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APPLICATION OF RELIABILITY CENTRED MAINTENANCE (RCM) IN DIFFERENT INDUSTRIES

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ABSTRACT

The power industry worldwide has been the subject of major reviews and reforms in recent years, which have resulted in changing demands in respect of enhanced safety, reliability, environmental safeguards and commercial competition. In such an environment it is essential that the personnel and the plant and equipment involved, perform to their optimum levels of capability. Reliability Centred Maintenance (RCM) is a maintenance Optimization tool which has a role in providing an effective response to such demands on the industry, by enhancing the effectiveness of operations and maintenance programmes. RCM is a technique initially developed by the airline industry that focuses on preventing failures. Now RCM is used in other industrial sectors than the aircraft maintenance sector. This paper describes the state of the art in Reliability Centred Maintenance (RCM) techniques and its application of several industries is to demonstrate that RCM has been successfully applied to most of them industries.

Keywords: Reliability Centered Maintenance (RCM), Maintenance, Industries

1.0 INTRODUCTION

Due to a competitive environment, many companies are required to reduce their overall costs while maintaining the value and reliability of their assets. The use of Reliability-Centred Maintenance, RCM, can help organizations to develop a systematic maintenance programme, meeting these requirements in a cost-effective manner. RCM basically combines different techniques and tools in a systematic approach to manage risks as a basis for maintenance decisions.

RCM is a systematic approach to determine the maintenance requirements of plant and equipment in its operating [1]. It is used to optimize preventive maintenance (PM) strategies. The developed PM programs minimize equipment failures and provide industrial plants with effective equipment [2]. RCM is one of the best known and most used devices to preserve the operational efficiency of the steam system. RCM operates by balancing the high corrective maintenance costs with the cost of programmed (preventive or predictive) polices, taking into account the potential shortening of "useful life" of the item considered. But it is difficult to select suitable maintenance strategy for each piece of equipment and each failure mode, for the great quantity of equipment and uncertain factors of maintenance strategy decision [3, 4].

RCM philosophy employs preventive maintenance, predictive maintenance (PdM), real-time monitoring (RTM), run-to-failure (RTF) and proactive maintenance techniques is an integrated

manner to increase the probability that a machine or component will function in the required manner over its design life cycle with a minimum of maintenance [5, 6] RCM is now used in all industrial sectors other than the aircraft maintenance sector. The state of the art of RCM techniques and applications in different industries is described, to demonstrate that RCM has been successfully applied to most of them industrial.

2.0 RELIABILITY-CENTERED MAINTENANCE METHODOLOGY

Reliability-centered maintenance (RCM) is the optimum mix 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 respective strengths in order to maximize facility and equipment reliability while minimizing life-cycle costs. Total productive maintenance (TPM), total maintenance assurance, preventive maintenance, reliability- centered maintenance (RCM), and many other innovative approaches to maintenance problems all aim at enhancing the effectiveness of machines to ultimately improve productivity .

2.1. RELIABILITY-CENTERED MAINTENANCE COMPONENTS

The components of RCM program are shown in Figure 1. This figure showing that RCM program consists of (reactive maintenance, preventive maintenance, condition based maintenance, and proactive maintenance) and its patterns. The RCM steps are presented. The steps describe the systematic approach used to implement the preserves the system function, identifies failure mode, priorities failure used to implement the preserves the system function, identifies failure mode, priorities failure modes and performs PM tasks. The RCM steps are as follows:

Step1: system selection and data collection.
Step2: system boundary definition.
Step3: system description and functional block.
Step4: system function functional failures.
Step5: failure mode effect analysis
Step6: logic tree diagram.
Step7: task selection.

2.2. SYSTEM SELECTION AND DATA COLLECTION

Determining the list of the system components is one of the first steps in RCM. The criticality analysis requires different kind of data of each component that build up the system. The effect of failure of the system main components may affect system productivity and maintenance cost. The factors effecting selection of critical system are as follows: 1) Mean-time between failures (MTBF). 2) Total maintenance cost. 3) Mean time to repair (MTTR). 4) Availability.

2.3. LOGIC TREE ANALYSIS (LTA)

The basic (LTA) uses the decision tree structure shown in Figure 2. From this figure, decision bins: 1) safety-related, 2) outage-related, or 3) economic-related were noticed. Each failure mode is entered into the top box of the tree, where the first question is posed: Does the operator, in the normal course of his or her duties, know that something of an abnormal or detrimental nature has occurred in the plant? It is not necessary that the operator know exactly what is away for the answer to be yes.

III. APPLICATION OF RCM IN DIFFERENT INDUSTRIES

3.1. Reliability Centered Maintenance in Aircraft and Aerospace Industry

The RCM methodology was developed for the first time by United Airlines Company for the Defence American Department and was published in 1978. In this part, different RCM (MSG-3) applications will be presented in order to show the work already done in this sector.

RCM has been used extensively in the military and commercial aerospace sector, together with AR&M, MSG-3 [MSG93] and LCC services. Examples of industries in this field are airline operators, manufacturers, air traffic management systems and baggage handling systems. We have made an extended study of the : US NAVY RCM [MIL96, NAV90, NAV00 approach, to show the RCM military approach, AIR CANADA to show civil usage of RCM tools in airline operators

3.2. Reliability Centered Maintenance in the Naval Air Systems Commands

Aviation maintenance philosophy has changed over the past twenty years. In the past, the Navy operated on the premise that the resources for performing maintenance tasks were unlimited. However, today the fact is that most resources are not only limited, but in most cases are lacking. This has driven to look for new initiatives designed to improve maintenance techniques and equipment availability. The NAVAIR Affordable Readiness effort is one such initiative. It recognizes Reliability-Centred Maintenance as the main tool in developing and implementing its integrated maintenance concept. Currently, RCM is being applied to all new NAVAIR acquisitions and major system modifications. The Navy uses several documents that provide guidance for the RCM program**.**

3.3. Reliability Centered Maintenance in Chemical Industries

The chemical process industries (CPI) are extremely diverse, producing hundreds of chemicals that are used in the manufacturing of consumer goods. The materials created and used in chemical process plants range from the relatively innocuous to those that pose significant risks to people and the environment. Industry is constantly being challenged to manage the risks associated with the production and use of these materials, while remaining competitive in the global marketplace.

For years, companies have concentrated on making their equipment more reliable, and on correcting perceived problems with technology. But while use of better technology has usually resulted in tremendous increases in productivity, there may not have been commensurate improvements in the prevention of major accidents. In fact, recent reviews show that human error and the lack of adequate management systems are the most significant contributors to major plant accidents.
Reliability Centred Maintenance (RCM) is being extensively used into this industrial area, existing strong regulations and development criteria.

3.4. Reliability Centered Maintenance in Petroleum Refineries

Refiners today operate their equipment for prolonged periods without shutdown. This is primarily due to the increased pressures of the market resulting in extended shutdown-to-shutdown intervals. This places extreme demands on the reliability of the plant equipment. The traditional methods of reliability assurance, like Preventive Maintenance, Predictive Maintenance and Condition Based Maintenance become inadequate in the face of such demands. The alternate approaches to reliability improvement, being adopted the world over are implementation of RCFA programs and Reliability Centered Maintenance.

3.5 Reliability Centered Maintenance in Shipping

RCM has been recently applied successfully to a sea going vessel. During the last six years, progressive maritime organizations around the world have been co-operating to form a worldwide information network, called RAM/SHIPNET, to support the optimization of these three key factors throughout all stages of a vessel's life cycle. Consisting of layered Reliability, Availability and Maintainability (RAM) databases, RAM/SHIPNET has been developed through a co-operative effort of owner/operators, government organizations and regulatory agencies. More information is provided in the RCM databases section.

3.6. Reliability Centered Maintenance in Nuclear Industry

One of the first sectors to use RCM methodology was the nuclear sector because of their similarities with the aeronautic sector (safety, availability, maintenance costs). Today, more than 400 nuclear power stations producing electricity are using RCM in different ways. Safety rules are very strict, thus each nuclear power station is checked by a specialized association in order to respect these rules. The application of Reliability Centred Maintenance (RCM) in the Nuclear Industry has been both enhanced and recommended. The failure mode analysis and effects analysis (FMEA) provides a format for identifying the dominant failure modes of

component failures leading to a functional failure and the impact of each component failure locally at the component, on the system, and on the plant. It is extensively used in most nuclear plants to enhance safety and reliability

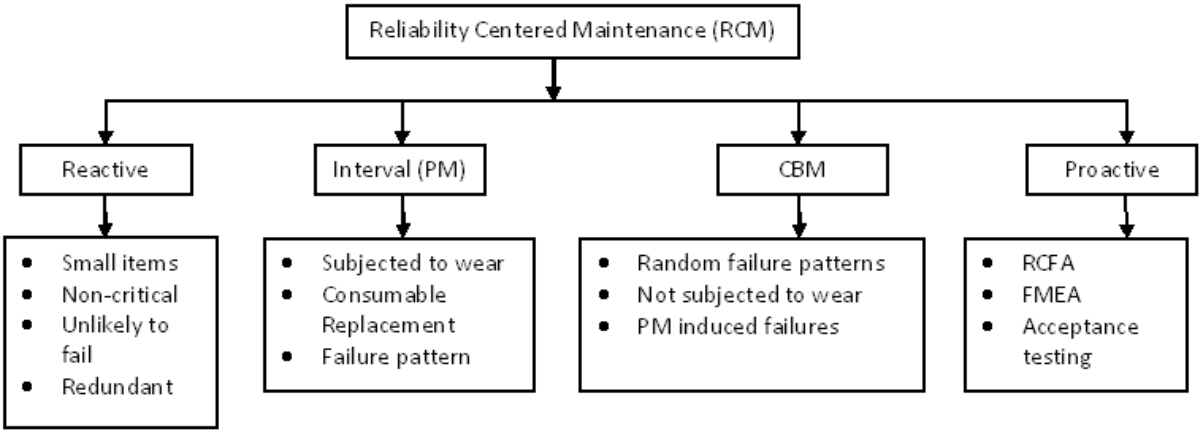

Figure 1. Components of RCM program

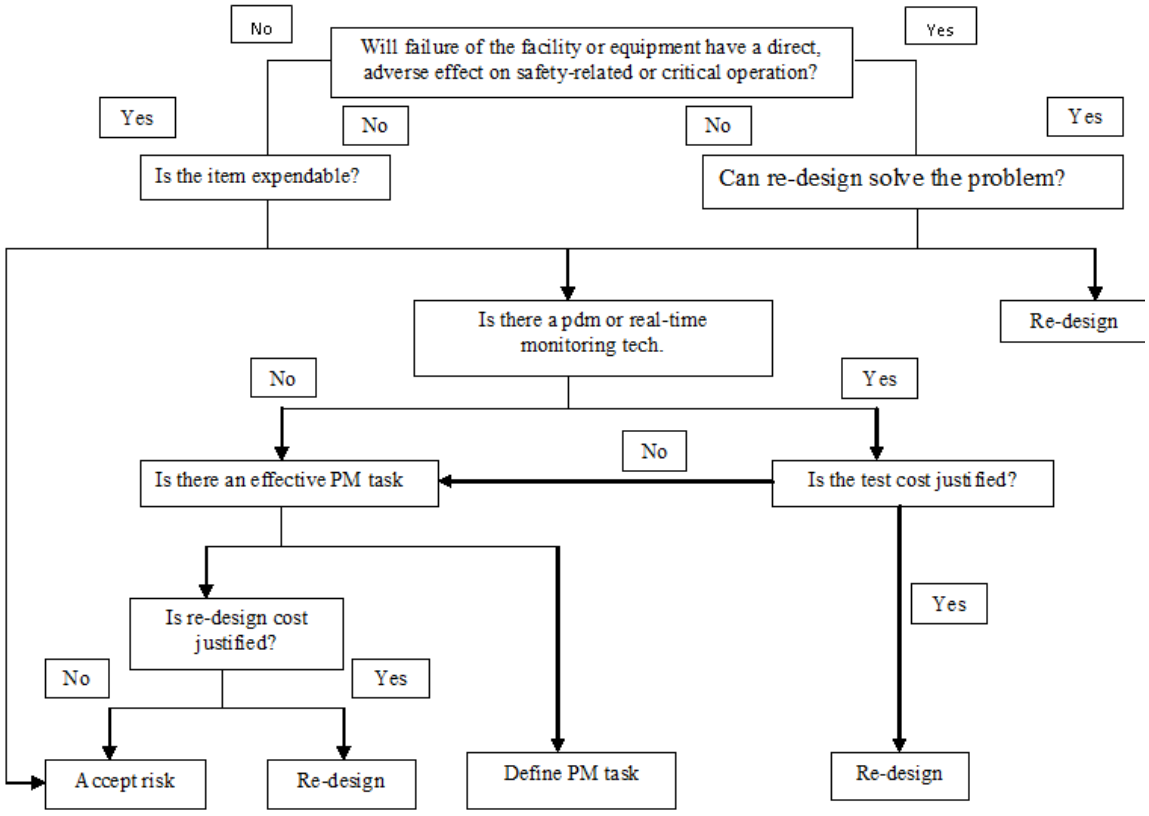

Figure.2. RCM Logic Tree

3.7. The Reliability Centered Maintenance Experiences in Smalls and Medium Industries

The RCM approach was applied to define a maintenance strategy for the SMEs. In this the results of two European projects are presented; the first is related to the foundry sector (TOMAS CRAFT-project) and the second to the sawmills sector (MELISSA CRAFT-project). In both these projects the RCM was used as the main method to define maintenance policies and adaptation was

necessary to meet the special constraints of each sector; these adaptations resulted in "lighter" RCM methods which can be transposed to SMEs.

3.8. Reliability Centered Maintenance Oil and Gas Industries

RCM is used in many oil companies, such as Shell, BP, Amoco, or OREDA, to enhance maintenance and reliability. In this section, the maintenance state of the art is shown for two companies: Amoco Oil Maintenance, Oreda consortium.

3.9. Reliability Centered Maintenance in Others Industries

RCM was used in other industrial and non-industrial sectors. In this paragraph we present RCM applied to the design of underground train lines, the definition of the maintenance policy of hospital technical equipment and also to a new definition of maintenance strategy of drinkable water treatment and supply

IV. CONCLUSION

RCM has been applied, first in the aircraft industry, and later in the military forces, the nuclear power industry, the offshore oil and gas industry, and many other industries. If RCM is correctly applied, it can reduce the amount of routine maintenance work by 40% to 70%. The cost-benefit payoff with RCM has been dramatic with its impact on commercial aviation, and potentially offers similar dramatic payoffs in other areas where complex plants and systems are routinely operated. The benefits and advantages of using RCM in several industries and have an impact on operations, safety, logistics, configuration, and administration. Some of the benefits are tangible and others are intangible. Let RCM move your maintenance program into the 21st century

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