SAND2007-2201C

THE RCM JOURNEY AT SANDIA NATIONAL LABS

Presented at MARCON by
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Sandia National Laboratories

An Overview of Sandia National Laboratories

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000. SAND -2005-6648P

Our Business: National Security

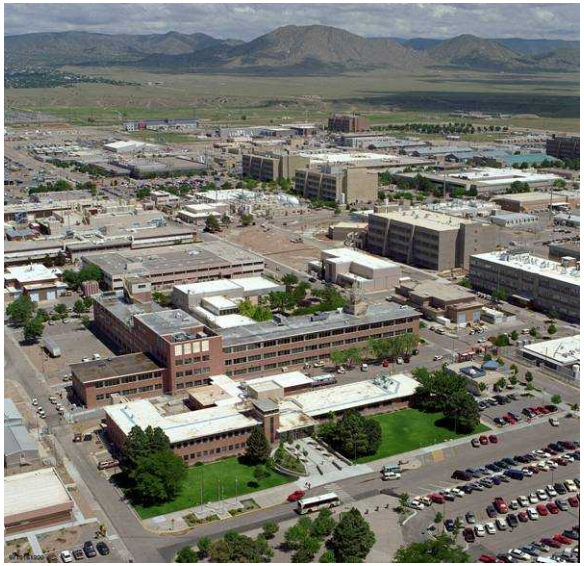
- **Core Purpose: to help our nation secure a peaceful and free world through technology.**
- **Highest Goal: to become the laboratory that the United States turns to first for technology solutions to the most challenging problems that threaten peace and freedom for our nation and the globe.**

Mission-Driven Laboratory

We serve many agencies of the US Government with:

- Design and development: nonnuclear portions of US nuclear weapons
- Production: advanced components
- Safety, security, use control
- Treaty verification, nonproliferation, counterproliferation
- Advanced military technologies
- Energy and environment
- Homeland security, countering weapons of mass destruction

Distributed Facilities to Meet National Needs



Albuquerque,
New Mexico

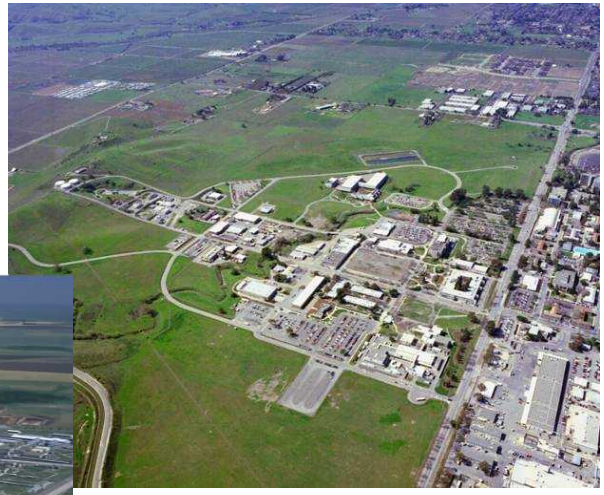
Kauai Test Facility,
Hawaii

Tonopah Test Range,
Nevada

Yucca Mountain,
Nevada

WIPP, New Mexico

Pantex, Texas



Livermore, California

National Nuclear Security Administration

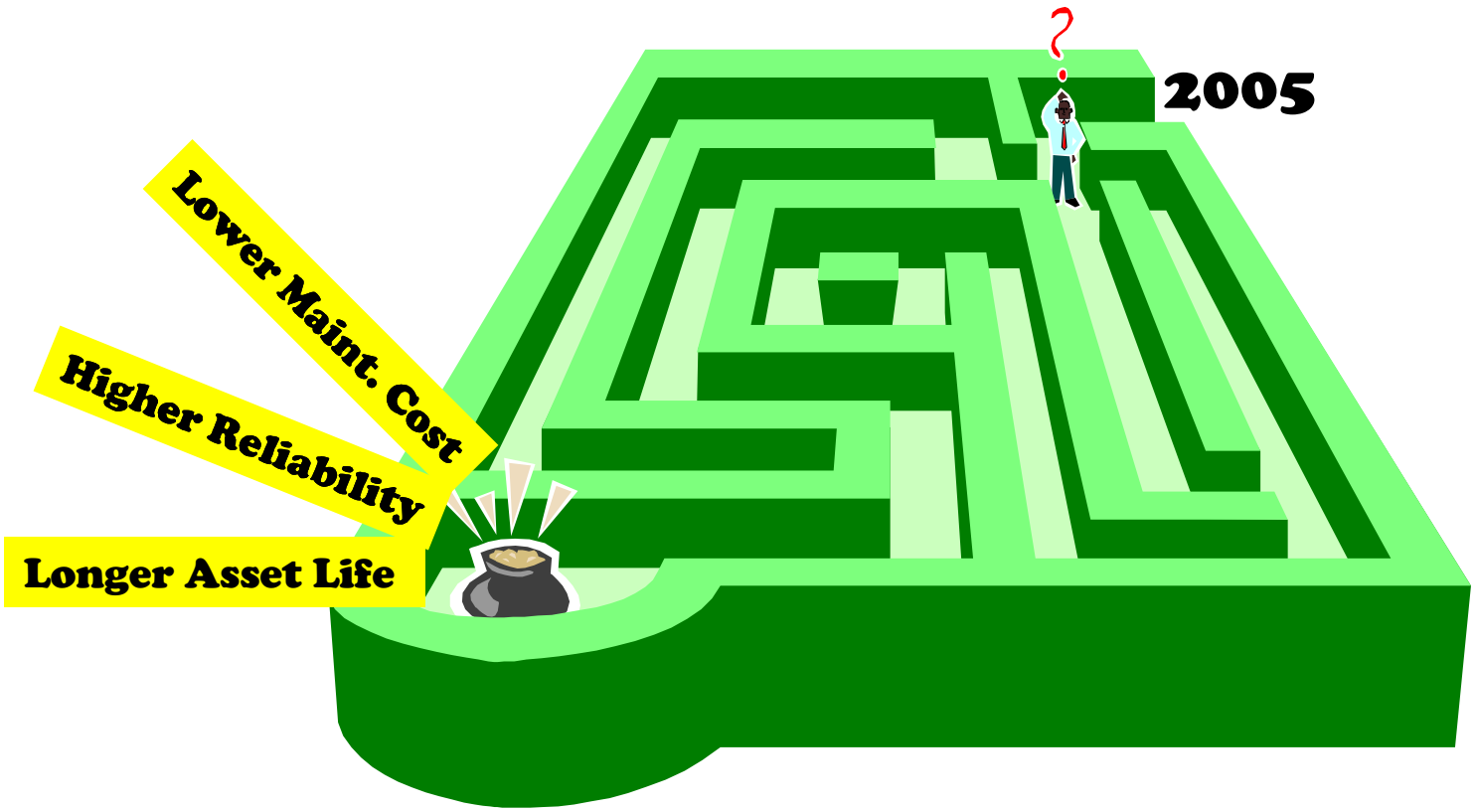
April 2007

Sandia National Laboratories

Four Mission Areas

- Nuclear Weapons
- Defense Systems and Assessments
- Energy, Resources, and Nonproliferation
- Homeland Security and Defense

Beginning the RCM Journey



Sandia National Laboratories

First Steps

- Creation of Maintenance Engineering Dept.
- Hiring of In-house RCM Facilitator
- Development of Project Charter
- Benchmarking with AEDC
- Decision to follow SAE JA-1011
- Partnering with RCM Consulting Firm for Training and Coaching

Choosing the Assets

- Microsystems & Engineering Science Applications (MESA) / Microelectronics Development Laboratory (MDL)
- Mission Critical Facility
- Manufacturing Environment
- Strong Customer Relationship

Sandia's RCM Experiences

- Acid Exhaust System
  - Existing Critical System (Life Safety & Operational)
- Fire Alarm System
  - Existing System expanded to larger networked system
  - Process / Human / Configuration Control Focus
- Heating Water System
  - Existing System being expanded to serve additional buildings
  - RCM done between design and construction

Project #1: Acid Exhaust System

- **Major Findings:**
  - **Discovered key vulnerabilities of system**
  - **Identified single points of failure**
  - **Changed operating philosophy of redundant pumps from alternating 50/50 to duty/standby**
  - **Documented operator tasks**
  - **Achieved understanding of and agreement on system functionality and performance requirements**

FMEA Example #1

	Function		Functional Failure		Failure Mode	Failure Effect	
1	To exhaust all non-solvent process exhaust required for all tools in Building 858N at a static pressure of 2.5"wc.	A	Unable to exhaust non-solvent process exhaust at all.	6	Nitrogen valve shut off.	There are several manually operated valves that could cause this failure mode. Dampers would spring shut, FCS alarms on low static pressure and screen shows dampers closed. Auto dialer alarms, tool specific alarms, decision to evacuate would depend upon ERT decision, loss of pressure balance in building (over pressurize). Possible health risk from loss of acid exhaust. Possible tool damage from loss of heat exhaust or from turning off tools. Operators would manually open valve. Downtime to switch to CDA: Up to 3 hours if building is evacuated. Downtime to resume "A" grade production rates: 1 day if no tool damage, weeks to months if tools are damaged. EMTBF: 5 years.	

FMEA Example #2

	Function		Functional Failure		Failure Mode	Failure Effect	
6	To control makeup water through the scrubbers at a rate of 6 to 8 gpm	**C**	Unable to control the makeup water through the scrubbers at a rate less than 8 gpm	**1**	Manual make up water valve left fully open	Could overflow the AWN floor drain. Depending upon how much water builds in the equipment room, could be injuries and/or environmental breaches due to chemicals in the water. Possible corrosion damage to equipment due to water/chemical contamination. Possible discharge to storm drain which could cause injury and fines. Repair time to diagnose and open valve: 1 to 4 hours. Note: if water contamination or overflow occurs in solvent fan or north equipment room, would have to contact IC and follow their instructions. EMTBF: 5 years.	

Project #2: Fire Alarm System

- Unique Characteristics:
  - Analyzed processes associated with the system from project initiation through full system operation
    - Communication
    - Documentation
    - Change Control
    - Human Interface
    - Training
- Many Hidden and Safety related failure modes
- Most Decisions classified as Redesigns:
  - Process Changes/Improvements
  - Procedures
  - Training
  - Physical Modifications

FMEA Example

	Function		Functional Failure		Failure Mode	Failure Effect	
3	To ensure smooth transition to operations	**B**	Ineffective transition to operations	**6**	Incomplete commissioning by contractor	Delays other maintenance activities. Delays project. Overtime costs for Sandia maintenance. Could delay building occupancy. Possible partial loss of functionality. Sandia becomes commissioning agent.	

Decision Example

- **Failure Mode Reference = 3B6:**
  - **Proposed Modification = Procedure**
    - **Monitor commissioning activities through network, download history from panel to verify completion of activities by contractor.**
    - **Conduct regularly scheduled meetings with contractor, maintenance, and engineering throughout commissioning process.**

Recommended Policies and Procedures

- Administrative Procedures
  - Fire Alarm Evacuation and Emergency Response Plan
  - Fire Protection System Training Matrix
- Operating Procedures
  - Fire Alarm System Operational Procedure
  - Fire Protection System Modification Request Procedure
  - Inspection, Testing, and Maintenance of Fire Alarm Systems
  - Acceptance Testing and Commissioning Procedure
- Spare Parts List

Project #3: Heating Water System

- Adding 8 modular boilers to 3 existing fire-tube boilers
- Construction scheduled for Summer 2007
- RCM Goals:
  - Determine operating and control strategy
  - Develop maintenance policy
  - Identify design improvements for reliability and maintainability
  - Eliminate single points of failure if possible
  - Provide a template for future heating water system installations

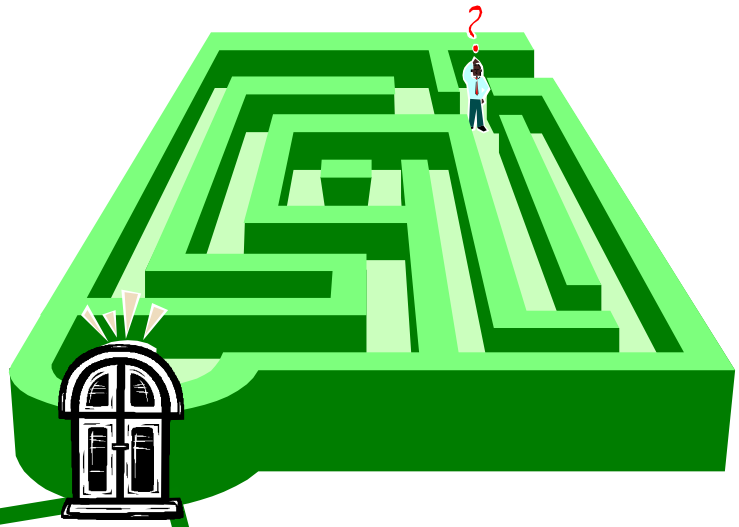
Gems We Found Along The Way

- RCM demands a paradigm shift.
  - PM is not always king.
  - Maintenance tasks should be driven by failure consequences.
  - Task frequencies should be derived from P-F intervals.
- Structure is good.
- Everyone learned.
- Operating Context!

Dead Ends and Detours

- Overwhelmed by other events.
- Management or Team Members not committed.
- Lack of RCM training.
- Incomplete team.
- Poor facilitation.
- Lack of accountability for implementation.
- Lack of funding and/or manpower for implementation.
- Resistance to change.

The Journey Has Just Begun!



RCM...the new paradigm