Value Based Maintenance
An Optimized Approach

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Agenda

• Embracing Cultural Shift
• Maintenance Optimization
• VBM Implementation Process
• How is VBM Different?
• Jacob’s Value Added Attributes
• VBM Program Overview
• Project Results
• Benefits
Embracing a **Cultural Shift**

- A desired culture that uses cost-effective maintenance strategies to advance safety and reliability. Senior facility leaders must drive the necessary behavioral changes to support the shift from a culture of low to zero-tolerance for equipment failures to a value-based maintenance culture that is appropriately tolerant for low-consequence failures.

- A value proposition (vision of excellence) where overall costs are reduced through establishing an appropriate balance between the maintenance performed on facility equipment and its impact to facility safety and reliability.

  - Ref: NEI EP 17-03b
Maintenance Optimization

Maintenance Strategies

- **Corrective Maintenance (CM)**
  - Reactive: Fix when broken

- **Preventive Maintenance (PM)**
  - Time or Interval Directed Maintenance (e.g. vendor recommendations)

- **Predictive Maintenance (PdM)**
  - Equipment Condition Directed Maintenance

- **Pro-Active Maintenance (PAM)**
  - Reduction/Elimination of Maintenance Burden Based on Eliminating Root Cause
Maintenance **Optimization**

The **investment balance** of the four maintenance strategies

Integrates all **financial, process, maintenance and diagnostic data** into the decision-making process
## Maintenance Optimization

<table>
<thead>
<tr>
<th>INDUSTRY TEMPLATE APPROACH</th>
<th>JACOB’S TARGETED ANALYTICAL APPROACH</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Well Defined PM Tasks Based on Experience and Qualified Resource</td>
<td>• Risk Based Approach</td>
</tr>
<tr>
<td>• Good Starting Point</td>
<td>• Plant Specific Equipment Evals (i.e. functional &amp; environmental)</td>
</tr>
<tr>
<td>• Subjective Application</td>
<td>• Equipment Aging and Material Analyses Using Existing Aging, Material, and Diagnostic Test Data</td>
</tr>
<tr>
<td>• Limited Functional and/or Aging Analysis</td>
<td>• Manufacturer/Model Specific Group Evaluations (Economies of Scale)</td>
</tr>
<tr>
<td>• Evaluations Generic in Nature</td>
<td>• Produces technically robust and better results</td>
</tr>
<tr>
<td>• Not Manufacturer/Model Specific</td>
<td></td>
</tr>
<tr>
<td>• Non-Risk Based</td>
<td></td>
</tr>
</tbody>
</table>

- Results in Increased PMs
- Improved Reliability & Cost Savings
Maintenance Optimization

Identifying the Right Work

- PM Time Directed
- CM Equipment Failure
- PdM Equipment Condition Directed
- PAM Eliminating Root Cause

Accomplishing the Work

- Work Planning & Execution
- Work Close Out

Learning from the Experience

Feedback & Analysis

Identifying the Right Work

- Identification of Maintenance Tasks
VBM Implementation

DATA COLLECTION

PERFORM TECHNICAL EVALUATIONS
- Performance and OE Based Analysis
- VBM Enhanced Analysis

ID CRITICAL EQUIPMENT/COMPONENT (Risk Based)

OPTIMUM MAINTENANCE STRATEGIES

CHALLENGE REVIEWS
- Risk & Cost Assessment

RETURN ON INVESTMENT/COST SAVINGS

TECHNICAL BASES

PROJECT IMPLEMENTATION

Data Visualization Tool
- Scoping
- Pareto Analysis - Focus Where Money is Being Spent.

VBM Evaluation Tools
- Industry and Military Material Aging Data
- EPRI PM Database

High Cost Non-Critical Preventive Maintenance Reduction
VBM Implementation

1. EQUIPMENT/Component Population
2. Performs Important Function?
   - NO
   - YES
3. Is it Economically Significant?
   - NO
   - YES
4. Failure Detrimental to Personal Safety or Poses Environmental Hazards?
   - NO
   - YES
5. Run to Maintenance Component?
   - NO
   - YES
6. Expert Panel Concurrence?
   - NO
   - YES
7. Run to Maintenance
   - Non Critical
   - Critical
VBM Implementation

Issue
There are a large number of high cost, high frequency, resource-intensive PMs performed on non-critical equipment (or component groups) without a return value in equipment reliability.

Efficiency Improvement Opportunity
Identifying highest cost, non-critical PMs, and then evaluating for value-based PM task and frequency optimization.
How is VBM Different?

• Risk based equipment criticality determination
• Facility specific equipment evaluations (i.e. functional, environmental, and alternative material analyses)
• Wearable/degradable parts (e.g. seals, plastics, diaphragms) sensitive to temperature effects over time
• Leveraging existing facility specific/industry component aging, material, and diagnostic test data
• PM intervals can be more precisely established (i.e. extended) with engineering technical evaluations
• Reduces/eliminates unnecessary intrusive maintenance
• Documented technical bases
VBM Attributes

- Equipment & Component Material Aging Test Data
- System Component Criticality Determination
- Jacob’s Processes
- Jacob’s Procedures
- Integrated Team
- Maintenance Work Histories
- Diagnostic Test Data
- Operating Experience (OE)
- Equipment Functional Analyses & Requirements
- Environmental /Process Parameters
- Design Data
- Vendor Requirements
- Enhanced Preventive and Predictive Maintenance Tasks & Frequencies

Typical Industry Activities

VBM Added Value

System Component Criticality Determination
VBM Program Overview

Enhanced Analysis

- **Material Aging**
- **Mechanical Wear**
- **Process/Media Impact & Compatibility**
- **Alternate Material Options**
- **Maintenance Work/Industry Failure Histories & Performance Trends**

**Optimized Maintenance Strategies (PMs/PdMs)**

**Compare Optimized Maintenance Strategies with Existing Plant PMs/PdMs**

**Issue PMCRs**

**Implementation and Evaluation of Field Testing, Measurements, Inspection, Etc.**

**Selection**

- **Plant Systems Equipment/Component Types**
- **System/Equipment Data**
- **Operating Service Conditions**
- **Process/Media Conditions**
- **Detail Functional Requirements**
- **Equipment/Material Aging Data**

**Data Gathering/Analysis Engineering Evaluation**

**Optimization**

**Existing PM Strategies for This Equipment?**

- Yes
- No

**Issue PMCRs**

**Feedback**
## Project Results

<table>
<thead>
<tr>
<th>No</th>
<th>PROJECTS</th>
<th>INVESTMENT</th>
<th>PAYBACK</th>
<th>SAVINGS *</th>
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</thead>
<tbody>
<tr>
<td>1A</td>
<td>Pilot Pneumatic Operated Valves</td>
<td>$67,200</td>
<td>&lt; 12 Months</td>
<td>&gt; $645,000</td>
</tr>
<tr>
<td></td>
<td>(Project Scope: 22)</td>
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<td></td>
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</tr>
<tr>
<td>1B</td>
<td>Pneumatic Operated Valves</td>
<td>$280,000</td>
<td>&lt; 12 Months</td>
<td>&gt; $9,000,000</td>
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<tr>
<td></td>
<td>(Project Scope: 650)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Control Relays</td>
<td>$83,000</td>
<td>&lt; 21 Months</td>
<td>&gt; $1,000,000</td>
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<tr>
<td></td>
<td>(Project Scope: 393)</td>
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</tr>
<tr>
<td>3</td>
<td>Diaphragm Valves</td>
<td>$60,000</td>
<td>&lt; 12 Months</td>
<td>&gt; $1,200,000</td>
</tr>
<tr>
<td></td>
<td>(Project Scope: 59 )</td>
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## Project Results

### Pneumatic Operated Valves

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<tbody>
<tr>
<td>✓ Risk Informed Categorization</td>
</tr>
<tr>
<td>✓ Phase 1: Pilot Project Outage Valves for 22 AOVs</td>
</tr>
<tr>
<td>✓ Phase 2: Awarded Full Scope for 650 AOVs</td>
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<tr>
<td>• For pilot project, reduced outage maintenance burden by 60% for AOVs</td>
</tr>
<tr>
<td>• Provided Sound Engineering Technical Bases</td>
</tr>
<tr>
<td>• Improved Equipment Reliability by Addressing Aging and Minimized Unnecessary Maintenance/Rework</td>
</tr>
<tr>
<td>• Reduced Long-Term Maintenance Costs (~$9.7M)</td>
</tr>
<tr>
<td>• Project Payback Within One Year</td>
</tr>
</tbody>
</table>

Note: EPRI templates were previously applied to the Valve Population.
Benefits

• Improved focus on critical equipment
• Reduction in outage scope and durations
• Reduced overall total maintenance costs
• Improved reliability and safety
• Quick payback on investments
JACOBS

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