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Research Review on Reliability Centred Maintenance

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ABSTRACT: This paper introduces basic concepts of Reliability-Centered Maintenance (RCM) that constitutes the process of selected the foremost effective maintenance approach. The RCM philosophy employs Preventive Maintenance (PM), Predictive Maintenance (PdM), Run-to-Failure (RTF- also known as reactive maintenance) Associate in Nursing Proactive Maintenance techniques in an combined manner to increase the likelihood that a machine or element can operate within the needed manner over its style life cycle with a minimum of maintenance. The goal of the philosophy is to provide the expressed operate of the ability, with the required dependability and convenience at rock bottom value. RCM requires that maintenance choices be primarily based on maintenance necessities supported by sound technical and economic justification.

KEYWORDS: Reliability-Centered Maintenance (RCM), Predictive Maintenance (PdM), Preventive Maintenance (PM), Run-to-Failure (RTF)

I. INTRODUCTION

A. Reliability-Centered Maintenance

As many industry equipment maintenance practices, the reliability targeted maintenance (RCM) concept originated inside the air craft industry. RCM has now been applied with sizable success for more than twenty years; first among the air craft industry, and later within the military forces, the nuclear power industry, the offshore oil and gas industry, and many different industries. Experiences from these industries' show significant reductions in preventive maintenance (PM) costs whereas maintaining, or even improving, the availability of the system [1].
Reliability-Centered Maintenance (RCM) is the optimum mix of reactive, time- or interval-based, condition-based, and proactive maintenance practices. The basic application of each strategy is shown in Fig. 1. These principal maintenance strategies, rather than being applied independently, are integrated to take advantage of their respective strengths in order to maximize facility and equipment reliability while minimizing life-cycle costs [1].

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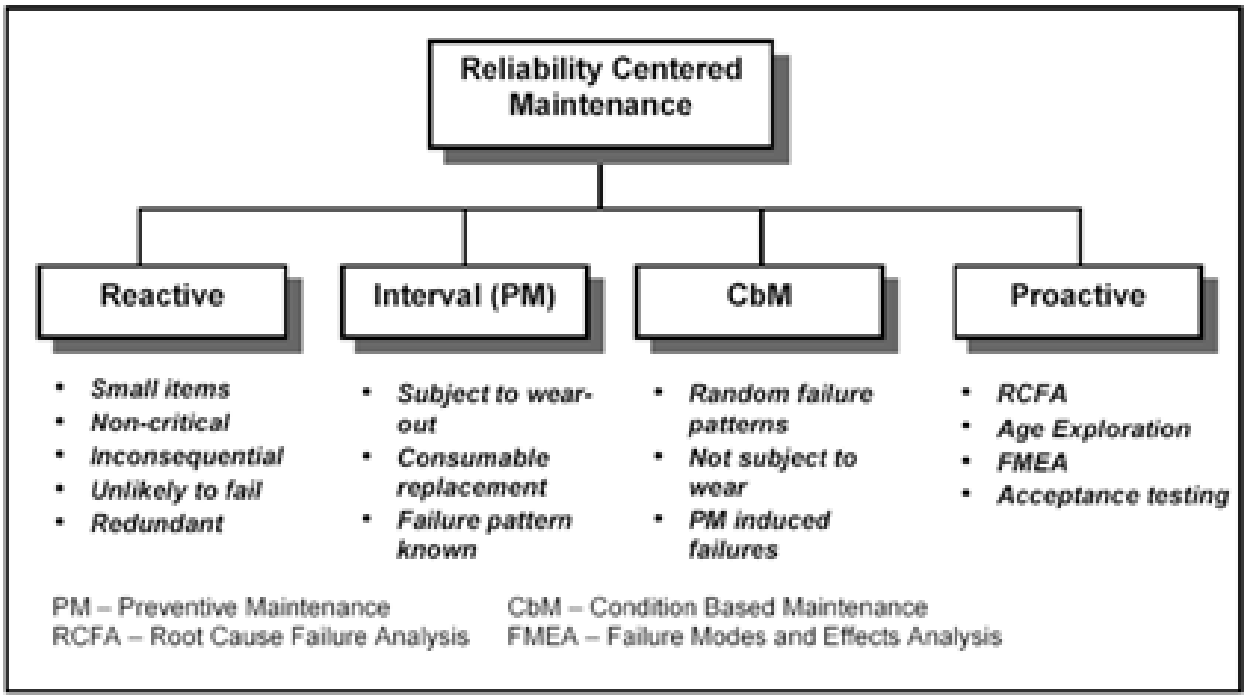

Figuer 1: RCM componets

RCM – Defination

"Reliability is the probability that a device will satisfactorily perform a specified function for a specified period of time under given operating conditions"[3] .

B. Reactive Maintenance (RM)

Reactive maintenance (also known as "breakdown maintenance") are repairs that are done when equipment has already broken down. Reactive maintenance focuses on restoring the equipment to its normal operating conditio [12].

C. Preventive Maintenance (PM)

Preventive maintenance is a planned maintenance activity which is designed to improve equipment life and eliminate any unplanned maintenance activities. Preventative maintenances are performed while the equipment is still working condition, so that unexpectedly it does not break down. Preventive maintenance is the foundation of the whole maintenance strategy. [10]
Preventive maintenance includes:
a) Inspection
b) Detection
c) Correction
d) Prevention of emergent failures

D. Condition based maintenance (CBM)

Condition based maintenance is a maintenance strategy that monitors the particular condition of the quality to choose what maintenance has to be done. CBM dictates that maintenance should solely be performed once bound indicators show signs of decreasing performance or future failure. Checking a machine for these indicators may embody non-invasive measurements, visual inspection, performance data and regular tests. Condition data will then be gathered at

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bound intervals, or continuously (as is done once a machine has internal sensors). Condition based maintenance will be applied to mission essential and non-mission essential assets.
Unlike in planned regular maintenance (PM), where maintenance is performed based mostly upon predefined regular intervals, condition based maintenance is performed solely when a decrease in the condition of the instrumentation has been determined. Compared with preventative maintenance, this increases the time between maintenance repairs, because maintenance is done on associate as-needed basis.[11]

E. Proactive Maintenance (PrM)

To Proactive maintenance is a preventive maintenance strategy for stabilizing the reliability of machines or equipment. It has combine part of preventive and predictive maintenance.
A proactive maintenance plan gives a company the ability to prolong the life of machinery and prevent a complete and unexpected breakdown of production facility. A proactive maintenance plan allows an organization to schedule production shutdowns for repairs, inspection and maintenance. [13]

II. RCM PRINCIPLES

1. RCM is Function orienting – It seeks to preserve system or instrumentality perform, not just Operability for operability's sake. Redundancy of function, through multiple equipment, Improves functional irresponsibleness, but will increase life cycle price in terms of procurance and Operating prices.
2. RCM is System Focused – It is additional involved with maintaining system perform than Individual component perform.
3. RCM is Reliability focused – It treats failure statistics in associate degree figurer manner. The relationship between operating age and the failures old is vital. RCM is not overly involved with simple failure rate; it seeks to apprehend the contingent probability of failure at specific ages (the probability that failure can occur in every given operational age bracket).
4. RCM Acknowledges Design Limitations – Its objective is to maintain the inherent irresponsibleness of the equipment style, recognizing that changes in inherent reliability square measure the province of style rather than maintenance. Maintenance can, at best, only deliver the goods and maintain the level of reliability for instrumentality, which is provided for by style. However, RCM recognizes that maintenance feedback can improve on the original style. In addition, RCM recognizes that a difference usually exists between the perceived style life and the intrinsic or actual style life, and addresses this through the Age Exploration (AE) process.
5. RCM is driven by Safety and Economics – Safety should be ensured at any cost; thenceforth, Cost-effectiveness becomes the criterion.
6. RCM Defines Failure as Any Unsatisfactory Condition – so, failure may be either a Loss of function (operation ceases) or a loss of acceptable quality (operation continues).
7. RCM Uses a Logic Tree to Screen Maintenance Tasks – This provides a consistent approach to the maintenance of all types of apparatus. See Figure 2
8. RCM Tasks Must Be Applicable – The tasks should address the failure mode and take into account the Failure mode characteristics.
9. RCM Tasks Must Be Effective – The tasks should scale back the chance of failure and be value effective.

10. RCM Acknowledges Three varieties of Maintenance Tasks
    A. Time-directed (PM) – Scheduled once acceptable.
    B. Condition-directed (PdM and real-time monitoring) – Performed once conditions indicate they are required
    C. Failure finding (one of several aspects of Proactive Maintenance) – instrumentation is run-to failure. This is acceptable for a few situations and a few forms of instrumentation.
11. RCM is a Living System – It gathers knowledge from the results achieved and feeds this data back to improve design and future maintenance. This feedback is a vital a part of the Proactive Maintenance element of the RCM program. [9]

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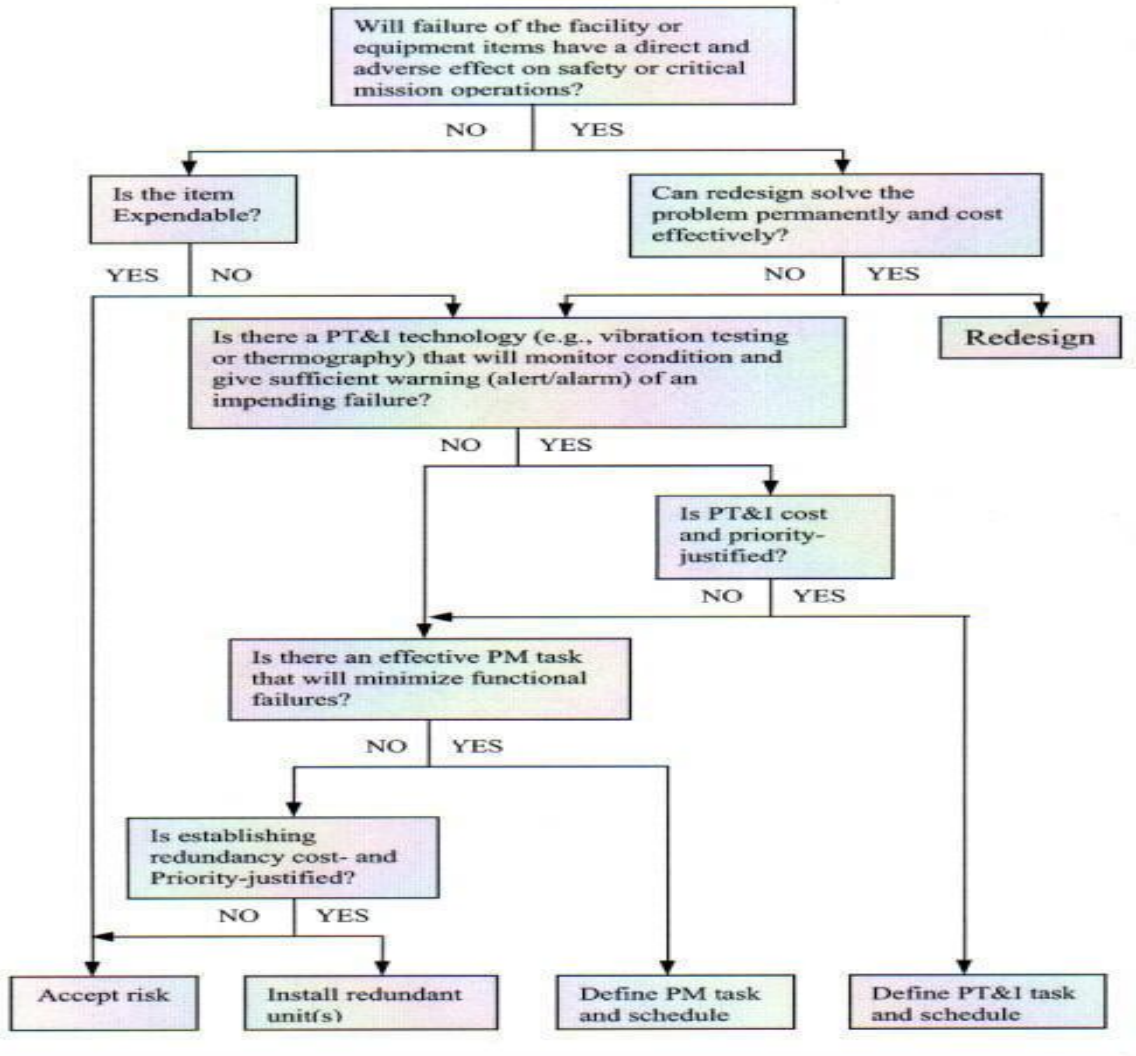

Figure 2: RCM logic diagram

III. STEP BY STEP ANALYSIS OF RELIABILITY CENTRED MAINTENANCE

Any RCM process shall compulsory that all of the subsequent seven queries are answered satisfactorily and are answered within the sequence show below

1. What are the functions and associated performance standards of the asset in its Present operating context? (function)
2. In what ways does it fail to fulfil its functions? (function failures)
3. What causes each functional failure? (failure modes)
4. What happens when each failure occurs? (failure effects)
5. In what way does each failure matter? (failure consequences)
6. What can be done to predict or prevent each failure? (proactive tasks and task intervals)
7. What should be done if a suitable proactive task cannot be found? (Default action)[7]

Briefly discussion above seven questions

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A. Function

The first step of the RCM analysis is to define the function of each chosen system

B. Functional failure

A functional failure, occurs when the system is unable to fulfil its function, to an accept level of performance set by the user. This type of failure isn't only concerning the loss of a single function; it's also loss of partial failures that could influence the production or quality.

C. Failure mode

When all possible functional failures have been recognized, the analysis will proceed. The next step in the analyze process is to identify all kind of reasonable causes, that make a functional failure happen. This goes under the name failure mode. Under this step, all kinds of failure are represented, both those who have happened, but also failures that could or are likely to cause the functional failure. There are many types of failure modes, often from wear and fatigue.

D. Failure effects

Failure effects is the fourth step in the RCM process, and it describes what happens when each failure mode occur. This step is in close relationship with the next step and it should support the analyst to find out the following

a. IN what way the failure is a threat to safety or the environment.
b. IN what way the production or operations are at risk.
c. WHAT physical damage is caused by the failure?

E. Failure Consequences

In a Mill or maintenance organization, there can be over thousands of different failure modes. Each of these failures effect the organization/Mill in the same way, but in each case, the affect is different. They may affect personal safety, environment, product quality, and production and operation capabilities. A positive effect with the RCM method is that the user becomes aware of that the only reason for doing a proactive maintenance task is to reduce the failure consequence, instead of avoiding the occurrence of failures.

- The RCM processes have four categories of failure consequences:
- Hidden failure consequences
- Safety and environmental consequences
- Operational consequences
- Non-operational consequences

The RCM processes are using these four failure consequences to increase the safety in the organization. The failure consequence also helps the user to realize that there are several ways to managing failures. Failure managing techniques are divided into two categories:

Proactive tasks Default action

F. The RCM Task Selection Process

After finishing step five in the RCM process, it's time for step six and the task selection. The RCM method uses a logic decision tree, in the form of a flow chart. For each step in the process, a logical question must be answered, yes or no. After ending the selection process, the RCM method will give some proposed maintenance tasks. After that, it's up to the analyst to compare the result from the RCM task selection process with today's maintenance, failure and operational history. From that analysis, some new solutions of proactive maintenance tasks will come out.

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G. Default Actions

This is the final step in the RCM process, if no proactive maintenance task has been found, a default action must be done. The RCM method has got three major categories of default actions,
These are:

- Failure finding.
- Redesign
- No scheduled maintenance

3.7.1 Failure finding the failure finding tasks in valve checking, whether something is still working. Failure finding applies only to hidden or not revealed failure systems.

3.7.2 Redesign The redesign is what it sounds like, redesign of systems, reconstruction or modification. Redesign is done to the hardware that doesn't fulfil the requirements set by the Mill/organization. The redesign is expensive and is therefore used as a last resort, if the problems affect the operation performance in a negative way.

3.7.3 No scheduled maintenance the no scheduled maintenance is most used when the failure is evident, and does not affect safety or the environment. The components are left in operation until they are either replaced or repaired, in other words they "run-to-failure". [8]

IV. RCM – METHODOLOGY

Reliability-centered maintenance is the optimum mixture of reactive, time or interval-based, condition-based, and proactive maintenance practices. These principal maintenance strategies, rather than being applied independently, are integrated to take advantage of their individual strengths so as to maximise facility and instrumentality irresponsibleness whereas minimizing life-cycle prices. Total productive maintenance (TPM), total maintenance assurance, preventive maintenance, reliability centered maintenance (RCM), and many different innovative approaches to maintenance issues all aim at enhancing the effectiveness of machines to ultimately improve productivity [2,3].

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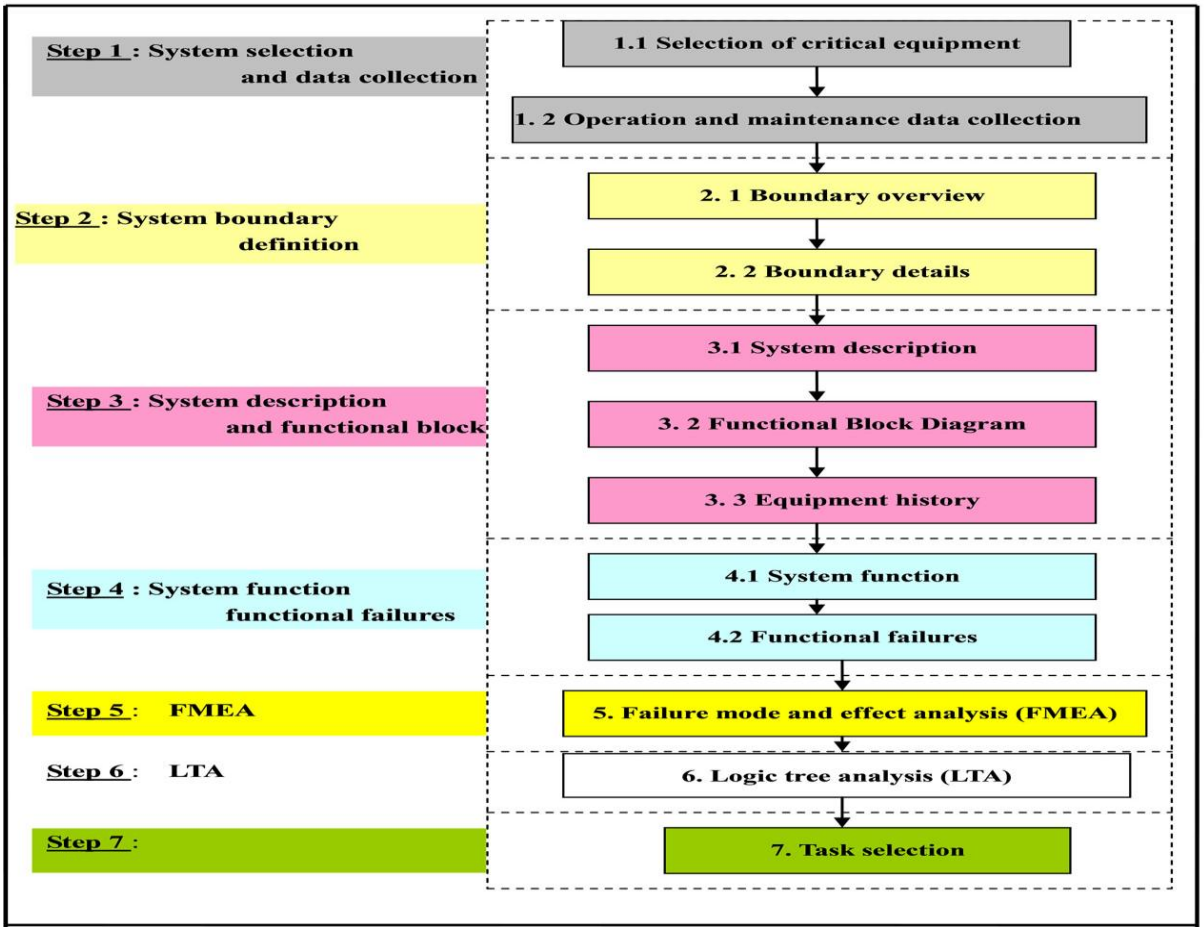

Figure 3: RCM Methodology

V. RESEARCH APPROACHES ON RELIABILITY CENTRED MAINTENANCE

Álvares, A. J (2010): In this paper, the application impact of the RCM (Reliability-Centred Maintenance) methodology on a power generating system was evaluated. The RCM warrants significant improvements in the maintenance-functions performance, and also an increase in reliability and availability of equipments. It permits the definition of a maintenance planning in a structured form [5].

Hossam A. Gabbar (2003): This paper presents detailed system design and mechanism of improved RCM process integrated with CMMS [6].

Afefy, I. H (2010): This paper describes the application of reliability-centered maintenance methodology to the development of maintenance plan for a steam-process plant. The main objective of reliability-centered maintenance is the cost-effective maintenance of the plant components inherent reliability value. The process-steam plant consists of fire-tube boiler, steam distribution, dryer, feed-water pump and process heater. Within this context, a maintenance program for the plant is carried out supported this reliability-centered maintenance concept. Applying of the reliability-centered maintenance methodology showed that the main time between failures for the plant instrumentations and also the probability of abrupt equipment failures square measure decreased [3].

J. Shayeri (2007): A specialized maintenance call support system supported irresponsibleness focused Maintenance (RCM) and also the United States of America dept. Of Defence's Failure Mode, Effect and Criticality Analysis (FMECA) has been developed. It was constructed employing a modular approach that unambiguously integrates the virtues of RCM and FMECA to perform the failure analysis operate. A Logic Tree Analysis (LTA) module supports the decision method by playacting value and Maintainability analysis to promote the most appropriate maintenance tasks. The Maintenance Planning Module applies "Theory of Constraints" to suit tasks into the production schedule [2].

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Rausand, M., & Vatn, J(2008): Reliability centered maintenance (RCM) is a method for maintenance planning developed within the aircraft industry and later adapted to several other industries and military branches. This paper presents a structured approach to RCM, and discusses the various steps in the approach [4].

VI. CONCLUSION

This paper highlights the review and critiques of RCM for the hydraulic systems. On the basis of literature review, the findings show the importance of reliability centred maintenance in terms of cost effectiveness. The RCM not only improve the responsibility of a system but also significantly reduce the needed maintenance in today's highly competitive world, and thereby reducing concerned cost, saved, both from reduced failures and reduced work. It also focuses on the safety of the system by assigning criticality index to the various subsystems and further selecting maintenance activities based on the risk of failure involved. Therefore, it can be said that RCM introduces a maintenance plan designed for maximum safety in an economical manner and making the system more reliable.

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