



RCM and Its Application at Sandia National Laboratories

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**Achieving Excellence in Facilities Management
and Sustainability**

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Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.



Sandia National Laboratories (SNL)



**Albuquerque,
New Mexico**



**Livermore,
California**



**Tonopah Test Range,
Nevada**



**Kauai Test Facility,
Hawaii**

SNL Facilities Management and Operations Center (FMOC)

- Has 392 Employees
- Has 84 Staff Augmentation Contractors
- Has 2,661 Construction and Service Contractors
- Maintains 6.3 million gross square feet (GSF)
- Maintains 49 miles of paved roads
- Maintains 38 miles of unpaved roads
- Stewards 8,600 acres of land
- Executes about 40,000 work requests per year
- Spends about \$200 million dollars a year

FMOC



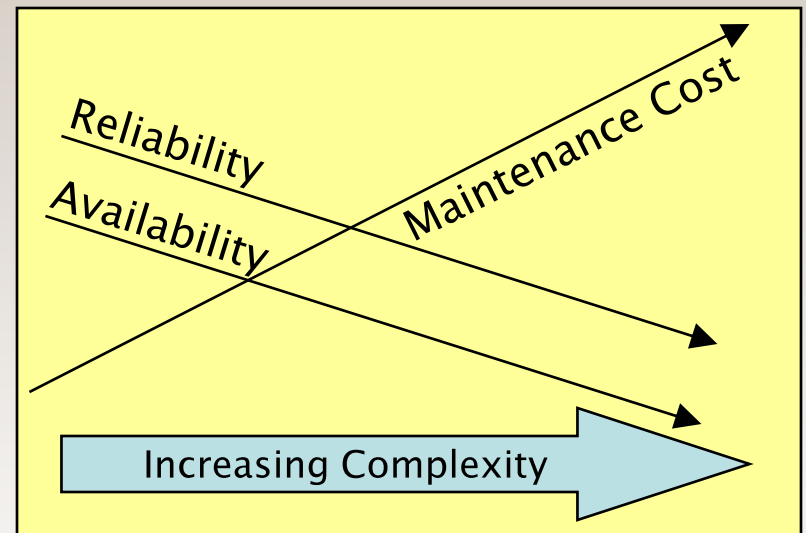
History of Reliability-Centered Maintenance (RCM)

- Commercial Airline Industry: 1950s-1960s



- Task Force

Traditional Maintenance Approach



1978: Nowlan and Heap report, *Reliability-Centered Maintenance*

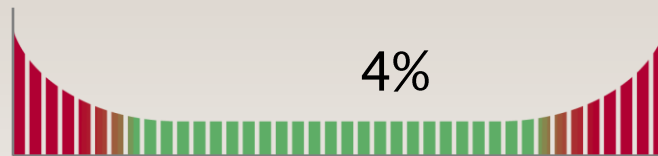
1980 to present: MSG-3 for all major types of civil aircraft, also adopted by military

1992: *RCM2*, by John Moubray (industrial application)

The Reality of Failure

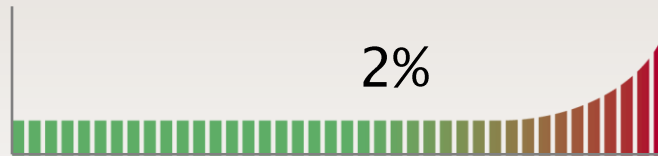
Six Failure Patterns

<20% age-related



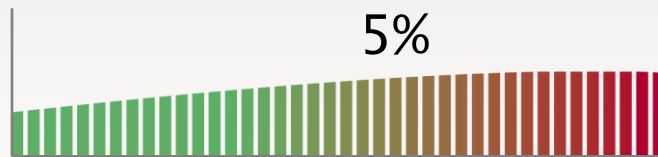
Bathtub

4%



Age-Related

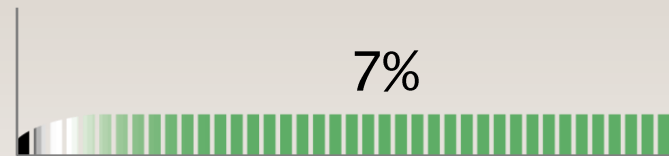
2%



Fatigue-Related

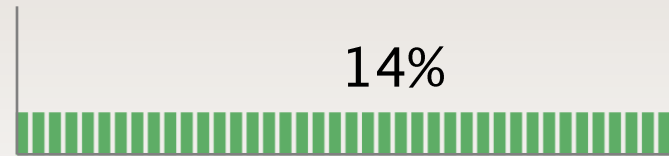
5%

>80% random



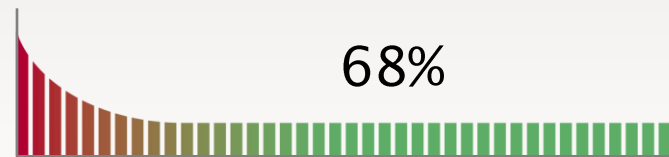
Condition-Related

7%



Random Failure

14%



Infant Mortality

68%

Most failures are random, not age-related.

F M O C

Tool: Reliability-Centered Maintenance

- “A process used to determine what must be done to ensure that any physical asset continues to do *whatever its users want it to do* in its *present operating context*.”
- SAE JA1011 Standard for RCM.
- DOE recognizes RCM as an O&M best practice.



7 Basic Questions of RCM

1. What are the functions of the asset?
2. In what ways does it fail to fulfill its functions?
3. What causes each functional failure?
4. What happens when each failure occurs?
5. In what way does each failure matter?
6. What can be done to predict or prevent each failure?
7. What should be done if a suitable proactive task cannot be found?

What RCM Achieves

- Optimized maintenance plan, including PdM and PM
 - *The right maintenance at the right time*
- Proactive operator tasks
- Design modifications that eliminate or reduce risk of safety, environmental, or operating consequences of failure
- Understanding of functions, capabilities, and performance expectations
- And, of course, *more reliable equipment!*



SNL's RCM Experiences



Acid Exhaust System



Heating Water System

- Increased system reliability
- Eliminated single points of failure
- Prevented operational downtime



Networked Fire Alarm System



Source Elevator System

SNL's RCM Experiences

- **Acid Exhaust System**
 - Reduced risk of system failure (safety and operational consequences).
 - Reduced annual corrective maintenance hours from 138 in FY06 to zero in FY07, FY08, FY09, FY10 and FY11 – so far.
 - Identified single point of failure, mitigated risk, and recommended a permanent solution.
- **Fire Alarm System**
 - Reduced false alarms, which cause costly evacuations.
 - Prevented 1- to 2-day evacuation by identifying and obtaining a critical spare for a network card.
- **Heating Water System**
 - Reduced PM hours on fire-tube boilers by 60%.
 - Developed operator tasks and PM plan for modular boilers, which can be applied to many installations.
- **GIF Source Elevator System**
 - Reduced frequency of PM tasks from 6 months to 1 year.
 - Established predictive maintenance task that identified overheating cabinet and prevented potential electrical failure or fire.





Optimizing RCM



- Perform full-blown RCM for critical systems.
- Apply RCM concepts in daily maintenance decisions.
 - Educate workforce in RCM.
 - Consider operating context, failure modes, and consequences.
- Incorporate RCM principles into O&M Strategic Plan.

Center for Excellence

Reliability and Maintainability Center at the University of Tennessee

- Annual Maintenance and Reliability Conference (MARCON)
- Degree programs in reliability
- Students with an interest in maintenance and reliability
- Boot camp
- Klaus Blache, Ph.D., MBA, CPE <http://kblache@utk.edu>



Society of Maintenance and Reliability Professionals (SMRP)

- Certified Maintenance and Reliability Professional (CMRP) Certification
- Annual Conference
- Body of Knowledge
- SMRP Job Board
- Free Publications
- Local Chapters
- <http://www.smrp.org>



RCM Today

- Delivered 3-day RCM training to 80+ people.
- Incorporated RCM principles into many systems, including air handlers and pumps, for on-condition tasks, such as operator rounds.
- Implemented a Building Operator role.
- Replaced some time-based PM tasks with on-condition rounds.
- Initiated a culture of a condition-based maintenance approach and strategy, using a PM-optimization approach.
- Developed a *Strategic Maintenance Plan*.
- Initiated a process to identify critical applications that might benefit from full-blown RCM analysis.
- Initiated a process of working with line customers to develop RCM-based maintenance strategies.