



# Reliability Centered Maintenance, RCM

Steve Williamson

November 19, 2009 / WMEA, San Antonio, Texas

**BREAKTHROUGH  
SOLUTIONS**

## Reliability Centered Maintenance - RCM

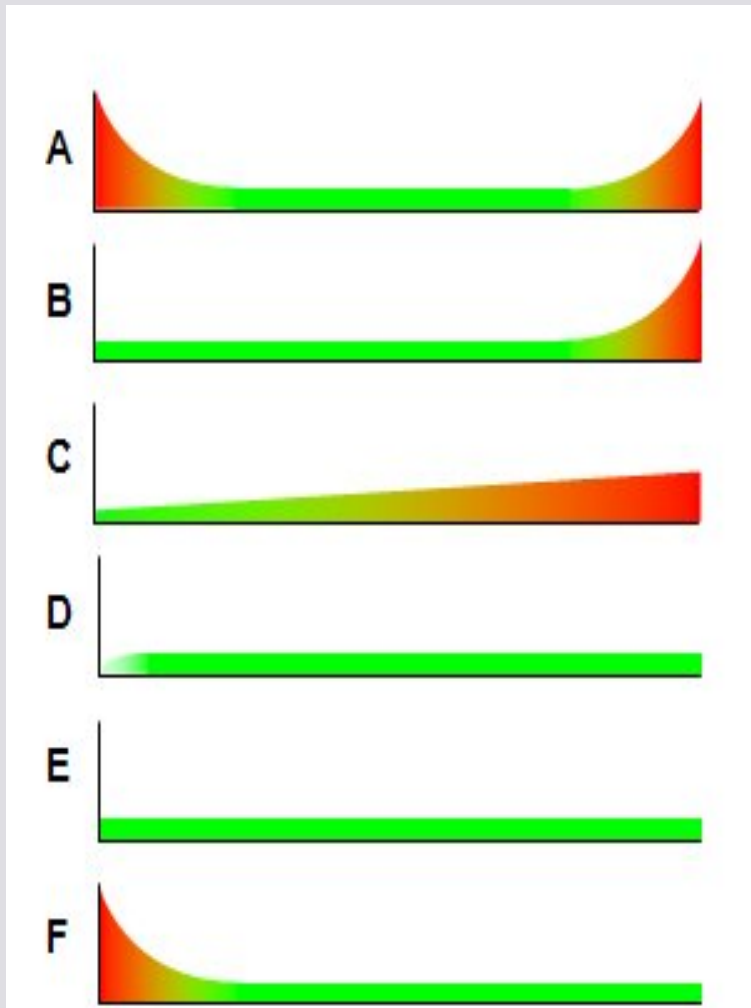
- What is RCM?

RCM is a process used to determine the maintenance requirements of any piece of machinery when it is operating. “Reliability-Centered Maintenance” develops Planned Maintenance Programs which are cost effective processes design to obtain the life expectancy of the component.

## How Does RCM Work?

- Once the RCM process has been applied to a system, assembly, or subassembly the following information is determined:
  - Function...What does this component do?
  - Functional Failure...How can it fail?
  - Failure Mode...How do you know it had failed?
  - Failure Effect...What is the impact of the failure?
- The above process is essentially a Failure Mode and Effect Analysis (FMEA).

## Six Failure Patterns



- A – Bathtub curve, infant mortality settling down to a random failure then wear out zone
- B – Traditional view, random failure then wear out zone
- C – Steady Increase in the probability of failure
- D – Sharp Increase in the probability of failure settling down to random failure
- E – Random failure, no relationship to age
- F – Reversed J-curve, infant mortality

## How Does RCM Work?

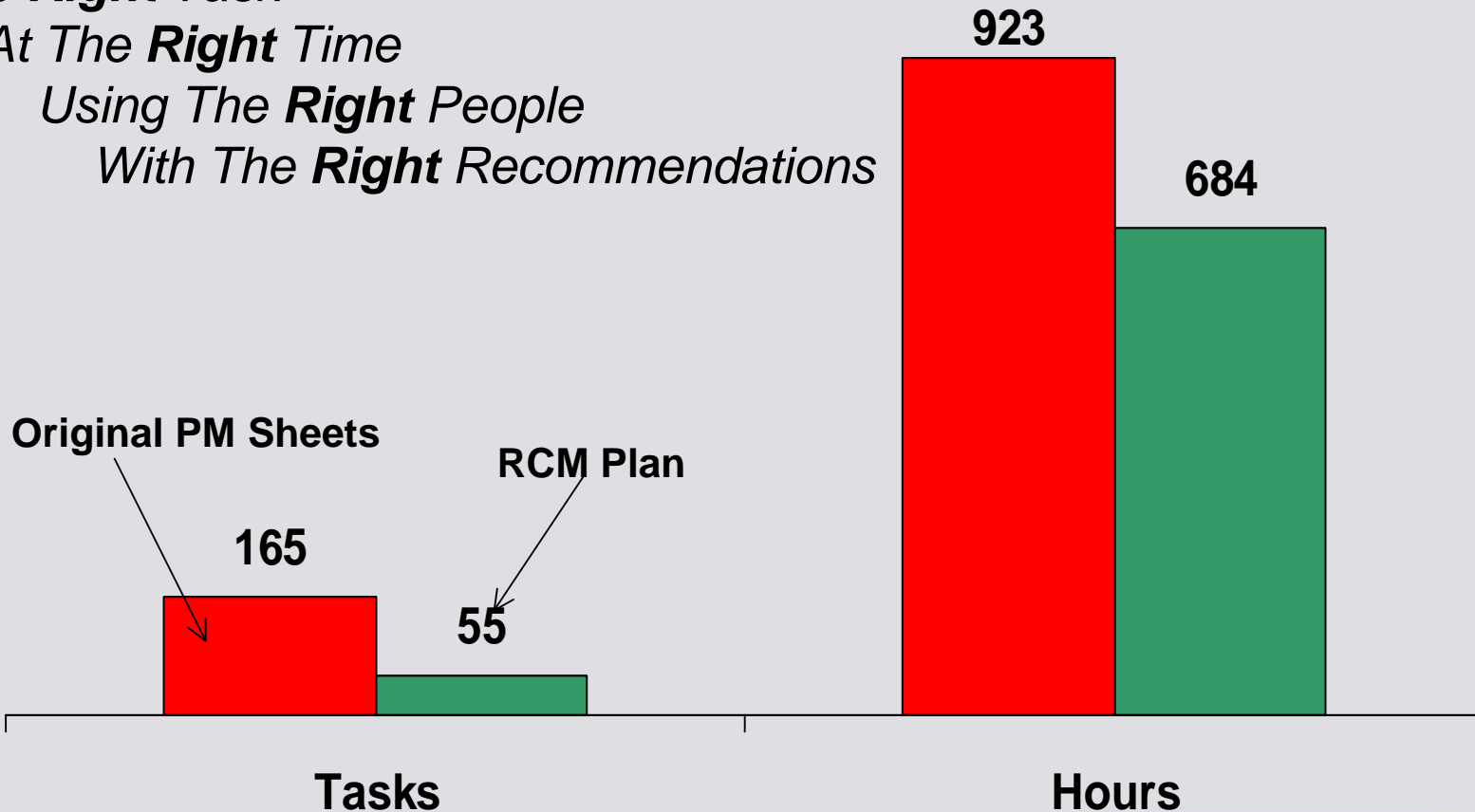
- Based on the Failure Mode & Effect Analysis, (FMEA), information the RCM process then examines Failure Consequences.
- Will the failure be immediately evident, Y or N?
- Does the failure impact
  - Safety
  - The Environment
  - Operations

## How Does RCM Work?

- Is a task to detect whether the failure is occurring or about to occur technically feasible and worth doing?
- If 'No', then there is **No** scheduled maintenance.
- If 'Yes' identify the type of task; inspection, repair, replacement or condition-based task.
- Then identify an 'Interval' for the task, (Frequency Hours)
- Then identify 'who performs' the task i.e. mechanic.

# RCM Task Analysis

*The **Right** Task  
At The **Right** Time  
Using The **Right** People  
With The **Right** Recommendations*



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# FMEA Results

RCM ANALYSIS PERFORMED ON A 4100 HOIST MOTOR, RESULT: THREE: PLANNED MAINTENANCE TASKS THREE: NO SCHEDULED MAINTENANCE REQUIRED																					
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
System Description	Functional Location	Part Code	Part Code Description	Functional Description	Failure Mode / Effect	Failure Cause	Failure Mode / Effect	Recommended Task	Safety Precautions	Special Instructions	Maintenance Drawings	Recommended Lubrication	Comments	Interval Hours	Trade	Resources	Task Type	Special Tools	PMS	POR	Consumables
4100XP B/C Hoist System	4100-XXXXXX-HST-EL-01	1875	Motor; DC; Hoist	To raise and lower the dipper in facilitate material movement with an RSL of 415,000 lbs	Unable to raise and lower the dipper in facilitate work movement	41-R-02: Motor Brushes Wear	Motor brushes wear excessively	Inspect / change motor brushes	Be sure that the Hoist system, fields and motor brushes are de-energized and locked out	38 brushes required for one complete motor brush change-out. Consider 38 brushes for each motor or 28 total for each maintenance schedule.	4100XP Maintenance and Operators Manuals	Brush Inspection / Replacement	Perform on front and rear hoist motors	500	Electrical	1	Preventive (Hoist-based PM)	1. Regulated compressed air supply or vacuum cleaners 2. Tape measure / brush length guide	RSE287056-Applicable to K-1638 PM R558374	28	Fluorescent sandpaper (80#)
4100XP B/C Hoist System	4100-XXXXXX-HST-EL-01	1875	Motor; DC; Hoist	To raise and lower the dipper in facilitate material movement with an RSL of 415,000 lbs	Unable to raise and lower the dipper in facilitate work movement	41-R-03: Motor Bearings Lack of Lubrication	Bearing seized or damaged due to lack of lubrication. Bearing temperature rises and alarm is generated when the bearing temperature reaches 180°C. If unattended motor shuts down when bearing temperature reaches 200°C. Downtime to replace motor and align, will take 12 hours.	Lubricate motor bearings		Lubricate the front and rear motors, but take pause each motor	4100XP Maintenance and Operators Manuals	Lubricate Motor Bearings	Lubricate bearings when the motors are still warm.	500	Electrical	1	Preventive (Hoist-based PM)	Cartridge type grease gun, dedicated for motor bearing lubrication, with a hose delivery to deliver 1/2 Oz.			Grease in PMS Spec 4726, Bar C
4100XP B/C Hoist System	4100-XXXXXX-HST-EL-01	1875	Motor; DC; Hoist	To raise and lower the dipper in facilitate material movement with an RSL of 415,000 lbs	Unable to raise and lower the dipper in facilitate work movement	41-R-12: Motor bearing normal wear	Normal wear of motor bearing	Vibration data collection	Vibration data collection requires working around rotating equipment with the guards removed. Exercise extreme caution to prevent serious injury. Each individual in raising, shelling, cables and equipment is secured in rotating equipment.	1. Ensure machine is parked on level floor, with sufficient space for equipment passage all safe distance from high wall. Consider where access ladders are located. 2. Align upper parallel to workbed, set the dipper on the ground, lower the hoist, set brakes and shutoff machine.	4100XP Maintenance and operators manuals	Vibration analysis (PDV)	Vibration Analysis	1000	Technician - All Diagnostic Services	2	Condition Monitoring (PDV)	Vibration signature Data Collector			None

Functional Location, Description, Failure Cause / Effect, Tooling, Skill, Time





# Maintenance Task Sheet

## RCM Recommendation

Function Description	To raise and lower the dipper to facilitate material movement with an RSL of 415,000 lbs
Functional Failure Description	Unable to raise and lower the dipper to facilitate earth movement
Failure Mode Cause Name	01-A-02- Motor Brushes Worn
Failure Mode Cause Description	Motor brushes worn excessively
Failure Effect Description	Over time the brushes wear and if not replaced in time, the brush pig tails make contact with the commutator and cause mechanical damage and/or flashing. The diverter system will shut the shovel down. Downtime to replace brushes if no damage occurred approximately 2 hours. In the event of damage to the motor, downtime may increase to 12 hours (motor needs replacement)
Recommendation ID	17-1-1-2-1-1
Recommendation Type	RCM
Recommendation Basis	RCM/FMEA Strategy Based
Part Code	1075 Motor;DC-Hoist
Asset ID	41XB-XXXXX-HST-EL-01
Recommendation Headline	Brush Inspection / Replacement
Task Description	Inspect / change motor brushes
Task Category	Maintenance
Task Type	Preventive (time-based PM)
Interval	500 HOURS
Recommended Resource	Electrical

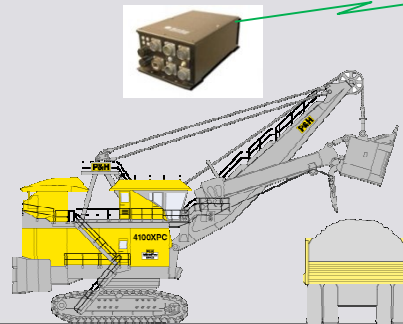
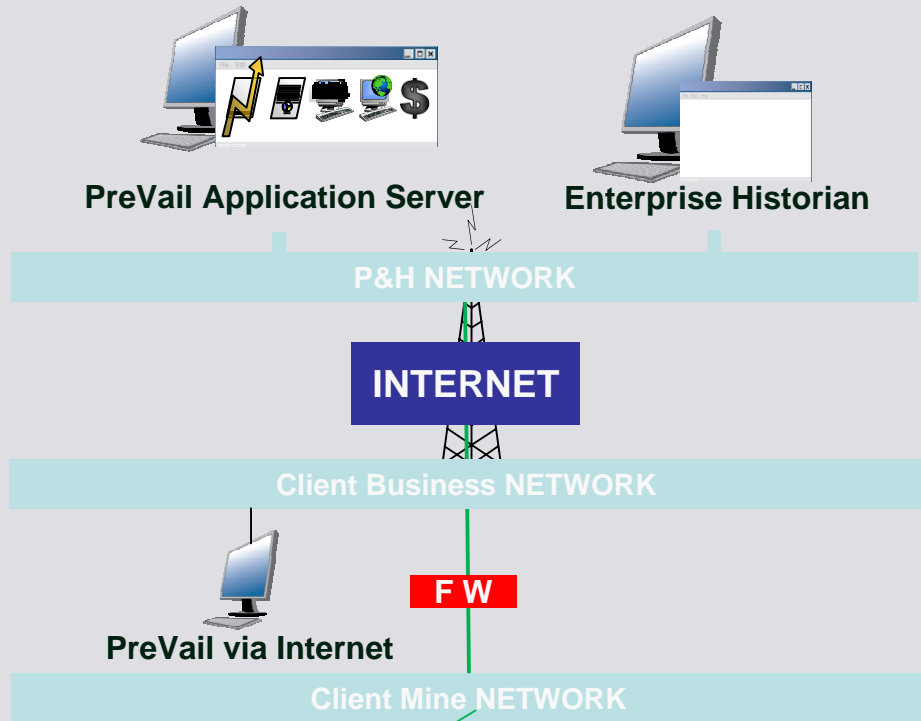
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# RHM PreVail Background

PreVail is a hosted solution

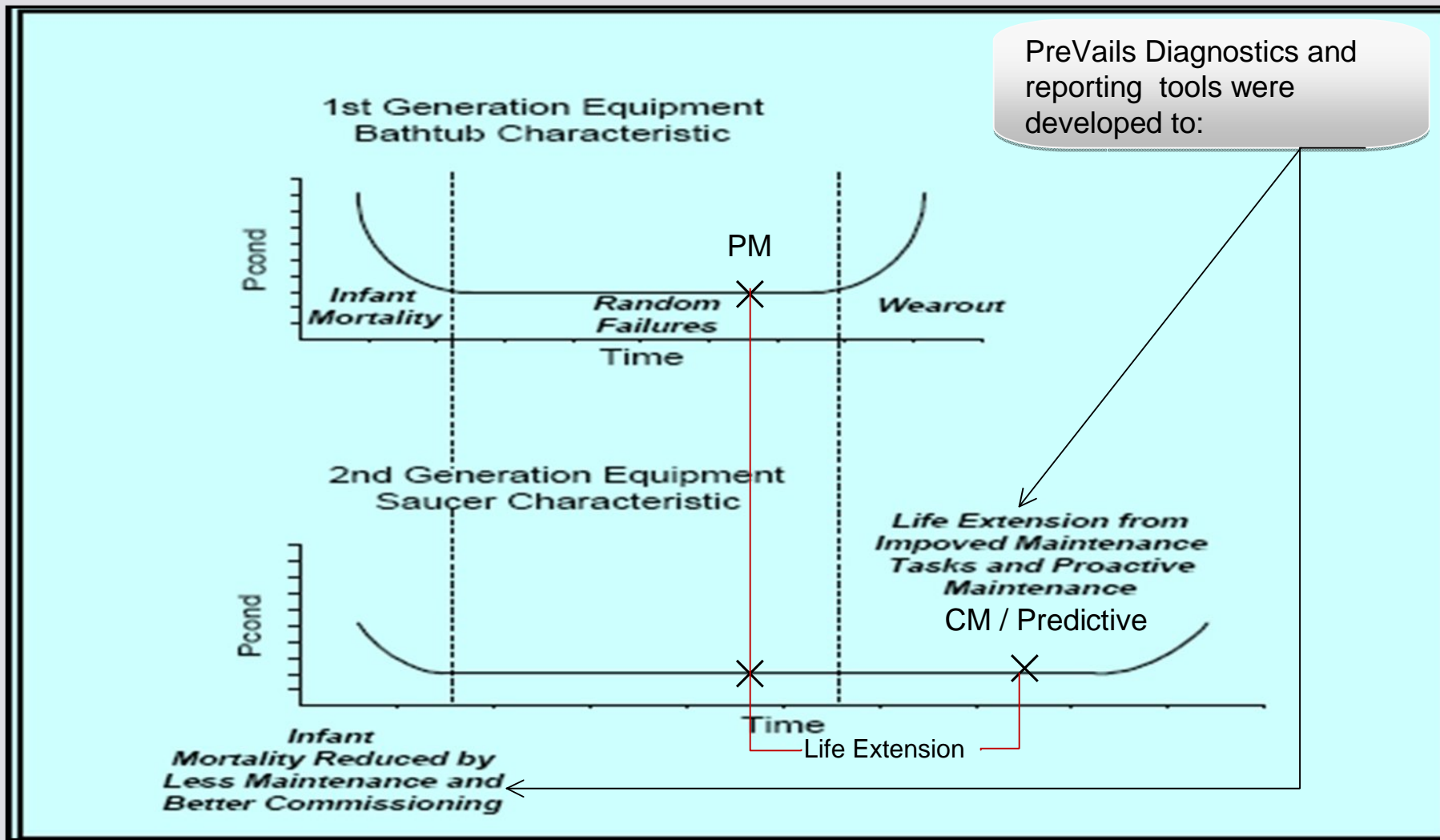
- ✓ Simplifies Implementation
- ✓ Reduces Cost of Ownership
- ✓ Instant Software updates
- ✓ Realize more value
- ✓ User access via any Internet connection



Data Logger  
Buffer Sensor & Alarm Data



## RCM Failure Mode Analysis



## RCM Benefits

- Improved productivity through the reduction in unplanned downtime.
- Higher Availability through reduced maintenance hours
- Receive a proactive maintenance plan focusing on what tasks need to be performed for each component



## Results to Date 2009

- Machine lives 17,000 to 83,000 Hours
- Availability 85 %to 91% (based on 24x7)
- Mean Time to Failure 78 to 845 Hours
- Mean Time between Failure 159 to 496 Hours
- Mean Time to Repair 6 to 44 Hours

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stack of  
67 billion  
beer cans

moon ●

earth ●

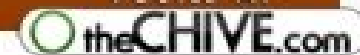
If all the beer consumed  
in the US in one year were in

**BEER CANS**

stacked  
**ONE  
ON  
TOP  
OF**  
another  
it could  
reach  
**THE  
MOON**

20 times

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