery time, flexibility, safety etc. at a time from these maintenance systems their integration may be explored. This can be done by inducting some features of a maintenance system into other or by fusing some features of different maintenance systems into one and then augmenting the same into proposed maintenance system. The authors while developing a maintenance policy considered that the core and allied maintenance must be done by maintenance personnel only and the superficial sort of maintenance such as tightening of bolts, cleaning, oiling etc. should be done by machine operator in order to achieve the perfectness in maintenance and therefore the RCM system is suggested at the center of implementation with few important features of other two maintenance systems.

The authors have considered streamlined RCM instead of classical RCM because streamlined RCM skips the time-consuming process of building a failure history database for each piece of equipment and allows the user to rely on the experience and knowledge of subject matter for failure modes and causes.

The feature condition monitoring of CBM and the features involvement of every employee, establishment of 5s, autonomous maintenance program and office TPM of TPM can be the part of streamlined RCM process to draw the maximum benefits.

The integrated maintenance policy is given below.

- Involve every single employee, from top management to workers on the floor in maintenance activity of the organization with initial education and training.
- Establish 5s within the company.
- Employ autonomous maintenance program.
- Establish boundaries.
- Identify interfaces.
- Specify important functions.
- Identify dominant failure modes.
- Identify critical failure modes.
- Identify dominant failure causes.
- Select maintenance tasks (Use condition monitoring technique wherever possible).
- Office TPM.

A quantitative decision making model for an integrated maintenance system is derived in order to assess the performance of the proposed maintenance policy. Numerical examples of calculation of optimal preventive maintenance age  $x$  and preventive maintenance number  $N^*$  for the given cost ratio of corrective replacement and predictive preventive maintenance are given.

## REFERENCES

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