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Here is an approach for making the transition.

The consideration to shift a well-organized, effective preventive maintenance (PM) program to a reliability centered maintenance (RCM) basis is attractive. RCM is the logic-based methodology for determining what preventive maintenance is required to maximize the reliability of equipment and production systems.

The concepts of the 80-20 approach to RCM are particularly well suited to this transition. With a well-established PM program, the initial concern is to conduct formal RCM analysis of any systems or types of equipment which are undergoing a significant number of failures affecting plant production or are absorbing a disproportionate amount of resources to keep running (either maintenance manpower or repair costs). In general, it will be found that about 20 percent of equipment or systems are responsible for 80 percent of the failures.

RCM considerations

After the infamous 20 percent is taken care of, the current PM program should be examined. If it is well established and consistently executed, the program may be a candidate for shifting to an RCM basis. The analysis required to effect this transition is not difficult, but should be precise to ensure that the logical foundation of RCM is fully incorporated. PM programs which have grown up over a period of years contain many valid maintenance tasks, but they also frequently contain tasks of questionable value whose existence is due only to their long-time presence within the program.

The key RCM screening activities are to ensure that the PMs are functionally related, applicable, and effective maintenance tasks.

Maintenance tasks which are related to preserving the function of the equipment or systems go to the heart of RCM. RCM is intent on maintaining function, not just equipment operability. Tasks which do not contribute to the preservation of function should be discarded.

The applicability criterion requires that each task accomplish something which prevents failure, or which delays failure and extends equipment life, or which substantially reduces the secondary damage resulting from a failure. Tasks which fail to meet this criterion also should be discarded.

The effectiveness criterion requires that maintenance tasks be worth doing (their value must be greater than their cost). Tasks which fail this criterion should be discarded. Maintenance tasks must satisfy all three of these criteria to merit their continuance as part of an RCM program.

The existing preventive maintenance tasks must be examined and screened to determine whether they qualify as valid maintenance or monitoring tasks under an RCM program. RCM recognizes three types of preventive maintenance tasks: time-directed, condition-directed, and failure-finding.

Time-directed tasks are hard scheduled tasks based on calendar time or operating age, and detailed information regarding the condition of the equipment is not required. (This implies that time-directed maintenance occurs at an age which is just before the equipment reaches the point of wearout or that the action taken is minor and condition monitoring of equipment condition is not warranted.)

Condition-directed tasks are accomplished only when the condition of the monitored equipment indicates that maintenance action is needed to prevent imminent failure.

The third category of maintenance tasks are the failure-finding tasks. These tasks are needed to ensure that nonrunning equipment or nonevident functions have not failed. This nonrunning equipment can fail and we remain unaware of the failure until the time it is needed and then it is discovered that the equipment is not available. Critical back-up and safety equipment often falls in this category.

The procedure which follows is a relatively straight-forward method to determine which PM activities within the current program should be included as part of the RCM program and which PM activities are unnecessary or redundant and should be discarded. It may help to refer to the model of the transition procedure illustrated in the three flow charts.

To start the screening process, we divide maintenance actions in the existing PM program into categories which parallel the RCM classifications: Time-directed maintenance actions (periodic overhauls, replacements, lubrication tasks, etc.), condition-monitoring actions (inspections,

checks, etc.), and failure-finding tasks, if any. Note that we are listing time-directed maintenance actions and condition-monitoring actions. The condition-directed maintenance actions are not listed directly because they result from the monitoring actions.

We next examine all the PM actions in each of the categories to determine whether they relate to the function of the equipment or system. If the PMs are not contributing to preserving the function, then they are failing RCM's applicability criterion and should be discontinued and discarded.

Time-directed maintenance actions

Each time-directed maintenance action should be examined for several characteristics. If the task which is being accomplished is presently applied to equipment which is likely to suffer wearout or the task is minor and extensive concern about wear-out is not warranted (simple lubrication, for example) then we can proceed to verifying the applicability of the task. However, if the test is failed, the task is examined for a means to monitor equipment condition as a replacement for the time-directed task.

For all the tasks which meet the wearout and minor task criteria, check each task for applicability. We ask, "With respect to failures which affect equipment function, is the task preventing failure, delaying failure, or reducing the effects of a failure?" If the answer is affirmative, then we proceed to verify the effectiveness of the task. If the answer is no, we should delete the task from the program.

If the task fails the wear-out or minor task test, then look for an appropriate method of monitoring the condition of the equipment which will put a condition-directed task in place of the existing time-directed task. If a means of monitoring equipment condition is available, then the task is re-classified as a condition-monitoring task. If a condition-monitoring task cannot be found, then the time-directed task should be discarded and the risk of failure accepted or the equipment redesigned.

All time-directed tasks satisfying the applicability criterion should be checked for effectiveness. Is the task providing a benefit whose value is greater than the cost to accomplish the task? If the answer is yes, the task is justified and we proceed to review the frequency at which the task is accomplished. If the task value does not justify the task cost, delete the task from the program. The value criterion for effectiveness will vary with the criticality of the equipment or system because we must decide how much we are willing to pay for failure prevention for

critical equipment than we are for equipment whose failure will have little effect on plant operation.

Those time-directed tasks which meet the effectiveness criterion may be designated as time-directed tasks which are part of the RCM program. We review the existing frequency of the tasks. Should the task interval be extended because no failures have occurred at this frequency? If failures have occurred within the current task interval, we may want to shorten the interval.

Condition-monitoring actions

The examination of each condition-monitoring action parallels that which we have just used for the time-directed tasks. Each action should be examined for the following characteristics: Is the monitoring which is being accomplished likely to detect degradation and to provide a reasonable basis for predicting when the point of potential failure is reached? If yes, we may proceed to check applicability. If no, the action should be deleted from the program.

For all the detectable and predictable monitoring actions, check the condition-directed task which will result from the monitoring for applicability. With respect to failures which affect the equipment function, would the task prevent failure, delay failure, or reduce the effects of a failure? If the answer is yes, we proceed on to check task effectiveness. If no, we delete the monitoring action and condition-directed task from the program.

For all monitoring tasks satisfying the applicability criterion, we next check the task which will result from the monitoring for effectiveness. Would the task provide a benefit whose value would be greater than the cost to accomplish the task? If yes, we proceed to the monitoring frequency review. If the answer is no, we delete the action and task from the program. Again, the value criterion for effectiveness will vary with the criticality of the equipment or system because we are generally willing to pay more for failure prevention for critical equipment than we are for equipment that has little effect on plant operation.

For those monitoring tasks satisfying the effectiveness criterion, we designate these monitoring actions and tasks as condition-directed tasks which are part of the RCM program. We review the existing frequency of the monitoring. Should the monitoring interval be extended so better indications of degradation can develop? If failures have occurred within the current monitoring interval, shorten the interval.

PMs for nonrunning equipment

For PM tasks associated with equipment which is not normally in operation, we must determine if these PMs would discover equipment failure prior to the equipment being run. If yes, we then proceed to check for the availability of an appropriate condition-directed task. If no, we delete the PM from the program and accept the risk of failure, or redesign or modify the equipment so the criterion can be met.

For PMs which are capable of detecting equipment failure prior to use, determine whether there is a condition-directed task which is both applicable and effective. If an applicable and effective condition-directed task exists, then add the PM to the RCM program as a failure-finding task and proceed to the frequency review. If no condition-monitoring task exists, then proceed to check for the availability of an appropriate time-directed task.

For those failure-finding PMs for which there are no appropriate condition-monitoring methods, we must determine whether there is an appropriate time-directed task which is both applicable and effective. (Remember that time-directed tasks are generally only appropriate for cases where wearout occurs or for minor tasks.) If such a time-directed task does exist, then add the PM to the RCM program as a failure-finding task and proceed to the frequency review for the task. If no time-directed task exists, then the risk of failure must be accepted or the design characteristics modified.

For those failure-finding tasks meeting all criteria, review the existing frequency of the PMs. Should the monitoring interval be extended or shortened to provide an appropriate level of comfort with regard to detecting hidden failures prior to the need for the equipment's use? **MT**

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