Challenges with Subsea Pipeline Integrity Management in the Middle East

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“Five Middle East oil producing countries are among top ten oil producers in the world”
Iran, Qatar & Saudi Arabia are among top ten producer of natural gas in the world

[Source: Reference # 11]
Regional Pipelines Distribution

Total pipeline length

Worldwide: 3,445,495 km
Middle East: 82,134 km

[Source: Reference #5]
Peculiarities of Middle East Fields

- Middle East has one of the largest oil and gas producing offshore fields
- Shallow water depths – increases probability of damage
- Hard seabed – burial is not economical
- Unplanned field developments – spaghetti of pipelines, cables and umbilical
- Multiple operators – no common design operating and maintenance philosophy
- No statutory guidelines – pipelines, vessel anchorage and loading areas

[Source: Reference #2 & 12]
Peculiarities of Middle East Fields

- No defined protection philosophy – unburied pipelines, sometimes without concrete coating
- Uncontrolled fishing activities – fish traps found on pipelines
- No abandonment plans – non-operational pipelines not removed or preserved
- Environmental guidelines – still immature
Offshore Steel Pipeline Incidents

- 30% Impact
- 26% Corrosion
- 21% Anchoring
- 6% Structural
- 5% Material
- 7% Natural Hazard
- 1% Construction
- 1% Maintenance
- 1% Human Error
- 1% Operational Problems
- 1% Other

[Source: Reference #7]
Threats to Pipelines

- Continuous field developmental activities: damages by
  - Construction barges/anchor handling tugs
  - Drilling rigs
  - Accommodation barges
- Heavy oil and LNG tanker traffic
- Fishing activities – mainly cable/umbilical damages
- Possibility of intrusions
Operators Preparedness

Preventive measures
- Security shields around offshore assets
- Satellite surveillance for vessels movement
- Information sharing among various operators

Emergency preparedness
- Pursue Emergency Pipelines Repair System (EPRS) studies
- Maintain repair apparatuses inventory
- Share resources – EPRS club
- Secure long-term contracts with vessel owners

[Source: Reference #1]
EPRS – Components

- Rapid, organized, response to identify, assess, stabilize and reinstate mechanical and operating integrity of damaged section of pipelines while maintaining high safety standards and mitigation against environmental impact.

- No industry code or standard exists.

[Source: Reference #1]
McDermott performed EPRS studies for North Field, Qatar operators

North Field
- 3rd largest non-associated gas reservoir in world, Discovered 1971
- Proven gas reserves of 885 tcf
- Reserve to production ratio – 160
- Integrated mega projects
- Operated by leading companies

Pipelines are life lines to uphold Qatar as:
- Meeting 30% of energy need of UAE
- Operating world’s largest GTL facility
- Largest LNG exporter – 85% of produced natural gas

[Source: Reference # 10]
EPRS- 9 Step Damage Repair Approach

- Reporting
- Pressure Reduction
- Inspection
- Repair Method
- Category
- Assessment
- Time Frame
- Intervention Procedure
- Inventory
Non-Corrosive Damages

- Gouge
- Gouge on weld
- Dent
- Gouge in dent
- Dent on weld
- Abrasion
- Anchor drag (Displacement)
- Displacement with dent and gouge
- Crack and crack like flaws
- Assessment performed for possible credible damage scenarios for all distinctive sections of pipelines
- Acceptable limit for gouges and dents were computed
- Anchor dragging simulated using Finite Element Tools
- All results knit into the decision making process through flow chart

<table>
<thead>
<tr>
<th>Pipeline Diameter</th>
<th>Concrete Thickness</th>
<th>Lateral Displacement for Yield (m)</th>
<th>Local Angle for Yield (°)</th>
<th>Global Angle for Yield (°)</th>
<th>Length of displaced section (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 inch</td>
<td>90 mm</td>
<td>4.2</td>
<td>0.8</td>
<td>9.1</td>
<td>350</td>
</tr>
<tr>
<td>28 inch</td>
<td>60 mm</td>
<td>5.7</td>
<td>3.9</td>
<td>8.5</td>
<td>350</td>
</tr>
<tr>
<td>24 inch</td>
<td>110 mm</td>
<td>3</td>
<td>0.8</td>
<td>3.1</td>
<td>240</td>
</tr>
<tr>
<td>18 inch</td>
<td>45 mm</td>
<td>7.1</td>
<td>0.7</td>
<td>9.1</td>
<td>390</td>
</tr>
</tbody>
</table>

- Failure at 182 bar
- Failure at 100 percent SMYS

- Gouge

- Pipeline Diameter
  - 30 inch
  - 28 inch
  - 24 inch
  - 18 inch

- Concrete Thickness
  - 90 mm
  - 60 mm
  - 110 mm
  - 45 mm

- Lateral Displacement for Yield (m)
  - 4.2
  - 5.7
  - 3
  - 7.1
  - 5.6
  - 7.3

- Local Angle for Yield (°)
  - 0.8
  - 3.9
  - 0.8
  - 0.7
  - 0.4
  - 1.5

- Global Angle for Yield (°)
  - 9.1
  - 8.5
  - 3.1
  - 9.1
  - 11.2
  - 10.5

- Length of displaced section (m)
  - 350
  - 350
  - 240
  - 390
  - 390
  - 480
Decision making tree aids operators in

- Swift decision on intervention or to continue operation
- Time frame for repair & Reduce loss in production
EPRS Manual Limitations

- Assessment performed for possible credible damage scenarios – provides quick guidelines
- Assessment based on generalized parameters
- Each damage is unique and sensitivity to location specific parameters can affect recommendations
- Certain damages at transition limits require sensitivity checks
- Explicit analysis are always recommended prior to any intervention
- Any further analysis require skilled team and software including Finite Element (FE) tools
EPRS – Why McDermott?

EPC Advantage - Single Window Solution

- Competent Engineering Team with FEA expertise
- Specialized Construction Support Engineering Team
- Proficient Marine Operations and Diving Team
- Marine Vessels
- Procurement Expertise
- Proven Track Record
  - EPRS Studies for RasGAS and QatarGas
  - Emergency Repairs for Dubai Petroleum Establishment
  - Damage Assessment for DuGAS, Dubai
EPRS – Why McDermott?
Beyond EPRS Manual

In addition, McDermott performed the following to have TOTAL READINESS

- Tow Analysis for Replacement Sections
- Identification/ Procurement of other installation aids – Buoyancy bags, Bear Clamp, Rollers, Pulling Heads etc.
- Independent FEA review for Mechanical Connector

Gripping Pressure Simulation
Conclusions

- Apart from Damage Assessment Expertise, contribution of Installation Contractors is equally imperative for Robust EPRS.
- EPC Contractors with integrity expertise can provide a single source solution to operators via long term contracts.
- Industry needs to develop codes and practices for EPRS.
EPRS IS NOT ONLY A MATTER OF PREPAREDNESS
BUT
TOTAL PREPAREDNESS

At McDermott – we have Total Preparedness
References

References


