SECTION 4-8: RELIABILITY CENTERED MAINTENANCE

4-8-00 POLICY

The purpose of this section is to provide general information that will introduce and encourage implementation of Reliability Centered Maintenance (RCM) concepts and programs within the HHS facilities community. The intended audience includes facility planners, designers, equipment procurement specialists, construction managers, systems engineers, and maintenance and operations (M&O) contract planners and managers.

A. BACKGROUND

Reliability Centered Maintenance (RCM) is a process used to determine the most effective approach to maintenance. It involves identifying actions that, when taken, will reduce the probability of failure through an optimal mix of Condition-Based Actions, Time/Cycle-Based actions, or a Run-to-Failure approach to take advantage of their respective strengths in order to optimize facility and equipment operability and efficiency while minimizing life-cycle costs. RCM data can also provide useful input for Facility Condition Assessments and for determining the Backlog of Maintenance and Repair (BMAR).

B. RESPONSIBILITIES

All HHS personnel with duties and responsibilities involving any aspect of the facilities life-cycle shall include Reliability Centered Maintenance considerations in their decision-making processes. These considerations are consistent and closely aligned with the concepts of Sustainability, Life-cycle costs, and Mission-dependency.

4-8-10 PROCEDURES

Properly implemented Reliability Centered Maintenance programs will optimize the life-cycle cost versus benefit of facilities and associated equipment. RCM is Function Oriented, System Focused, Reliability Centered, Acknowledges Design Limitations, Driven by Safety and Economics, and Relevant to the failure mode. RCM analysis considers the following questions:

- What does the system or equipment do; what is its function?
- What functional failures are likely to occur?
- What are the likely consequences of those functional failures?
- How quickly and cost effectively can failures be mitigated?
- What can be done to reduce the probability of the failure, identify the onset of failure, or reduce the consequences of the failure?
- How does the cost to deter/prevent failure compare with the consequences of failure?

4-8-20 GUIDANCE AND INFORMATION

The Reliability Centered Maintenance (RCM) philosophy employs Preventive Maintenance (PM), Predictive Testing and Inspection (PT&I), Repair (also called reactive maintenance), and Proactive Maintenance techniques in 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. The goal is to deliver required reliability and availability at the lowest cost. RCM requires that maintenance decisions be based on maintenance requirements supported by sound technical and economic justification.

An RCM program includes reactive, preventive, predictive, and proactive maintenance. The following definitions describe these and some additional RCM concepts.

Reactive maintenance - also referred to as breakdown, repair, fix-when-fail, or run-to-failure (RTF) maintenance. Equipment repair or replacement occurs only when the deterioration in the equipment's condition causes a functional failure. In addition there is no ability to influence when the failures occur because no (or minimal) action is taken to control or prevent them. A high percentage of unplanned maintenance activities, high replacement part inventories, and inefficient use of maintenance effort typify this strategy. Reactive maintenance can be used effectively when it is performed as a conscious decision, based on the results of an RCM analysis that compares the risk and cost of failure with the cost of the maintenance required to mitigate that risk and cost of failure. Components for which RTF may be appropriate are non-critical restroom exhaust fans, water heaters, and items where the consequences of failure are negligible and the time required to remedy the failure is acceptable.

Preventive Maintenance (PM) - consists of regularly scheduled inspection, adjustments, cleaning, lubrication, parts replacement, calibration, and repair of components and equipment. It is performed on a time-driven or scheduled interval basis without regard to actual equipment condition. Traditional PM is keyed to failure rates and times between failures. It assumes that these variables can be determined statistically, and therefore one can replace a part due for failure before it fails. PM is based on the assumption that the overhaul of machinery by disassembly and replacement of worn parts restores the machine to a like new condition with no harmful effects. However, it has been shown that in a large number of cases, imposing an arbitrary preventive task increases the average failure rate through “infant mortality.”

For some items, while failure is related to age, it is not equally likely to occur throughout the life of the item. In fact, the majority of equipment is not subject to wear-out (a sharply increasing conditional probability of failure at a specific operating age). Therefore, timed maintenance can often result in unnecessary, even harmful, maintenance. In summary, PM can be costly and ineffective when it is the sole type of maintenance practiced.

Predictive Testing and Inspection (PT&I) - also known as predictive maintenance or condition monitoring, uses primarily non-intrusive testing techniques, visual inspection, and performance data to assess machinery condition. It replaces arbitrarily timed maintenance tasks with maintenance that is scheduled only when warranted by equipment condition. Continuing analysis of equipment condition-monitoring data allows planning and scheduling of maintenance or repairs in advance of catastrophic and functional failure. Methods of analysis include trend analysis, pattern recognition, data comparison, tests against limits and ranges, correlation of multiple technologies, and statistical process analysis. Data acquired from the various PT&I techniques can and should be correlated with each other to increase the probability of detecting and correctly evaluating equipment condition.

Proactive maintenance improves maintenance through better design, installation, maintenance procedures, workmanship, and scheduling. Proactive maintenance typically employs the following basic techniques to extend machinery life:

- Specifications for new/rebuilt equipment. Specifications should include, as a minimum, vibration, alignment, balancing criteria, and other important performance criteria. Good feedback and communications are necessary to ensure that recommended changes in design or procedures are rapidly made available to designers and managers.
- Precision rebuild and installation. Equipment requires proper installation to control life-cycle costs and maximize reliability. Poor installation often results in problems routinely faced by both maintenance personnel and operators. The adoption and enforcement of precision standards can more than double the life of a machine.
- Failed-part analysis. This proactive process involves inspecting failed parts after their removal to identify the cause(s) of their failures.
- Root-cause failure analysis (RCFA). In some cases, plant equipment fails repeatedly, and the failures are accepted as a normal idiosyncrasy of that equipment. Recurring problems such as short bearing life, frequent seal fracture, and structural cracking are symptoms of more severe problems. RCFA proactively seeks the fundamental causes that lead to facility and equipment failure. Its goals are to:
    - Find the cause of a problem quickly, efficiently, and economically.
    - Correct the cause of the problem, not just its symptom/effect.
    - Provide information that can help prevent the problem from recurring.
    - Instill a mentality of “fix forever.”
- Reliability engineering involves the redesign, modification, or improvement of components or their replacement by superior components.
- Rebuild certification/verification. When new or rebuilt equipment is installed, it is essential to verify that it is operating properly. To avoid unsatisfactory operation and early failure, the equipment should be tested against formal certification and verification standards.
- Age Exploration. Age Exploration (AE) is a key element in establishing an RCM program and provides a methodology to vary key aspects of the maintenance program in order to optimize the process. For example, during visual inspection of a chiller, the technician notes the condition of various components. The condition evaluation sheet is then correlated with performance data from the Energy Management and Control System (EMCS), vibration data, and oil analysis data. As a result of this analysis, the decision is made to change the interval of the open and inspect until monitored conditions indicate degradation has occurred.
- Recurrence Control. This element provides a systematic approach using technical analysis of hardware and/or material failures for dealing with repetitive failures.