Maintenance Optimization of Ageing Assets with Fit For Purpose RBI & Corrosion Management Delivery

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Approach and Execution Strategy

- The Vision
- The Journey
- Risk Based Inspection
- Approach and Methodology
- Deliverables
- Success Factors
- Challenges and Mitigations
- Sample Results
- Interface Integration
- Conclusions
The Vision

Goals:
- Reduce costs
- Improve reliability
- Improve availability

What it takes:
Affirmative action to create effective change i.e. the pulling of “levers”

What is needed:
Actionable information to support decision making

What we typically have:
A growing base of disparate data, systems & tools

A clear, data-driven connection to tangible organisational improvements
‘Connecting the Dots’

Goals:
- Reduce costs
- Improve reliability
- Improve availability

What it takes:
Affirmative action to make a difference i.e. the pulling of “levers”

What we typically have:
A growing base of disparate data, systems & tools

- Data conversion (extraction of all attributes from different sources)
- Simple & Pragmatic RBI
- Governance by the Corrosion & Inspection Manual policy
- Enable inspectors to develop Written Schemes of Examination and update RBI post inspection with TMLs
- Backlog of overdue inspections!
The Journey of Project Delivery

- Process
  - ERP
  - WSE

- People
  - Coaching

- Technology
  - Data & CLs
  - Excel-based Tool
Risk-based inspection

RBI program improves facility safety at reduced cost
What is Risk?

The product of the likelihood that a failure will occur and the consequence of that failure

Risk = probability x consequence

Consequence can be:
• Injury or death due to fire, explosion, or toxic release
• Harm to the environment
• Financial (revenue loss, repair / replacement costs)
## Typical Benefits of RBI

<table>
<thead>
<tr>
<th>Benefit</th>
</tr>
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<tbody>
<tr>
<td>Regulatory compliance/acceptance</td>
</tr>
<tr>
<td>Improved safety and reduced risk</td>
</tr>
<tr>
<td>Long-term cost benefits</td>
</tr>
</tbody>
</table>
  - Focused inspections
  - CML reduction
  - Extending intervals beyond 10 years
  - Opportunity to reduce internal inspections
| Reliability, reduce unexpected failures           |
| Turnaround planning                               |
| Use of new inspection (NDE) technology            |
| Informed, documented, defensible decisions        |
RBI Scope of Work

Natural Gas Liquids & Compressor Station Facilities

• Over 1000 equipment including:
  • Drums & Vessels
  • Heat Exchangers
  • Storage Tanks
  • Columns
  • Heaters
  • Filters

• Acid Gas Removal
  • Equipment & Piping
Methodology Work-Flow

Data Gathering* → Asset Register Compilation* → Corrosion Loop Development, Mark-Up* → RBI assessment

- Assess Consequence of Failure (CoF)*
- Assess Probability of Failure (PoF)
- Identify Overall Risks*

Create Inspection Plan* → Convey Findings (Report + RBI assessment Tool)*

Company Review & Update the processes → Implementation & Integration with Turnaround Scope

Review Results & Feedback

Description:
*Internal review performed at every stage.

PFD/P&ID
MSDs
HMBs
Asset lists

Inspection
Records,
Reports

Technical
Documents
(Condition
Reports etc.)

Process
and Design
Data

A presentation by Wood.
Methodology (Corrosion Loops)
Summary of Deliverables

Corrosion & Inspection Manual:
- Single document that captures all the key integrity issues, IOWs, Inspection Strategies, assumptions

Excel Based RBI Tool:
- Established RBI Excel tool that automates the RBI assessment
- Ability to generate inspection plans
- Uncovered overdue inspection and damage threats

Risk Classification In Assets

Corrosion Monitoring Locations:
- Digital Mark-up of CMLs
- Enabler for inspectors to inspect in the right locations
Success Factors

Performance-driven solutions, from start to end.

1. First RBI assessment for the assets
2. Remote Execution
3. Excel-Based Tool
4. Site visit workshop
5. Weekly progress & cost tracking

A presentation by Wood.
Remote Collaboration

- Audio Calls
- Documents SharePoint
- Video Conferencing
- Emailing
Remote Collaboration Advantages

- Avoiding travel logistics
- Safety
- Economical
- Light on resources
- Saves Time
Weekly Engagements

- Progress Review Meetings
- KPIs Management
- Project Risks

A presentation by Wood.
Excel-based RBI Tool

Corrosion Rate Calculations

Statistical Analysis of results

Automated RBI Methodology

Automated Inspection Plan

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Excel-based RBI Tool Benefits

Advantages of Excel-based RBI Tool

- Reduced manhours and cost
- Optimization of RBI methodology
- Reducing human error in calculations
- Simplifying checking and review process
- Dynamic database which the client can continuously update
- Accessible and user-friendly interface that facilitated RBI Implementation by inspectors
Site Visit & Workshop

Train Inspectors

Validate Results

Workshop

Gather Data

Build Relations
## Challenges and Mitigations

<table>
<thead>
<tr>
<th>Challenges</th>
<th>Mitigations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Management</td>
<td>Regular online technical sessions to align with our stakeholders</td>
</tr>
<tr>
<td>File Sharing</td>
<td>Establishing appropriate SharePoint</td>
</tr>
<tr>
<td>Results Presentation</td>
<td>Prioritizing immediate actions in the action tracker</td>
</tr>
<tr>
<td>Safeguarding of the MS Excel Tool (people making changes on the formulas, etc)</td>
<td>Updating the MS Excel tool and putting more controls in place (training of the users and assigning a single focal point)</td>
</tr>
</tbody>
</table>
Sample Results: PoF & Risk

PoF & Risk Results:
- Equipment Level

<table>
<thead>
<tr>
<th>Category</th>
<th>PoF</th>
<th>Risk</th>
</tr>
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<tbody>
<tr>
<td>E</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>H</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>MH</td>
<td>0</td>
<td>88</td>
</tr>
<tr>
<td>M</td>
<td>111</td>
<td>53</td>
</tr>
<tr>
<td>L</td>
<td>32</td>
<td>49</td>
</tr>
<tr>
<td>N</td>
<td>54</td>
<td>8</td>
</tr>
<tr>
<td>Total</td>
<td>201</td>
<td>201</td>
</tr>
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</table>

PoF Results (Equipment Level)

Risk Results (Equipment Level)
Sample Results: Inspection Plan

- **Inspection Interval Plan:**
  - **Equipment Level**

<table>
<thead>
<tr>
<th>Inspection Interval (Years)</th>
<th>No. of Equipment</th>
</tr>
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<tbody>
<tr>
<td>&lt; 1</td>
<td>2</td>
</tr>
<tr>
<td>[1-3]</td>
<td>20</td>
</tr>
<tr>
<td>[4-6]</td>
<td>41</td>
</tr>
<tr>
<td>[7-9]</td>
<td>34</td>
</tr>
<tr>
<td>[10-12]</td>
<td>24</td>
</tr>
<tr>
<td>&gt;12</td>
<td>46</td>
</tr>
<tr>
<td>Detailed Analysis</td>
<td>2</td>
</tr>
<tr>
<td>N/A*</td>
<td>32</td>
</tr>
<tr>
<td>Total</td>
<td>201</td>
</tr>
</tbody>
</table>
Interface between RBI & Maintenance Optimization

- RBI Team
- Risk Based Inspection Plan
- RCA Integration with Maintenance and Turnaround Plans
- Inspection Team
- RBI Plan Integration with Existing Inspection System
- Company Internal Stakeholders
Conclusions

- Pragmatic RBI Approach
- Remote Collaboration
- Successful Partnership
- Integration with the Company's Internal Process (Maintenance, Turnarounds)
- Robust Excel-based RBI Tool
- Comprehensive Progress Tracking
Q&A