Fundamentals of Asset Integrity Implementation

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MODULE 4:
OVERCOMING PLANT CHALLENGES IN INTEGRITY IMPLEMENTATION
Plant Challenges

- Major equipment integrity strategies / plans
- Defining risk management activities
- Corrosion management
- Deploying risk-based inspection
- Anomaly handling and fitness-for-service analysis
- Safety instrumented systems – SIL / LOPA
- System testing
- System inhibits
- Maintenance management system
Plant and Process Integrity

The assurance of fitness for service by:

✓ **Construction / fabrication** to a suitable design, materials and workmanship, in accordance with recognised codes and standards

✓ **Commissioning** and **Operation** within approved design parameters

✓ **Inspection, Maintenance** and **Repair** to a condition consistent with the original design or to approved fitness-for-service criteria
Krechba (In Salah) Gas Plant, 2004

Immediate cause:

piping design error and vibration-induced fatigue
Incorrectly Installed Materials
Corrosion Management

- External – visual inspection and coatings
- External subsea – ROV surveys, cp measurements
- Internal
  - Monitoring
  - Chemicals
  - Inspections
  - Corrosion resistant materials
Inspections

Why inspect?

- Confirm equipment within safe limits
- Confirm assumptions regarding equipment degradation
- Identify unexpected problems
- Avoid premature failures

No single inspection method can find everything

- Generally need combination of methods
- Preferences for on-line vs off-line
- Risk-based inspection (RBI) considered best practice
Inspection Tool-Box

- VISUAL
- DIMENSIONS
- SURVEYING
- ENHANCED VISUAL
- ULTRASONICS
- RADIOGRAPHY
- DYE PENETRANT
- MAGNETIC PARTICLE
- EDDY CURRENT
- HARDNESS
- FLUX LEAKAGE
- METALLOGRAPHY
- THERMOGRAPHY
- LOAD TESTING
- PRESSURE TESTING
- ACOUSTIC EMISSION
Risk Based Inspection

• A best practice, now common
• API 580 / 581 provides downstream approach
• Many options available – qualitative to quantitative
• Most service companies have software
Risk Based Inspection

- RBI process follows hazid and risk assessment approach
- Incorporates corrosion risk assessment
- Should include a continuous improvement aspect
Anomaly Processing

• Logs of defects maintained
• Fitness-for-Service analysis performed
• Corrective actions with due dates defined
• Corrective work orders entered into maintenance management system
• Action accountabilities assigned
• Defect logs reviewed regularly
• Senior approvals for deferrals
Fitness for Service Analysis

- Many methods, based on equipments and defect types
- Max. allowable working pressure through ASME B31-G defect analysis common
- API RP 579 a comprehensive guide
- In complex cases, finite-element (FE) analysis used
Maintenance Strategy

Process

- Identify potential failure modes
- Gather data; review trends
- Carry out corrective actions & adjust plans
- Rank equipment criticality by risk
- Define constraints or limits
- Identify monitoring variables & methods
Definition

Those safety systems, devices and controls which make a primary contribution to preventing, detecting, controlling or mitigating a major accident, or ensuring the escape and survival of people.
Protective Systems Types

- Protective instrumentation to alert/alarm/control
- Devices to maintain SOLS, especially pressure
- Ignition prevention measures
- Fire/gas detection, alarms, interlocks
- Emergency shutdown, isolation, and blowdown
- Fire protection
- Evacuation/survival equipment

Class 1 Div. 1
Inspections and tests

- All protective systems, including evacuation

- Emergency management plans
- Evacuation and lifeboat plans & drills
- Re-validation of design & capability
- Management of Change
Example Safety Instrumented Function

Control Room

Operator Interface

Shutdown System Logic Solver

Plant Area

High Pressure Sensor

Mechanical Relief Valve to Flare

Separator

Well Fluids

ESD Valve

Gas

Water

Oil
Safety Integrity Levels (SIL)

<table>
<thead>
<tr>
<th>Safety Integrity Level (SIL)</th>
<th>Probability of Failure on Demand (PFD)</th>
<th>Probability of Functioning on Demand</th>
<th>Risk Reduction Factor</th>
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<td>1-0.1</td>
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<td>100-1,000</td>
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<tr>
<td>4</td>
<td>0.0001-0.00001</td>
<td>99.99-99.999%</td>
<td>10,000-100,000</td>
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As defined in IEC 61508 & IEC 61511
What Velosi Can Assist With

Asset Integrity Implementation: Plant

- Corrosion risk assessments
- Mechanical integrity program development / audit
- Assessment / development of AIM programs
- RBI – development and assessment
- Reliability Centered Maintenance (RCM) development / auditing*
- Inspection and maintenance planning
- Safety Integrity Level (SIL) assessments*
- API 579 Fitness-for-Service assessments
- API 571 Damage Mechanism review
- Pipeline Integrity*  

* Software enabled