Risk Based Maintenance
Overview

- Delivering sustainable improvements is hard
  - No time
  - Changing priorities
  - BUT concepts appear well understood

- Risk Based Maintenance (RBM) can help
  - Reduces costs, improves reliability & integrity
  - Basic principle relates actions to levels of risk

- Paper covers RBM approaches that work
Risk Based Maintenance (RBM) - Concepts

- Managing Risk = finding the right balance

- Asset Risk concepts familiar to most
  - Probability of event X consequence of event
  - Most approaches only look at technical side
  - Don’t consider implementation risks

- Solutions are often simple technically

Many approaches don’t deliver results
Maintenance Strategy Model

Maintenance is about more than equipment!

ASSET PERFORMANCE MANAGEMENT
WORK MANAGEMENT
PEOPLE & ORGANISATION

Business Strategy
Integrated Maintenance Strategy
Manufacturing Strategy

LEGISLATIVE COMPLIANCE
ENGINEERING RESOURCES MANAGEMENT
FINANCIAL CONTROL
Factors for Implementation

- Size of prize and rate of return depend on start point
- Most problems have many possible solutions
Common Pitfalls

A common approach – inefficient and inappropriate

Situational analysis to decide what to improve

Select solution

Solution is unworkable so rework based on feedback

Better Approach

– right first time

Situational analysis to decide what to improve – including analysis of implementation factors

Select optimum solution
Risks Associated with Implementation

- Time – availability, time management etc.
- Organisation – right skills, right responsibilities
- Energy – short term and long term to drive success
- Consistency of purpose – will it still be important / get attention next week?

- Most improvements require long term change
So - Where to Begin? Theory

- Lowest risk: last
- Highest risk: 1st
- Overview
- Study
So - Where to Begin? Reality

Devil in detail

Change & time management

Complex range
Of factors

Harvest
low hanging
fruit – but keep
direction
Examples of some Helpful Approaches

RBI
Supplier Mgmt

Start
Quick wins
Overview study
Screening
RMA CEDAC

80%
Risk Based Inspection (RBI)

- Joint approach developed with Huntsman Petrochemicals on their 860,000 t/yr ethylene cracker
- Aimed at reducing shutdown costs
  - Reduced number of inspections
  - Reduced scope of inspections
  - Increased time between inspections
  - Enhanced prediction of necessary repairs
- Applied over 2 shutdowns – 1997, 2002
Risk Based Inspection - Overview

“A Rigorous Team Based Approach to Managing Pressure System Risks”

- Understanding
- Probability of Failure
- Consequence of Failure
- Optimum Inspection Regime

WHY – to satisfy safety authorities
How – Tolerable defect sizes, fracture mechanics, localised effects, tolerable leaks, mitigation, advanced NDE, use of database and IT tools, process maloperation…….
The Results

<table>
<thead>
<tr>
<th></th>
<th>1997</th>
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<td>Items Due for Inspection</td>
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<td>Predicted Repairs</td>
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<td>Unforeseen Shutdown Repairs</td>
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</table>
Supplier Improvement

- Major Chemical company looking to reduce maintenance spending by $1.3 M
- $650K already saved through other ABB supported work
- Target to save $400K from sub-contracted maintenance
- Initial view
  - savings come from lots of small improvements
  - requires changes to working practices
- The approach taken was to run an improvement team
  - Cross slice of maintenance organisation
    - Facilitated by ABB
    - Supported by expertise as required
  - Had to deliver benefit in 10 weeks
8 Step Improvement Team Process

1. DEFINE PROCESS
   - ‘Gut feel’ for the problem

2. DEVELOP HYPOTHESIS

3. COLLECT DATA

4. ANALYSE DATA
   - Clear data based problem definition

5. DEVELOP SOLUTIONS
   - Solutions to address the real problem

6. COMMUNICATE RECOMMENDATIONS & IMPLEMENT
   - Solutions that get commitment

7. MEASURE BENEFITS

8. COMMUNICATE RESULTS & HANOVER
   - Next wave of improvement - continuous
Outcomes

- Within the 10 weeks $ 650K p.a. savings delivered
- Further $ 2.4M identified
- RBM savings identified through workscope reduction
- Further savings through
  - Scaffolding control
  - Cost control system
  - Lagging specifications
- Team approach benefits
  - Get to the real problem and real root cause
  - Workable / efficient solutions
  - Commitment to making solutions work
  - Continuous improvement culture
Rapid Screening Techniques

- Producer looking to increase shutdown interval by 1 year
- Wanted rapid assurance that risks acceptable – safety, business, quality, environmental

- Approach focussed purely on feasibility of interval extension
  - Aim to minimise time and effort involved
  - Multi-disciplinary team follow 3 stage review
  - Degree of study applied to equipment relates to risk
  - Needs rapid identification of equipment with risks below a low threshold
Phased Equipment Review Process

- **Step 1:** Pre-screening Process
- **Step 2:** Asset Care Criticality Analysis Process
- **Step 3:** Review Process (e.g., FMECA; RBI)
**Assessment Process**

**PROBLEM**
Can the Process Units be operated for another year?

**STEP 1**
Pre-Screening Study

**STEP 2**
Criticality Analysis

**STEP 3**
Risk-Based Inspection

**Implement Actions**

**DECISION**
Decision based on outcome of RBI & required actions

- **Extension of run length**
  - By 1 year

- **Rapid sort method**:
  - To eliminate items - low increased probability of a problem in final year & low consequence

- **Criteria based ranking method**:
  - To investigate & identify items that may pose a threat

- **Detailed Assessment**:
  - To evaluate, categorise & develop appropriate action plans

- **Implementation of actions**
  - to support decision making process regarding identified threats
Outcomes

- Step 1 studied 1328 items
- Step 2 studied 221 items (17%)
- Step 3 studied 82 items (6%)
- 6 items needed action to operate for extra year with acceptable risk. (20 others were acceptable, but simple actions reduced risks further)
- RBI step was ‘slimmed down’ to minimise effort and scheme of examination was not reviewed
- Overall project done in less time and significantly less cost than a full RBI – RBI will follow to minimise workscope in shutdown
Understanding Criticality and Vulnerability

- Resins plant – seeking to improve plant reliability
- Re-organisation led to new operations and maintenance teams
- Wanted a process that they could continue to run themselves
- 10 plants were studied
- Approach taken was a Rapid Maintenance Assessment
- Team facilitated by ABB
Maintenance Definition Process

- Criticality Analysis
  - Non critical
  - Mid-Range Criticality
  - High Criticality
- Maintenance Decision Process
- Identify Maintenance Tasks, Frequencies, Resources & Spares
- Maintenance Summary Sheet
- PM Schedule Generation & Analysis
- Implementation

Equipment Selection for further analysis
RCM Turbo or FMEA
Maintenance Type Selection
Maintenance Task Definition
Maintenance Task & Frequency Summary Sheet
Analysis using RCM Turbo

Maintenance / Spares Decision Process
# Vulnerability

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**Criticality**
# Equipment Care Strategy

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<th>TRAINING</th>
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- Spaces used for valves. May only have overhaul spaces. May valve is the most expensive. One installed valve can be used as a space.
- No protection against vacuum pump pulling bits of material through. Low vacuum switch does not always work.
- No protection against vacuum pump pulling bits of material through. Low vacuum switch does not always work.
Outcomes

- 70-80% less effort than full FMECA analysis with exactly the same results
- Only 12 days for all plants
- Prioritised action list for improvement
  - Maintenance and operating practice improvements
  - Spares holding changes
- Wealth of experience for operations and maintenance team
Conclusions

- You need to find the right place to start
- At some point you do need to assemble a ‘route map’ that includes understanding the risks from all perspectives
- Make sure the approach / partner you use comes from a reality based viewpoint
- You need to plan to keep going – success comes from permanent changes
- You need to look for constant challenges to stimulate improvement
- Don’t forget that things / assumptions will change
- Uncertainty and risk management are facts of modern maintenance – they need to be mastered not feared
Maintenance Definition – Overall Process

Step 1
- Criticality Analysis

Step 2
- Development of Maintenance Requirements & Schedule
- Categorise equipment & produce required generic policies
- Review all items Maintenance Definition Process

Step 3a & b
- Review & finalise defined Maintenance Schedule

Step 4
- Maintenance Schedule Analysis

Step 5
- Pre-Implementation Review

Step 6
- Maintenance Schedule Implementation
Maintenance Definition Process

Criticality Analysis

High / Medium Criticality (as agreed)

Known problem item / high unreliability?

Problem identified & understood

Collect information & analyse

Root Cause Analysis (or other process) if required

High / Medium / Low Criticality item?

Existing, successful Maintenance Policy

Review Maintenance Policy

Further analysis required?

Reformat & reissue existing Maintenance Policy

Failure Identification Process

Maintenance Decision Process

Maintenance Task Definition

Rapid Maintenance Analysis

Maintenance required by Generic Policy? eg lubrication

Maintenancerequired byGeneric Policy?

eg lubrication

Y

N

HIGH – Step 1

MEDIUM - Step 2

LOW - Step 3

Write & issue Maintenance Policy (if policy required)

Maintenance Spares Review (as required)

Contingency Planning Review (as required)

Other Additional Processes as required