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# Reliability Centered Maintenance

## Which Approach Is Best For Your Company?

A look at a systematic program for asset management

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Reliability-centered maintenance (RCM) is a systematic approach to developing focused, effective, and cost-efficient preventive and predictive maintenance programs. The RCM technique is best initiated early in the equipment design process and should evolve as the equipment design, development, construction, commissioning, and operating activities progress. The technique, however, can also be used to evaluate preventive and predictive maintenance programs for existing equipment systems with the objective of continuously improving these systems while increasing the equipment capacity.
The goals for an RCM program are to:

- Achieve maximum reliability, performance, and safety of the equipment.
- Restore equipment to required levels of performance when deterioration occurs (but before failure).
- Collect the data (during the life of the equipment) to change the design of the equipment in order to improve its reliability.
- Accomplish the above with minimal life-cycle costs.

## RCM History


Reliability-centered maintenance is one of several processes developed during the 1960s and '70s in various industries, in order to help companies determine the best maintenance and engineering policies for managing physical assets and the probable (and in some cases, possible) consequences of their failures. Of all available asset management processes, RCM is the most thorough.

The RCM process systematically identifies all of an asset's functions and functional failures, and then identifies all of its reasonably likely failure modes or failure causes. Next the process identifies the consequences of these likely failure modes and how those consequences affect the asset. Once this information has been gathered, the RCM process selects the most appropriate asset management policy. Unlike some other maintenance development processes, RCM considers all asset management options, which may include preventive maintenance, predictive maintenance, condition monitoring, small engineering design changes, or a complete redesign of the asset.

## The Traditional RCM Analysis

In the design phase, the first task in an RCM analysis for equipment is to identify critical system functions and/or components. The significance of the asset is usually determined by its value to the company's profitability.

The identified critical assets are next subjected to the tailored RCM decision logic. The objective here is to better understand the nature of the probable failures associated with a critical system's functions or components. In each case, and whenever feasible, this knowledge is translated into either a set of preventive/predictive maintenance tasks designed to prevent the failure or a set of redesign requirements. Numerous decision logic trees, with slight variations and tailored to address certain types of systems, have been developed and are being used.

Failures may be classified as follows:

- An unsatisfactory condition (It may be a catastrophic shut down or just an out of specification condition, such as a quality defect).
- A condition in which the equipment does not meet a certain performance standard.
- A physical change in the equipment indicating that a failure is imminent (this is referred to as a potential failure).

Slight variations notwithstanding, the first concern is whether a failure will be evident or hidden. A failure could be made evident with the aid of certain color-coded, visual gauges and/or alarms. A failure may also become evident if it has a perceptible impact on a system's operation and performance. By contrast, a failure may not be evident in the absence of an appropriate alarm, or if it does not have an immediate or direct impact on system performance. In the event a failure is not immediately evident, it may be necessary to either institute a specific maintenance task to find the potential problem as part of the overall predictive maintenance program or design in an alarm that signals a failure or pending failure.

Once the potential failure has been identified and distinguished as a certain type, the RCM analysis attempts to identify a feasible set of compensatory preventive or predictive maintenance tasks. Is a lubrication or servicing task applicable and effective and, if so, what is the most cost-effective and efficient frequency? Will a periodic check help prevent the failure, and at what frequency? Periodic inspections or checks are most applicable in situations where a failure is unlikely to occur immediately, but is likely to develop at a certain rate over a period of time. The frequency of inspections can vary from very infrequently to continuously, as in the case of condition monitoring.

## Applying the Results

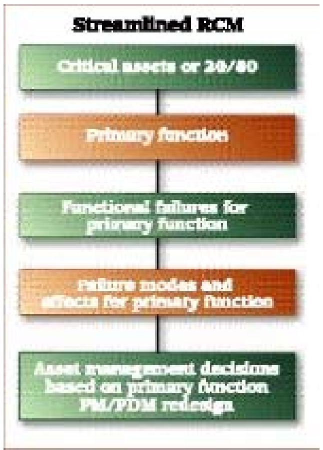
For each analysis, a trade-off study comparing performing or not performing a task needs to be done in terms of the benefit/cost and overall impact on the system. In the event that a set of applicable and effective preventive or predictive maintenance requirements are identified, they are input into the program-development process and subsequently implemented as part of the installation process. If no feasible, cost-effective maintenance task can be identified, an equipment redesign effort may be required.

Frequently, after development and implementation of a PM program, it is discovered that the program fails to consider certain aspects of the system, is too conservative, or both. Continuous monitoring and evaluation of PM tasks, along with all other corrective maintenance actions, is imperative in order to realize a cost-effective program. Further, given the continuously improving technologies available for condition monitoring, sensing, and measurement, PM tasks need to be re-evaluated and modified regularly, and certainly require re-evaluation when they prove inadequate.

The preventive maintenance requirements, identified during the RCM analysis, are subsequently translated into a set of specific preventive maintenance tasks, along with suggested frequencies. The extent and scope of these requirements and tasks reflect upon the overall maintainability of a product or process. Extensive PM requirements are likely to negatively impact a system's life-cycle costs and may indicate an inadequate system design from the perspective of maintainability.

The preventive maintenance tasks and their frequencies identified during this analysis become input in the process of developing predictions about a system's maintainability. For example, the information is necessary to determine a system's mean-time-to-repair metric. Further, the results from the RCM analysis are incorporated into the task analysis for overall system maintenance in order to identify required resources such as facilities, test equipment, tools, maintenance personnel, skill level requirements, etc.

As highlighted in this brief overview, RCM is a thorough, analytic process that can be used to developed maintenance programs and manage physical assets. It is therefore appropriate for traditional RCM to identify every possible failure mode. While "possible" is obviously subject to interpretation by the RCM analysts, it is possible to name some of the things that are expected, including certain things that some processes exclude from their analyses.




For example, some RCM processes explicitly exclude failure modes already addressed by an existing maintenance program. Traditional RCM still examines these failure modes in order to decide whether existing maintenance practices are truly the best way to manage those failure modes.

Another thing that a traditional RCM process will include is failure modes that have not happened but are likely in the operating context. Some analytic processes, such as root-cause analysis, look only at failure histories and do not attempt to foresee future problems. In retrospect, it is often said of many asset failures that "they were simply waiting to happen." It was only a matter of time before the company's customary maintenance and operational practices arranged* themselves in a sequence that led to a failure. Before this sequencing of events, the failure mode had never appeared in the site's failure history.

The traditional RCM process does not restrict itself to engineering processes; it also considers causes such as deterioration, human error, and design defects that lead to many failures. At most industrial sites, it is common to find that no one looks at these topics in a detailed and organized manner.

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## Streamlined RCM

Streamlined RCM takes a slightly different approach. Instead of focusing on all possible failures of asset systems, the focus is on failures of primary functions of the asset. Some streamlined approaches focus on just 20% of the equipment at the plant and give only secondary focus to the other 80%.

When considering the functional failure of equipment, the streamlined RCM approach focuses on an asset's primary function. If a failure could occur that does not affect the primary function, the analysis of that failure is relegated to a secondary priority. This reduces the amount of analysis that needs to be performed to gain the primary benefit of increased uptime for the asset. While the probability exists that a secondary failure could occur, it is likely not to have a major impact on the availability of the asset.

The 20-80 approach to RCM focuses on the equipment that will provide the greatest return on investment. Some of the criteria that determine the 20% include: high value of lost production; high cost of repair; and safety, health, and environmental issues. This approach can be cost-effective, especially at the beginning of an RCM program.

While RCM consultants will argue the value of varying approaches to RCM, some observations from practitioners are helpful. At a recent RCM forum, one practitioner observed that every site should go through the traditional approach to RCM on at least one asset system. This enables the company to understand the detailed RCM methodology before implementing any streamlined approaches. Once traditional RCM is understood, the streamlined approach can be much more effective.

A second point from the forum focuses on accurate data that an organization collects about its assets. For example, how many companies actually collect accurate meantime-between-failure (MTBF) and mean-time-to-repair (MTTR) data on their equipment? This data typically is derived from equipment history in the computerized maintenance management system (CMMS). However, many companies fail to collect accurate enough data to allow these histories to be applied in an RCM analysis. Companies should be good at detailed data collection before using computerized maintenance management system data in an RCM analysis.

RCM is an effective tool in any asset management program. Whether the streamlined or traditional approach is taken, the benefits in equipment availability can have a dramatic impact on a company's financial position. Following the guidelines presented in this article should prove to be beneficial to any company investigating reliability-centered maintenance and its application to that company's assets. ED



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