



National Grain and Feed Association

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Reliability-Centered Maintenance – What’s It All About?

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[Editor’s Note: This is the seventh and final installment in a series of articles on various aspects of preventive maintenance programs for grain elevators, feed and feed ingredient manufacturers, and grain processing facilities. The first six articles in this series were published on Nov. 7 and Dec. 18, 2008, and on Jan. 15, Feb. 12, March 12 and June 30, 2009. The complete series also is available on the NGFA’s website by [clicking here](#). You are encouraged to share these publications with those at your facility responsible for preventive maintenance and safety programs.]

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“If it ain’t broke, don’t fix it.”

This old tenet is one approach that can be used to address facility maintenance issues.

An underlying premise for the “if it ain’t broke, don’t fix it” mindset is that the use of more proactive maintenance practices can result in money being spent on unnecessary activities and repairs.

That’s a legitimate concern, and one that a reliability-centered maintenance (RCM) program attempts to address. RCM can be defined as “an approach to maintenance that combines reactive, preventive, predictive, and proactive maintenance practices and strategies to maximize the time that a piece of equipment functions in the required manner.”

The goal of RCM is to find the “right” mix of maintenance activities that results in the minimal equipment and repair cost.

Types of Maintenance Practices

To better understand the concept of RCM, it’s helpful to review the types of general approaches that may be used for facility maintenance. These include:

▶ **Reactive Maintenance:** This approach follows the “if it ain’t broke, don’t fix it” or “run-to-failure” principle. Under the reactive-maintenance approach, equipment and facilities are repaired only in response to a breakdown or a fault. A reactive-maintenance program often is characterized by short-term, intense work patterns. Because of this, some maintenance experts define reactive maintenance as all maintenance work that is scheduled less than 24 hours before it is executed.

▶ **Preventive Maintenance:** A preventive-maintenance program includes procedures for inspecting, testing, and reconditioning equipment and other systems at regular intervals according to specific instructions. The goals in performing such procedures are to prevent failures in service and to prolong the life of the equipment or system.

Within a preventive-maintenance program, personnel often perform maintenance procedures at established time intervals. For example, the program may specify that one type of equipment is to be inspected and serviced weekly, while another type is to be inspected and serviced monthly. A basic assumption made when using a calendar-based

preventive-maintenance program is that equipment or system failure can be eliminated or controlled by performing procedures at specified time intervals.

Typically, the next step up from a calendar-based preventive-maintenance program is one in which the frequency of maintenance practices is based upon equipment or system run time. Using a run-time method for determining the frequency of inspecting and servicing equipment typically is an improvement over a calendar-based schedule. Equipment generally should not need to be repeatedly inspected or serviced if it has not been used. It is the actual operation of the equipment that wears it down, so it makes sense to check the equipment after it has run a sufficient length of time to incur some wear.

Unfortunately, there are a variety of other factors, in addition to run time, that may influence the frequency of equipment and system failure. Such factors may include external environmental conditions, equipment and system loading, and instances of severe stress.

As a result, a possible outcome from using either a calendar- or run-time-based preventive maintenance program is that the “right” maintenance mix is not achieved. When this occurs, a facility, in some instances, may experience equipment failures caused by inadequate inspection and servicing. In other cases, it may be wasting maintenance dollars by spending too much time servicing and inspecting properly functioning equipment.

► **Predictive Maintenance:** Predictive maintenance – often referred to as condition-monitoring – may be defined as the use of maintenance techniques to help determine the

condition of in-service equipment and systems to predict when maintenance should be performed. The ultimate goal of predictive maintenance is to perform maintenance at a scheduled point in time when the activity may be accomplished in the most cost-effective manner and before the equipment or system loses optimum performance. This approach may provide cost savings over routine or time-based preventive maintenance because tasks are performed only when warranted.

One example of a predictive-maintenance technique is the use of infrared thermography, which provides a method for maintenance personnel or technicians to detect temperature discrepancies – areas hotter or colder than allowable – within equipment and systems, which enables them to take corrective action before a costly shutdown, equipment damage or personal injury occurs.

Another example of a predictive-maintenance technique is the use of vibration analysis. Maintenance personnel or technicians may use vibration analysis to measure and analyze equipment vibration to potentially detect changes or abnormal patterns in the machine’s operating condition.

Predictive-maintenance techniques may work well to monitor the operating conditions of certain types of equipment and systems. But such techniques generally cannot be applied across all equipment within an entire facility. In some cases, predictive-maintenance tools may not be effective in monitoring equipment condition. In other instances, such techniques may be too expensive when compared to the frequency, cost and consequences of equipment failure.

How Does Reliability-Centered Maintenance Fit In?

The purpose in implementing RCM principles is to create a maintenance-program framework that helps ensure that the proper maintenance activity is performed at the right time, and that the equipment is operated in a way that maximizes its opportunity to achieve a level of reliability consistent with the safety, environmental, operational and profit goals of the facility. This is achieved by addressing the basic causes of equipment and system failures, and ensuring facility plans have been implemented to prevent or lessen the business impact of such failures when they occur.

Background of RCM: The aviation industry began developing the RCM approach more than 40 years ago. In the late 1950s, airlines were experiencing high maintenance costs. At the same time, the Federal Aviation Administration wanted to identify aircraft-maintenance practices that potentially would provide better results than those achieved through interval-based maintenance. In response, the airline industry in 1960 formed

a task force to study the effectiveness of airline preventive-maintenance programs and explore alternative maintenance approaches.

The principles contained within the subsequent report issued by the airline industry task force were the precursors of what eventually would become RCM. These principles defined and standardized the basic logic to be used in developing an effective and economical maintenance program. Today, RCM formally is defined in the Society of Automotive Engineers’ standard JA1011, Evaluation Criteria for Reliability-Centered Maintenance Processes. This standard sets out the minimum criteria for what constitutes RCM.

Although created by the aviation industry, RCM principles can be applied across many other industries, including processing and manufacturing facilities.

RCM Principles: The major principles incorporated within the RCM approach to maintenance include:

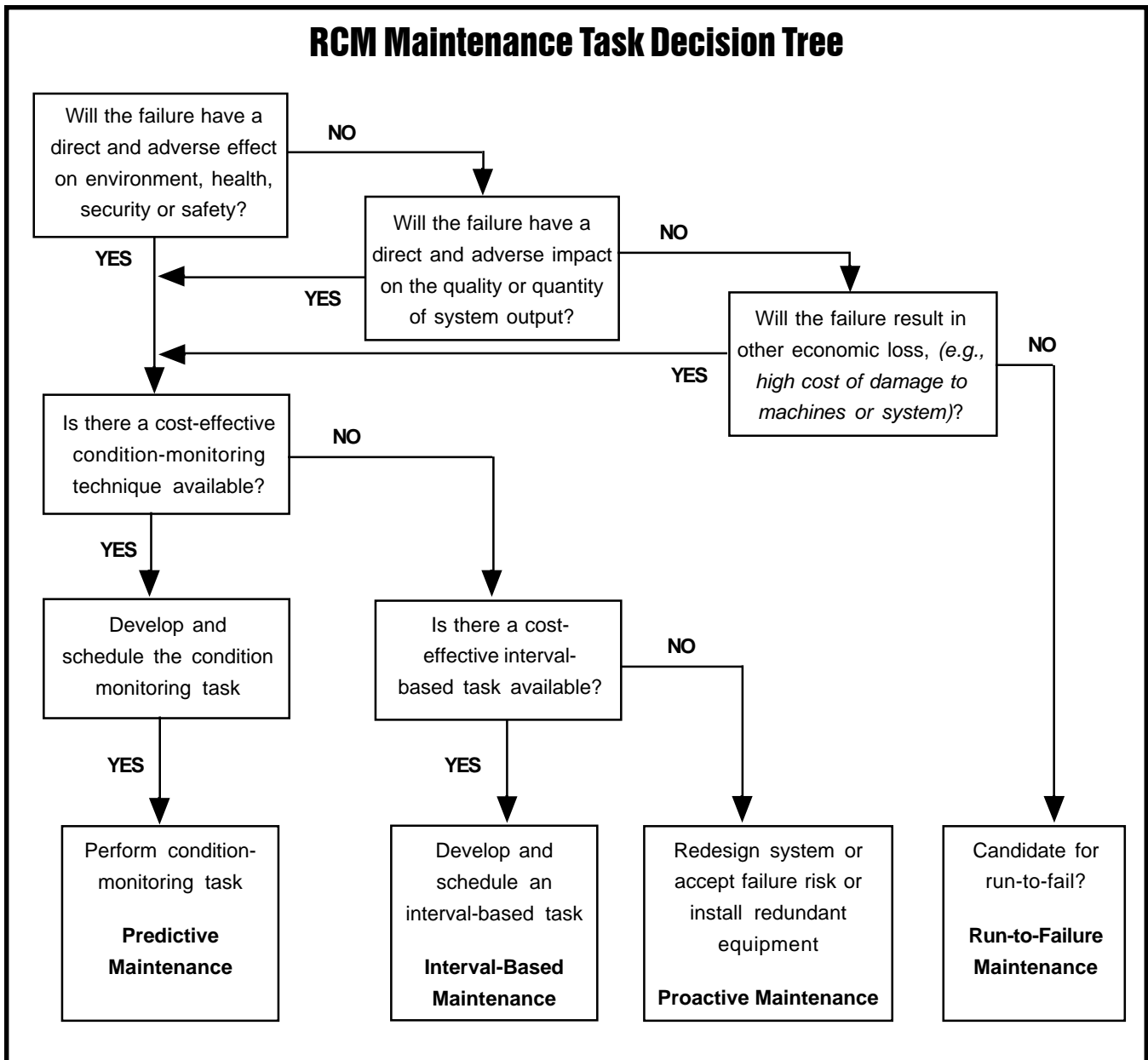
- ▶ **The primary non-safety related purpose for maintenance activities is to preserve overall system functionality.** This concept differs from the typical maintenance philosophy of preserving equipment operation. Obviously, system functionality ultimately is preserved through preserving equipment function. But the RCM process focuses first on the desired system output or function, and only then determines how maintenance should be performed to best preserve the system output. Such an approach does not assume that every item of equipment is equally important, contrary to the theory that may apply under other maintenance approaches.
- ▶ **To preserve overall system functionality, maintenance activities need to address those equipment or component failures that potentially could disrupt system output.** When using the RCM approach, a key question asked related to this concept is: “Can this system still provide its primary output or function if a component fails?” If the answer is “yes,” then it may be appropriate to allow the component to operate until failing.
- ▶ **Safety always comes first in any maintenance task.** Therefore, when evaluating the cost-effectiveness of maintenance activities, the expense associated with safe working conditions is not considered part of the overall program expense. Once safety conditions are assured, the RCM approach assigns costs to all other maintenance activities.
- ▶ **The tasks performed within the maintenance program are to reduce the number of output or function failures, or at least to reduce the damage attributable to such failure(s).** Under the RCM approach, tasks that fail to achieve this objective are to be redesigned or eliminated.
- ▶ **Maintenance activities are assigned to one of four established maintenance categories.** The RCM approach uses a systematic method to screen maintenance tasks and enhance consistency in determining how to perform maintenance on all types of facility equipment. Based upon the potential severity associated with failure, each piece of equipment is assigned one of four categories: 1) run-to-failure; 2) calendar or run-time-based maintenance; 3) condition monitoring, performed with predictive-maintenance techniques; or 4) proactive maintenance. Within the concept of RCM, proactive maintenance is defined as applying the lessons learned from past maintenance experience to future situations.
- ▶ **The maintenance program is designed to gather information about results achieved and then evaluate such information to improve the program and future maintenance activities.** Such an information-gathering and feedback system is an important part of the proactive-maintenance element of a RCM program. Examples of potential proactive

practices could include changing old equipment specifications that have proven to be inadequate or incorrect, rebuilding worn/failed equipment to better resist failure, performing failed-part analysis and conducting a root-cause failure analysis.

The RCM Process: Developing and implementing a RCM program involves following a systematic process called RCM analysis. During such an analysis, facility management carefully considers and answers the following questions:

1. **What systems exist, and what do they do?** Every facility is designed to produce some desired output. To achieve this output, equipment is grouped into systems that are used to produce the end product. Within this part of the RCM analysis, facility management first identifies and defines major systems and their equipment components. Then, the management team describes the function of individual systems, along with the expected performance standard.
2. **What functional system failures are likely to occur?** The next step in the RCM analysis is to identify the system failures likely to occur that could disrupt the system’s function. During this step, facility management should consider and identify what could go wrong that would prevent the system from producing its desired function.
3. **What are the possible causes for likely system failures?** The purpose for implementing a RCM program is to prevent functional failures from occurring. The cause for a functional failure may be the breakdown of some equipment part. But it also may be a failure in some human activity. Within this step, facility management should identify all factors that are possible causes for likely system failures.
4. **What are the likely consequences of each failure?** During this step of the RCM analysis, facility management should assess what happens when a failure occurs and what the likely consequences of the failure are. Not all failures are equal in terms of their affect on system output. One criterion to consider during this assessment is the events that will be required to bring the process back to normal operating conditions. Another criterion to consider is the likely severity of the failure. Facility management may wish to consider ranking the severity of failures using a criticality index, which is the result of combining probability and consequence rankings together to yield a single number that may be used to develop a relative severity ranking of potential failures.
5. **What can be done to prevent these functional failures?** Once potential failures have been evaluated fully, facility management should consider what type of maintenance tasks, if any, may be used to prevent or predict such failures. The decision tree on page 4 outlines the RCM logic that may be used to determine appropriate maintenance activities for equipment.

RCM Maintenance Task Decision Tree



Conclusion

The RCM approach provides a systematic way to determine the optimum mix of applicable and effective maintenance activities needed to sustain the operational reliability of systems and equipment, while ensuring their safe and economical operation and support.

For this reason, managers of facilities involved in grain handling, grain processing and feed and feed ingredient manufacturing may wish to consider using RCM concepts within their maintenance programs.