

**Formulation of maintenance strategy for a newsprint manufacturing company**

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Abstract – *The production process in an organization is affected by the frequent break down of equipments. There is a need for better maintenance strategy. RCM Philosophy incorporates different maintenance techniques in an integrated manner to increase the probability that a machine or component will function in required manner over its design life cycle with a minimum of maintenance. Reliability Centered Maintenance can be used to create a cost-effective maintenance strategy to address dominant causes of equipment failure. In this project it aims to identify vital equipments in the utility department of a newsprint manufacturing company to measure the reliability of vital equipments ,to understand about the causes and effects of failure of these vital equipments. And finally formulating a maintenance strategy for vital equipments which can minimize maintenance issues.*

Key words: RCM, maintenance strategy, productivity

I. INTRODUCTION

Over the past twenty years, maintenance has changed, perhaps more so than any other management discipline. The changes are due to a huge increase in the number and variety of physical assets (plant, equipment and buildings) which must be maintained throughout the world, much more complex designs, new maintenance techniques and changing views on maintenance organization and responsibilities. Maintenance is also responding to changing expectations. These include a rapidly growing awareness of the extent to which equipment failure affects safety and the environment, a growing awareness of the connection between maintenance and product quality, and increasing pressure to achieve high plant availability and to contain costs. The changes are testing attitudes and skills in all branches of industry to the limit. Maintenance people are having to adopt completely new ways of thinking and acting, as engineers and as managers. At the same time the limitations of maintenance systems are becoming increasingly apparent, no matter how much they are computerized. In the face of this avalanche of change, managers everywhere are looking for a new approach to maintenance. They want to avoid the false starts and dead ends which always accompany major upheavals. Instead they seek a strategic framework which synthesizes the new developments into a coherent pattern, so that they can evaluate them sensibly and apply those likely to be of most value to them and their companies. RCM transforms the relationships between the undertakings which use it, their existing physical assets and the people who operate and maintain those assets. It also enables new assets to be put into effective service with great speed, confidence and precision. Since the 1930's, the evolution of maintenance can be traced through three generations. RCM is rapidly becoming a cornerstone of the Third Generation, but this generation can only be viewed in perspective in the light of the First and Second Generations. Reliability Centered Maintenance (RCM) is the process that is used to determine the most effective approach to maintenance. It involves identifying actions that, when taken, will reduce the probability of failure and which are the most cost effective. It seeks the optimal mix of Condition-Based Actions, other Time- or Cycle-Based actions, or a Run-to-Failure approach, as shown in Figure 1-1. The principal features of each strategy are shown below their block in Figure 1-1. RCM is an ongoing process that gathers data from operating systems performance and uses this data to improve design and future maintenance. These maintenance strategies, rather than being applied independently, are integrated to take advantage of their respective strengths in order to optimize facility and equipment operability and efficiency while minimizing life-cycle costs

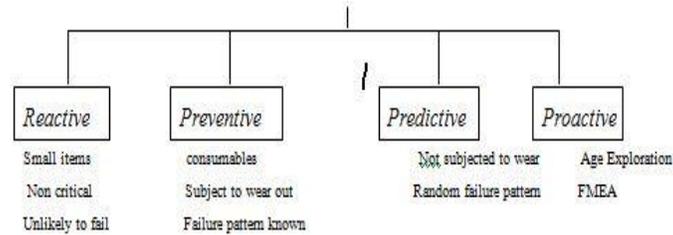


Fig 1.1 Features of RCM

II. LITERATURE REVIEW

Analysis of maintenance policy in the airline industry in the late 1960's and early 1970's led to the development of Reliability Centered Maintenance (RCM) concepts. The principles and applications of RCM were documented in Nowlan and Heap's publication, Reliability-Centered Maintenance.¹ The work demonstrated that a strong correlation between age and failure rate did not exist and the basic premise of time based maintenance was false for the majority of equipment. Additional studies performed by the Department of Defense (DOD) and several nuclear utilities confirmed Nowlan and Heap's work. From approximately 1960 until the late 1980s, Preventive Maintenance (PM) was the most advanced technique used by progressive facilities maintenance organizations. PM is based on two principles – 1) a strong correlation exists between equipment age and failure rate, and 2) individual component and equipment probability of failure can be determined statistically, and therefore, parts can be replaced or rebuilt prior to failure. PM assumes that failure probabilities can be determined statistically for individual machines and components and parts or adjustments can be replaced or performed in time to preclude failure. For example, a common practice in the past was to replace or renew bearings after some number of operating hours based on the assumption that bearing failure rate increases with time in service. This has proven to be ineffective. In all the studies, it was noted that a difference existed between the perceived and the intrinsic design life for the majority of equipment and components. In fact, it was discovered that in many cases equipment bearing life greatly exceeded the perceived or stated design life. For example, SKF Industries proposed changes in the method for evaluating bearing life - from the original method (empirical) proposed by Lundberg and Palmgren³ to one where "bearings exhibit a minimum fatigue life; that is, 'crib deaths' due to rolling contact fatigue are non-existent when the aforementioned operating conditions (properly lubricated, mounted, operated and protected from dirt and moisture) are achieved."⁴ This lack of a predefined fatigue life for bearings greatly impacts the concept of a predetermined design life for rotating equipment where rolling element bearings are used and provides the basis for extending the time between overhauls and equipment replacement. This process, known as Age Exploration (AE), was used by the U.S. Submarine Force in the early 1970's to extend the time between periodic overhauls and to replace time based tasks with condition based tasks. While the initial program was limited to Fleet Ballistic Missile (FBM) submarines, it was continuously expanded until it included all submarines, aircraft carriers, other major combatants, and ships of the Military Sealift Command (MSC). Furthermore, the Navy has invoked the requirements of RCM and condition monitoring as part of new ship design specifications. It should not be inferred from the above that all interval based maintenance should be replaced by condition based maintenance. In fact, interval based maintenance is often appropriate Eschmann, et al, Ball and Roller Bearings: Theory, Design, & Application, John Wiley & Sons, 1985 . G. Lundberg and A. Palmgren, Dynamic Capacity of Roller Bearings, Acra Polytech, Mechanical Engineering Series 1, R.S.A.E.E., No. 3, 7, 1947. Tedric A. Harris, Roller Bearing Analysis, Second Edition, John Wiley and Sons, New York, 1984 those instances where an abrasive, erosive, or corrosive wear takes place, material properties change due to fatigue, embrittlement etc. and/or a clear correlation between age and functional reliability exists. Development of new technologies during the 1990's, including affordable microprocessors and increased computer literacy in the work force, has made it possible to determine the actual condition of equipment and not have to rely upon estimates of when the equipment might fail based on age. These new cost effective technologies and the lack of correlation between age and failure in many equipment items have increased the emphasis on condition monitoring. Condition monitoring, commonly called Predictive Testing and Inspection (PT&I) within the HOC facilities maintenance environment, has resulted in a need to review existing Preventive (PM) and Programmed (PGM) Maintenance efforts and ensure that the most effective approach is being used. RCM provides the structure for

developing that approach. Closely aligned with determining what maintenance approach to use are the subjects of who should do the work and what parts and material will be needed to ensure that the work is done in the most cost efficient manner. Most recently, RCM has taken on a prominent role in NASA's facility and equipment maintenance and operations program. RCM principles have been integrated into the SPECSINTACT wherein designs now have requirements for designing to maintainability. PT&I is used within the construction contractor's quality control program before and during commissioning to ensure that there are no latent manufacturing and installation defects at the time of equipment acceptance. PT&I and proactive used in developing Condition Assessments and in determining the Backlog of Maintenance and Repair (BMAR). RCM principles and procedures are used every day in the maintenance of NASA's facilities where methods, frequencies, periodicities and other criteria are identified in the Annual, 5-Year, and more frequent Work Plans. This guide is intended to provide detailed information for aiding in the implementation of RCM concepts and supporting programs within the NASA facilities community. Intended users include facility planners, designers, equipment procurement specialists, construction managers, systems engineers, and maintenance and operations (M&O) contract planners and managers. According to John Maubry, Reliability-centered Maintenance is a process used to determine - systematically and scientifically - what must be done to ensure that physical assets continue to do what their users want them to do. According to Sourav Kumar Chatterjee, Mean time Between Failure or "MTBF" a term related to any item or asset or equipment, which is designed to deliver service at selected level under certain condition within specified time period. This factor indicates the degree of performance level in terms of "Reliability" and also communicates to concerned for initiating "Root cause failure analysis" followed by corrective action to improve the level of service by the equipment. In other wards MTBF is a measurement of equipment's performance quality in which all aspects of expected service level from it must be taken into account. This also acts as an alarm to draw the attention of operating/maintenance personnel for necessary action and to avoid catastrophic failures.

In any process plant equipments are expected to:

- a) Perform maintaining rated parameters
- b) Perform up to life-designed life cycle
- c) Have less down time
- d) Consume less operating/maintenance cost
- e) Maintain hazard free operating condition

Inability to comply with any of above said tasks is considered as "failure". The degree of importance of above said factors increases with the increase of equipment criticality factor. The criticality factor of equipment can be computed in line with framework mentioned below.

Criticality calculation = CF x RF x DF x SFx FF

Where CF=Consequence factor, RF=Redundancy Factor, DF= Down time factor, SF=Severity factor, FF=Frequency factor

If score value > 80 equipment is critical

60 < score value < 80 equipment is semi-critical

When equipment undergoes operation, following are the practical modes, which mostly prevail.

- 1) Delivers expected process output as well as maintains healthy operating condition.
- 2) Delivers expected process output but displays potential failure modes creating disturbed situation, but without any physical hazard.
- 3) Delivers designed process output with no measurable indication of failure modes but creates hazardous situation on sudden failure.

MTBF = Total Number of Equipments / Total Number of failures x review period in month .are present-oriented and perceive time as time left in life and limited.

III. METHODOLOGY

This study was conducted in HNL, Kottayam. In order to formulate the most appropriate maintenance strategy, primary data from direct observation, personnel interviews with department heads and secondary data from annual reports, history card, performance reports, journals, breakdown analysis reports and websites were collected. Reliability Centred Maintenance

Concept was used to determine the most critical equipments among functional equipments. Using this method, 5 of the functional equipments were identified as critical. A cause and effect analysis was conducted to get an understanding about the nature of failure in critical equipments and it was interpreted with fish bone diagram. Based on this analysis, the final maintenance strategies for the 5 vital equipments were formulated.

IV. ANALYSIS AND FINDINGS

Reliability Centred Maintenance Concept

Steps Involved in the critical equipment identification:

- Listed all selected group equipment (411)
- No: of failures and cost of maintenance are recorded during the time period of 17 years
- Based on the cost of maintenance and number of failures, equipment from each group are shortlisted
- Criticality and reliability is calculated for each identified equipment and grouped based on defined criteria
- A Criticality Reliability Matrix is constructed based on the criticality reliability values
- From the above matrix a cell which encompasses the most critical but non reliable group is chosen

Cause and Effect Analysis

It is a diagram that demonstrates the relationship between effects and their categories of causes. The arrangement of the diagram looks like a fishbone, hence the name fishbone diagram. Steps involved in the cause and effect analysis:

- Identified the problem
- Worked out the major factors involved
- Identified possible causes
- Analysed the constructed cause and effect diagram.

Data analysis and interpretation

From the 411 functional equipment, 52 significant equipment were identified by considering the failure and cost of repair values.

- The number of functional heat exchangers in the plant was found to be 192. Among this, 7 heat exchangers were identified as significant.
- The number of functional pumps in the plant was found to be 403. Among this, 34 pumps were identified as significant
- The number of functional vessels in the plant was found to be 206. Among this, 3 significant vessels were identified.

Findings from fish bone diagrams of 5 vital equipment:

1) E-2010

A functional failure occurred in this exchanger and the causes for this failure are tube corrosion and gasket failure.

2) C-4002

A functional failure occurred in this column and the causes for this failure are tube corrosion and the corrosion happens due to shell gauging, Slippage of NaOH etc.

3) E-2006

Here a corrosion of tube occurred and the causes for this failure is lack of process control and carbon steel corrosion.

4) C-4502

A functional failure occurred in this column and the causes for this failure are tube corrosion and the corrosion happens due to caustic gauging and contamination of service fluid.

5) P-3503

A mechanical seal failure occurred and the causes for this failure are poor selection of pump.

Based on the above analysis, short terms as well as long term maintenance strategies were formulated for all 5 vital equipment as mentioned below:

Equipment Code	Short Term Strategy	Long Term Strategy
E-2010	a) Use metallic gaskets and avoid using CAF gasket.	Replace the tube before every 7years.
E-2006	b) Plug the leaking tube. c) Inspect the exchanger and decide for appropriate action in every 2 years.	Replace the tube before every 12 years.
C-4002	An unexpected catastrophic failure. Leaking joint can be sealed with leak sealing compound.	Replace with new column with proper post weld treatment welding process.
C-4502	The column fails due to process upsets and can't predict the periodicity of failure. So repair the shell by patching the leaking portion.	Improve the process characteristics.
P-3503	MTBF is found to be 139 days or approximately equal to 4 months. Repair the seal & pump before every 4 months.	Replace the pump with diaphragm metering pump

V. CONCLUSION

A literature survey has been conducted to study the maintenance related issues in a newsprint manufacturing industry. The data collected from various sources revealed that numerous equipment failures occur in the plant. Poor maintenance strategy adopted by the company was found to be the major reason behind these failures. The revamping of existing maintenance strategy is done by implementing a new maintenance strategy using Reliability Centered Maintenance (RCM). It will help the company to increase the performance and efficiency in the entire system. By adopting the proposed maintenance strategy, company can reduce its frequent breakdowns.

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