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Reliability-Centered Maintenance (RCM)

Sandia's Experience

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John Zavadil
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.

First Steps

- Creation of Maintenance Engineering Department
- Hiring of in-house RCM facilitator
- Development of project charter
- Benchmarking with Arnold Engineering Development Center (AEDC)
- Decision to follow Society of Automotive Engineers (SAE) Standard JA-1011
- Partnering with RCM consulting firm for training and coaching – Strategic Technologies, Inc.

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Choosing the Assets

Microsystems & Engineering Science Applications (MESA)/ Microelectronics Development Laboratory (MDL)

- **Mission critical facility**
- **Manufacturing environment**
- **Strong customer relationship**

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Sandia's RCM Experiences

- Acid Exhaust System (MDL)
  - Existing critical system (life safety & operational)
- Fire Alarm System (MESA)
  - Existing system expanded to larger networked system
  - Process/human/configuration control focus
- Heating Water System (MDL/MESA)
  - Existing system was 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.	

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

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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
- RCM performed 3 months prior to construction
- RCM accomplishments:
  - Determined operating and control strategy (changed sequence of operations from design)
  - Developed maintenance policy (saved >100 labor hours per year with RCM strategy as opposed to OEM recommendations)
  - Identified design changes that impacted safety (emergency stop buttons, fall protection)
  - Eliminated single points of failure

Benefits

- RCM demands a paradigm shift
  - Preventive Maintenance is not always king
  - Maintenance tasks should be driven by failure consequences
  - Task frequencies should be derived from Potential-Failure 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

Q&A, Point of Contact

- Questions?
- For more information, contact Shelley Whitener at Sandia National Laboratories:
  - Phone: (505) 284-1853
  - E-mail: swhiten@sandia.gov

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