Quantifying the Cost of Asset Integrity – Is there a better way
INTSOK – Seminar on Deep Water and Harsh Environments
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We offer safe operations, increased reliability, improved production and lower cost through our integrated provision of Asset Integrity Management services.
Defining our approach is our service capability and ability to provide our customers with a completely integrated offering to suit every challenge throughout the lifecycle of an asset.
What is Asset Integrity

Ability of an asset to perform its required function effectively and efficiently whilst protecting health, safety and the environment and the means of ensuring that the people, systems, processes, and resources that deliver integrity are in place, in use and will perform when required over the whole lifecycle of the asset.
Pressure System Integrity

We offer safe operations, increased reliability, improved production and lower cost through our integrated provision.
Non Intrusive Inspection

Why Consider?

Non Intrusive Inspection of vessels is fast becoming the preferred method for fitness-for-service assessment due to the substantial cost saving made by not shutting down for internal visual.

- **HSE:** No need to break containment and enter the tank/vessel. No Confined Space Entry.
- **Quality:** Improved detectability and sizing of defects compared to internal visual inspection.
- **Cost:** Shorter & more predictable shutdowns, man-hour reduction, increased uptime.
- **Efficiency:** In-service; flexible planning & optimisation of shut downs & maintenance programs.
- **Knowledge:** Improved knowledge of technical condition, identify and quantify the total integrity of the vessels.
- **Documentation:** Improved documentation of technical condition in order to defer IVI activities.
Identify the objective:
- Compliment an internal inspection program
- Provide supporting information to defer an IVI
- Replace the IVI inspection program

The NII process
- Integrity Review
- Decision Process
- Planning Process
- Inspection
- Evaluation
Non Intrusive Inspection
Integrity Review

Vessel background information compiled in an Equipment Profile:

- Vessel identity and design
- Type of vessel
- Operation and service details
- Detailed drawings
- Modifications and repairs
- Previous inspection results
- General experience
- Complimentary information
- Accessibility
- Safety Requirements
- Possible flaws/degredation
Non Intrusive Inspection

**Planning Process**

**Screening:**
- Is the vessel intrinsically suitable for NII?
- Has the vessel previously been inspected and is it still relevant?
- Will the vessel be entered for other reasons?

**High Level Decision:**
- Confidence in our ability to predict types and locations of degradation.
- The effectiveness of previous inspections
- The severity and rate of any known or predicted degradation
Non Intrusive Inspection

Main Elements:
- Establish the Inspection planning team
- Determine the inspection strategy type:
  - Type A
  - Type B
  - Type C
- Define vessel zones
- Select inspection methods
- Prepare the Work-pack
Inspection Planning - Modeling of Vessel

Integrity & fitness for service assessment
Key Features

- 3D imaging of beam profile within any media enables visualization of the distribution of energy.
- Model the flaw interaction with the beam to assess POD.
- Simulate inspection scan pattern (The mechanical movement).
- Design probes.
- Determine best Inspection Technique to utilize.
## Inspection Plan

### Sample Plan

<table>
<thead>
<tr>
<th>Zone</th>
<th>Lower Shell</th>
<th>Inspection Point</th>
<th>Description</th>
<th>Degradation Mech.</th>
<th>Insp. Method</th>
<th>Nm. Wt.</th>
<th>CA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lower Shell</td>
<td>1</td>
<td>Shell Lower Dome Head</td>
<td>Pitting</td>
<td>UT Corrosion Mapping</td>
<td>55</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>Lower Weld</td>
<td>2</td>
<td>Circumferential Weld, Lower Head to Shell</td>
<td>SCC</td>
<td>Phased Array</td>
<td>55</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>Lower Weld</td>
<td>3</td>
<td>Weld, Outlet NOZZLE</td>
<td>SCC</td>
<td>Phased Array</td>
<td>55</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>Lower Nozzle</td>
<td>4</td>
<td>Liquid Outlet NOZZLE</td>
<td>Pitting</td>
<td>Radiographic</td>
<td>31.7</td>
<td>0</td>
</tr>
</tbody>
</table>

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Inspection Execution

- Perform the Inspection
- Review Inspection Results
- Inspection according to plan
- Alternate inspection possible
Mapping of internal and external Corrosion with digital data and models.

- Cost effective mapping (scanning speeds of 750mm per second!!!)
- Digital documentation
- Surface temperature of 250 °C
- Immediate model of corroded area
- Input to NII and FFS models
Review of Anomalies and Findings

**Objective**

- Finding the correct allowable stress criteria for a finding
- Assess fatigue and stress in the vessel by using a fitness for service (FFS) approach (i.e., Modelling by Integri-Tech* or equivalent technic)
- Assess operability
- Assess mitigation action
Review of Anomalies and Findings

Integri-Tech FFS Integrity Assessment

Advanced Corrosion Scanning

Inspection Data Mapped onto FFS Model

Integri-Tech FFS Integrity Assessment

Integri-Tech FFS Model

Integri-Tech Stress Analysis
Non Intrusive Inspection – Case Study

Operator - Offshore Production Facilities – Norwegian Continental Shelf

- Centralized initiative to reduce turnaround (TN) scope for 2014
- Part of owner’s working smarter program
- Pilot was performed in 2010

<table>
<thead>
<tr>
<th>Installations</th>
<th>Vessels Screened</th>
<th>Vessels suited for NII</th>
<th>Vessels out of TN scope</th>
<th>hrs out of TN2014</th>
<th>hrs by using NII</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 Production Facilities</td>
<td>146</td>
<td>53</td>
<td>26</td>
<td>13 000</td>
<td>4 000</td>
</tr>
</tbody>
</table>

Program Advantages
- Significant reduction in offshore person hours
- Estimate 16 Million USD extra in production value in 2014.
- Significant reduction in HSE risk. 26 Vessels removed from the shutdown
- Significant reduction in risk of damage to equipment (flange faces, internals, etc) due to exposure from personnel, equipment, etc.
- Significant savings in materials (flanges, gaskets, bolts, scaffolding, etc)

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Internal Inspection of Vessel – Direct Cost

<table>
<thead>
<tr>
<th>Onshore Planning - Eng</th>
<th>Project Management</th>
<th>Offshore Support - Craft</th>
<th>Offshore - Inspection</th>
<th>Total Hours</th>
<th>Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>90 hours</td>
<td>56 hours</td>
<td>332 hours</td>
<td>12 hours</td>
<td>439 hours</td>
<td>$16,500</td>
</tr>
</tbody>
</table>

Inspection of Pressure Vessel - NII

<table>
<thead>
<tr>
<th>Onshore Planning - Eng</th>
<th>Project Management</th>
<th>Offshore Support - Craft</th>
<th>Offshore - Inspection</th>
<th>Total Hours</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>260 hours</td>
<td>20 hours</td>
<td>24 hours</td>
<td>48 hours</td>
<td>313 hours</td>
<td>$5000</td>
</tr>
</tbody>
</table>

Advantages of NII vs Internal Inspection

- 28% reduction in total person hours.
- Reduction in offshore person hours by 80%.
- No need to shutdown so zero lost in production.
- Significant reduction in HSE risk. Less mechanical work offshore and no need to enter the vessel.
- Eliminate risk associated with leaks during start-up.
- Eliminate risk of damage to equipment (flange faces, internals, etc) due to exposure from personnel, equipment, etc.
- Improve data associated with the integrity of the pressure boundary.
Non-Intrusive Inspections

Summary

NII can be a useful tool in the management of fixed pressure equipment assets.

More than one potential application:
- Compliment an internal inspection program
- Provide supporting information to defer an IVI
- Replace the IVI inspection program
- Quantify damage to pipe, vessel, flange, etc prior to shutdown so appropriate plans can be put in place to repair

Many advanced NDE tools are now available to provide the necessary information required for NII.
Thank you for your time

Any questions?