

# Keeping

# Facilities Fit

***Some federal agencies are using predictive technologies to identify and correct equipment problems before failures occur.***

By Wayne Powell

**R**eliability Centered Maintenance (RCM) aims to improve the reliability and availability of critical systems plus lower life cycle operations and maintenance costs. RCM differs from earlier maintenance programs that simply reacted to equipment failures, and from other programs that aimed to restore or replace components before failures occur. RCM has been used by the commercial aviation industry since the 1960s, and more recently it has been applied to military aviation and ship maintenance programs.

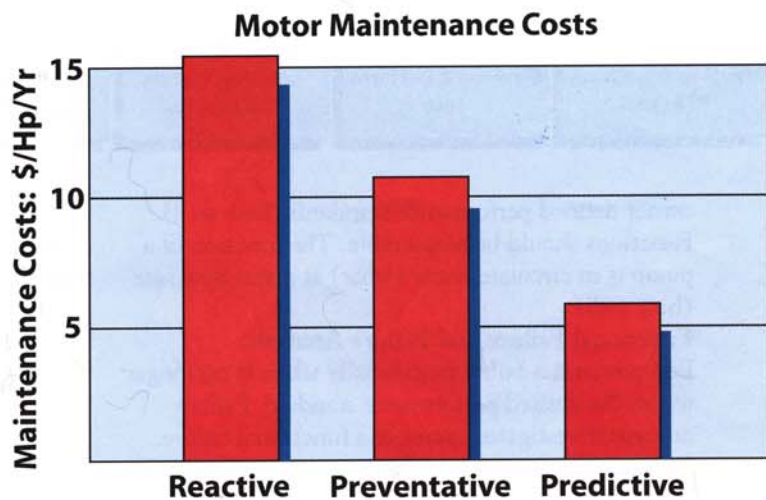
Facilities maintenance programs at most federal installations employ a mix of preventive and reactive maintenance, including those recommended by manufacturers to satisfy warranty requirements, but they are often based on worst-case operating environments.

Some agencies use predictive technologies as the basis of their maintenance program.

Predictive technologies can identify and correct equipment problems before failures occur. For example, infrared thermography can identify a broad range of conditions, such as roof leaks and electrical hot spots. The Federal Facilities Council's Committee on Operations and Maintenance is developing a list of best practices in federal facilities operations and maintenance (O&M). Among those practices is RCM. The use of RCM has taken the maintenance programs of some federal agencies to a higher level. The National Aeronautics and Space Administration began using RCM in 1996 (see *The Military Engineer*, June-July 1998).

## What is RCM?

RCM programs combine a proper mix of reactive, preventive, predictive and proactive maintenance practices. RCM identifies why equipment fails and leads to technologies that predict failures before they occur. When the combination of these practices can't provide the desired reliability,

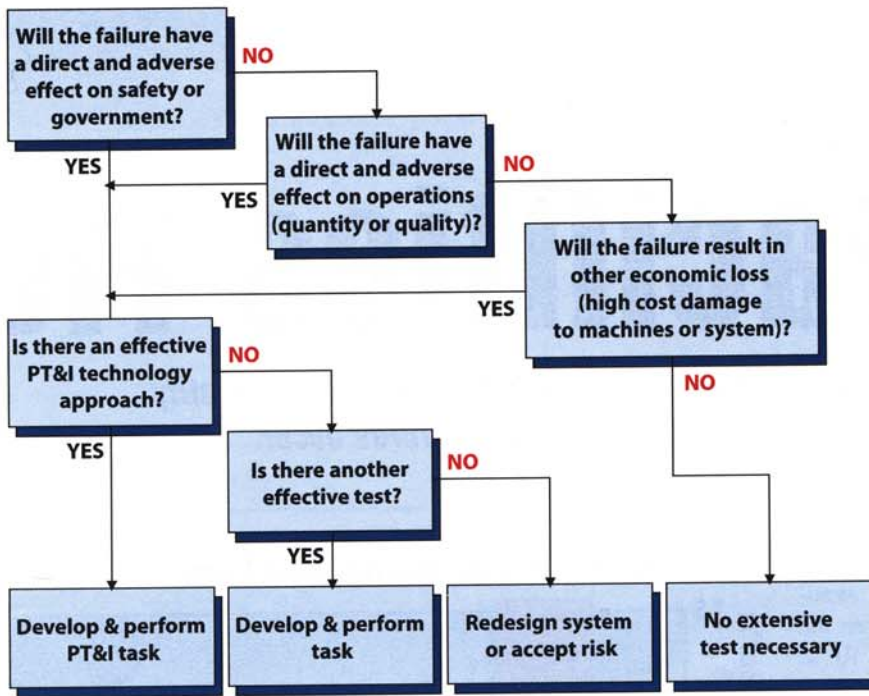


process redesign or equipment changes are suggested. RCM creates an "engineered" maintenance program. It optimizes the use of maintenance practices to improve equipment reliability and safety, and it minimizes adverse environmental impacts and life-cycle costs.

The development of an RCM maintenance program for a given system and its individual components involves a consistent, well-documented process. Here we summarize and illustrate the key steps of the process and how it leads to selecting proper maintenance practices.

- **The Operating Context.** Know how each piece of equipment supports the overall operation of a system to develop a prudent maintenance program. This must go beyond the recommended "minimum" maintenance to satisfy equipment warranties.
- **Failure Modes and Effects Analysis (FMEA).** FMEAs evaluate equipment functions, potential failure modes, failure effects, and failure consequences. The components of FMEAs are:

**Function.** The function defines the performance expected from the equipment (what), and includes



## NASA & BOS Contractors

NASA started RCM in the early 1990s by implementing a streamlined program that focused on its most critical facilities equipment (heating and ventilation systems, electrical systems, etc.). At one installation, 600 pumps used in HVAC systems had a mean time between failure (MTBF) of about two years. After implementing RCM, the MTBF increased to six years. At an average repair cost of \$1,800 per failure, the RCM program saved more than \$360,000 annually.

Since implementing RCM, NASA has absorbed more than \$275 million in maintenance budget cuts. System reliability and availability improved, and savings due to avoided failures and mission impacts were significant. Within two years, the costs of reactive maintenance shrank from 70 percent to less than 30 percent of the overall

facilities maintenance budget. At one NASA center, calls to perform breakdown maintenance were reduced by 40 percent within six months after implementing RCM.

Starting an RCM program requires an initial investment in education and training, predictive technology equipment, RCM analysis, and changes to existing scheduled maintenance programs. The initial cost to implement RCM at a typical NASA center was less than \$1 million, and paybacks through reduced preventive maintenance, fewer trouble calls and improved system reliability were between one to two years.

An increasing number of Base Operations Support (BOS) contractors are also using RCM, allowing them to improve service while lowering operating costs for clients. TME

owner defined performance standards (how well). Functions should be measurable. The function of a pump is to circulate water (what) at given flow rate (how well).

### Functional Failure and Failure Analysis.

Equipment has failed functionally when it no longer meets the desired performance standard. Failure analysis investigates causes of a functional failure. Failure analysis occurs at the system, sub-system and component level. RCM examines all possible functional failures, and develops prudent maintenance programs to minimize each. There may be several failure modes for each functional failure. The possible causes of pump failure include worn impellor blades or plugged filters.

**Failure Effects.** Failure effects describe what happens when failures occur. The failure effects analysis documents how failures occur, and how the organization is prepared to handle the failure. Items like spare parts, response protocol, and response time are included in this part of the analysis. Knowing such details aid the development of a maintenance program.

**Failure Consequences.** The FMEA concludes with a description of the failure consequences. Operational, safety and environmental impacts resulting from the failure are assessed. This assessment is a key component in the cost-benefit analysis of current and proposed maintenance programs.

- **The RCM-based Maintenance Program.** The final step involves developing the RCM-based maintenance program. The program ensures desired availability and reliability levels are met at minimal costs.

