FSES FUNCTIONAL SAFETY ENGINEERING SERVICES

SAFETY SYSTEMS, ENGINEERING & SERVICES

Brief Overview Reliability Centered Maintenance (RCM) Life-Cycle and Methodology

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INTRODUCTION

RCM is a systematic consideration of system functions, the way functions can fail, and a priority-based consideration of safety and economics that identifies applicable and effective Preventive Maintenance (PM) tasks.
RCM is a very powerful technique for reducing PM costs while maintaining, or even improving, the availability of the system.
But, when misunderstood, it could result in an unexpected waste of time and money. For that reason it is crucial to know exactly where and how to apply the RCM methodology.
The RCM concept is described in several standards, reports and textbooks. Among these are Nowlan and Heap (1978), IEC-60300-3-11, SAE JA1012, NASA (2000), DEF-STD 02-45 (2000), MIL-STD 2173 (AS), Smith (1993) and Moubray (1997). The main ideas presented in the various sources are more or less the same, but the detailed procedures may be rather different. We follow the procedure stated in the standard SAE JA1012.

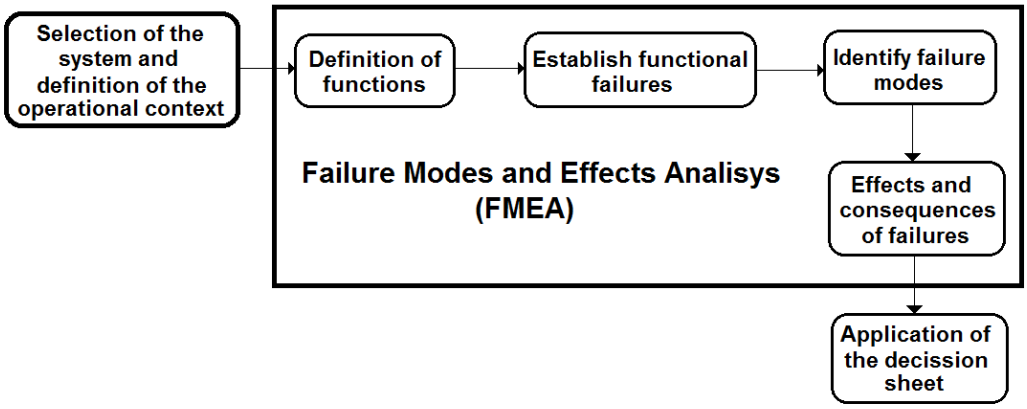
1.1 Where RCM is interesting?

Not all the equipment in a facility needs such an exhaustive study like RCM. Only critical equipment with multiple failures modes achieve all the benefits of the technique.
RCM will also provide useful information not only about how the critical functions of a business are maintained; but also what is involved in this critical function, what is the functional philosophy and when redesign is needed due to unacceptable consequences which can not be controlled.

1.2 How to apply RCM technique?

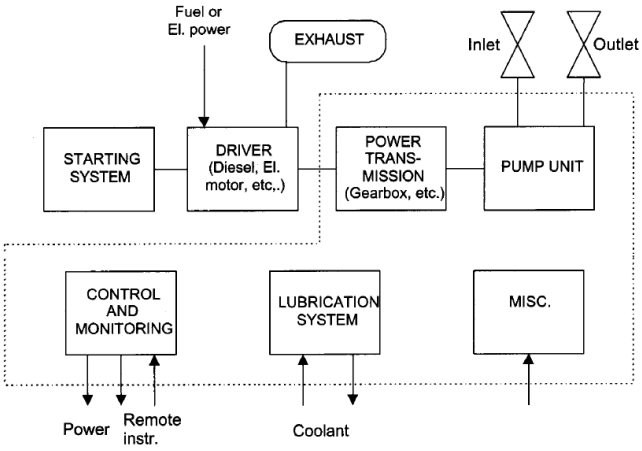
First of all we have to identify where RCM is going to provide more benefits than the cost of carrying out the study.
That is why the first step is a criticality study of all the systems in the facility. After this initial assessment, those critical systems with complex configurations and multiple failures modes are identified. Only this systems will be subject to a RCM study.

The criticality assessment will be followed by a Failures Modes and Effects Analysis (FMEA).
Once a critical system has been selected its operational context must be defined. Primary and secondary functions are listed and the scope of the study limited. All the equipment that could have an adverse effect in any of the critical functions are included in the operational context.



The goal of maintenance is to maintain the functioning of the asset. We will define in detail all primary and secondary functions highlighting what the system needs to do in the operational context and what we want the system to be able to do (operational range). This is defined as the execution standard. Every time in which

the system is not able to provide its defined function in its defined range (execution standard) will constitute a functional failure of the system.



RCM defines functional failure as the state in time, in which the asset can not achieve its expected execution standard and it has the consequence of the asset not performing totally its intended function. Each execution standard could have more than one functional failure. Every functional failure must be identified and defined.

Once all functional failures have been identified, we have to continue inquiring to identify all the failure modes. RCM defines failure mode as the physic cause of each functional failure. In other words, the failure mode is what causes the total or partial loss of function of an asset in its operational context. Each functional failure could have more than one failure mode. The key is to orient the maintenance to each failure mode, focusing on what, not who causes the failure. We are interested in what has failed, in order to restore it. There are other techniques available for the identification of who causes the failure, such as Root Cause Analysis (RCA).

We have to proceed describing the effects and consequences for every failure mode. In order to do this, we will answer the following questions:

- What evidences do we have that the failure has occurred?
- How the failure affects to safety and the environment?
- How the failure affect to production and operations?

- What damage caused the failure?
- What do we have to do to repair the failure?

Once that the FMEA has been done, we will apply to the system the RCM decision sheet. We will identify how we are going to fight each failure mode by selecting the most appropriate maintenance task. Also, RCM technique will inform us when critical safety failures are not under control and a redesign is mandatory. The proposed maintenance task of our RCM technique are the followings:

- PROACTIVE TASKS (PREVENTIVE)
  - Condition based tasks
  - Cyclic restoration tasks
  - Cyclic replacement tasks
  - Hidden failures hunting
- REACTIVE TASKS
  - Redesign
  - No preventive maintenance

In the last step of the RCM, when our system has been perfectly defined and every failure mode has associated its better maintenance task, is when reliability enters in the game. We will use the estimated or predicted failure rate of each failure mode to calculate the most efficient frequency interval for each maintenance task.
It is clear that RCM help us in decision making to optimize our maintenance resources and to know where to put our efforts.

1.3 How the study is carried out?

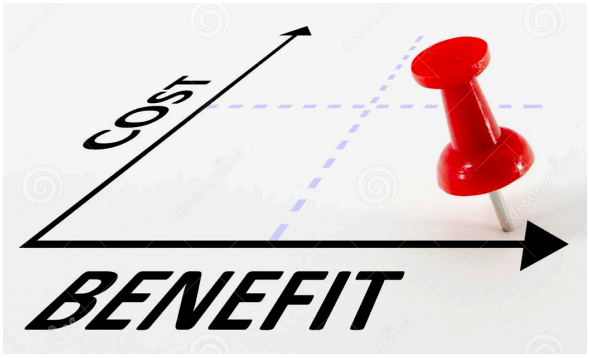
This study is carried out in brainstorming sessions by a multidisciplinary group of experts which will provide all the necessary knowledge to achieve the best results. The number of people must be the minimum possible with which we can ensure all the required knowledge will be present, normally between five and seven people.
The responsible of selecting the group is the RCM coordinator. This person must have a fully understanding of the RCM methodology.
A typical RCM group will contain, but not limited to:

- RCM Coordinator. Must lead the group applying the methodology to achieve the desired results.
- Process engineer. Global vision of the process
- Programmer engineer. Systematic vision of the activity and operations

- Operator. Expert in handling and operability of systems and equipment
- Maintainer. Expert in repairing and maintaining systems and equipment
- Experts (if needed). Expert in an specific area

Each person present in the brainstorming session must have the responsibility and knowledge degree for being able to make any decision without consulting with a superior range colleague.

1.4 What are the benefits of RCM?



RCM is currently the best methodology to create a preventive maintenance planning for a system. This methodology is able to provide end users with great benefits in their critical asset management, If they know where and how to apply it. Remember that if misunderstood could result in an undesired waste of time and money, so it is only really interesting for critical equipment with complex configurations and multiple failures modes.
The most relevant benefits of RCM are:

- Full understanding of our critical systems and functions knowing all the equipment that are involved in them
- Identification of all the failures modes presents in our critical system knowing their effects and consequences
- Application of the correct maintenance task for each identified failure mode
- Development of an effective and optimized maintenance planning by setting the frequencies of every maintenance task taking into account the failure rate of the specific failure mode
- Identification when redesign is mandatory due to critical failures not under control

Maintenance frequencies should be reviewed after a period of time when enough field failure data has been gathered in order to reassess and update the RCM results.
For facilities where there exist a maintenance planning, RCM will identify if all the failures modes had been covered and if the existing planning is under or over maintaining the assets.
Under maintaining a critical asset could be dangerous and risky, while over maintenance leads to undesired maintenance cost due to planned unavailability and waste of resources.