Subsea Pipeline Leak Detection

DNV GL Technology Week

Sonia Furtado, Luis D'Angelo, Mohsen Shavandi, Eric Allen
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Agenda

- Oil Spill Impacts and Solutions
- Challenges in Leak Detection
- Overview of the DNV GL RP F302 – “Selection and Use of Subsea Leak Detection Systems”
- Leak Detection Selection
- Overview of the MyLDS tool
- Case study - Selecting leak detection technology through MyLDS
Oil Spill Impacts and Outcomes

Impacts to
- Marine and coastal ecosystems
- Health of response workers
- Economic hardships

Outcome
- Stricter national and international requirements
- Stakeholder’s expectations for better environmental performance
- Focus shifted to barrier management

■ Early leak detection (LD)
- Early LD could prevent a subsequent uncontrolled release of hydrocarbons
Common challenges with leak detection techniques

Technique Selection
- How to select a system that meets the requirements?

Performance, Requirements
- What size leaks are to be detected?
- Is it possible to define “pollution of significance” or “acute leaks”?
- Will authorities approve?

False Alarms
- This technique gives both false positives and false negatives. How do we respond?
- While high sensitivity is beneficial, it requires significant resources

Reliability, Robustness
- Will the coverage be stable with reliable indications, expected durability and required maintenance?
Offshore leak detection – A challenge facing the industry

- Difficult to get a good system with a demonstrated track record that covers an entire field, both subsea and on the surface.
- Need for a common approach so that the operators and suppliers can jointly improve these systems.
- Need to define reasonable specifications and requirements.
- How different technologies can be integrated into a system that is practical for the end user.
In 2013, DNV GL and the Oil & Gas industry joined forces

- **DNV GL-RP-F302** “Selection and Use of Subsea Leak Detection Systems” is an international recommended practice (RP) for offshore LD addressing the lifecycle phases of a typical offshore development project.

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
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<td>1</td>
<td>Regulations and requirements</td>
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<td>2</td>
<td>Operational experience and leak statistics</td>
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<td>3</td>
<td>Technology mapping</td>
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<td>BAT and selection process</td>
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<td>5</td>
<td>System design, integration and testing</td>
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<tr>
<td>6</td>
<td>Operation of the leak detection system</td>
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</table>
LDS Selection and Implementation Process

**Functional requirements:**
- Regulations and standards
- Risk assessment
- Environmental conditions
- Establishing Functional requirements

**Design requirements:**
- Design life
- Mechanical design and interfaces
- Communication and control requirements
- Power requirements
- Material selection
- Inspection, maintenance and repair

**Technology selection:**
- BAT process
- Combining technologies
- Technology qualification

**Detailed design:**
- Design specifications
- System performance and interface engineering
- Data handling and interpretation
- Testing and training

**Function testing:**
- Acceptance criteria
- Function test methods

**Operation:**
- Principles
- Framework
- Work process
- Training and competence
Main Aspects in the Selection of LDS

Regulatory Requirements
Often broad and high level; covered in requirements related to:
- release and discharge control,
- pollution control and monitoring, and
- control and mitigating measures

Operational experience and leak statistics
Some findings on leak incidents:
- Information challenge – root cause difficult to find
- Often occur at or close to subsea installations
- More than 70 % are small (<0.1 t) and from smaller diameter piping/pipelines
- In relation with a transient situation: production shut-in/start-up, drilling, work-over or intervention activities
Main Aspects in the Selection of LDS

Field Experience with types of sensors
- Subsea sensors – Capacitance, Mass balance, Passive acoustic, Camera (ROV)
- Surface sensors - Radar from airplane, satellites and helicopters, Radars from vessels and platforms

Parameters of the Technique
- Principle behind the method of detection
- Performance
- Requirements
- Limitations
- Maturity and availability
- Dimensions
Available Techniques

**Subsea techniques:**
- Active acoustic
- Bio sensor
- Capacitive sensor
- Fibre optic
- Fluorescent
- Internal leak detection system/ mass balance
- Volumetric collection
- Methane sniffer
  - Semi-conductor
  - Optical NDIR
  - Laser absorptiometry
- Optical camera
- Passive acoustic
- Multisensor

**Surface techniques:**
- Radar
  - Ground-Penetrating Radar
  - Navigation radar with oil spill detection
  - Side-Looking Airborne Radar
  - Synthetic Aperture Radar
- Fluorescence
  - Hyper-spectral Laser-Induced Fluorescence LIDAR
- Electromagnetic reflection
  - Infrared imaging
  - Microwave radiometer
  - Spectral scanners
  - Ultraviolet sensor
  - Visual surveillance camera
LDS Selection process

- Identify the techniques that are **best for the environment as a whole**, and that are economically and technically available

- Assessment for leak detection technique:
  - **Conditions**: relevant requirements, project and site specifications, and expectations
  - **Leak scenarios**: description about the area/ equipment and medium to be detected
  - **Techniques**
Simplifying the Selection Process - MyLDS Tool

**Inputs**

- Installation details
- For Environmental performance
  - Time frequency
  - Sensitivity to detect
  - Distance from platform
  - Other environmental concerns
- For Economical availability
  - CAPEX
  - OPEX
- For Technical availability
  - Readiness/Maturity
  - Interaction with other systems

**MyLDS**

MyLDS provides access to the results related to your Leak Detection System assessment for offshore or onshore Oil & Gas pipelines. The tool compares different available systems that matches a customer specific pipeline requirement.
Case Study for MyLDS (Pipeline data and Profile)

<table>
<thead>
<tr>
<th>General information</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scope and site specifications</strong></td>
<td></td>
</tr>
<tr>
<td>Field/installation name</td>
<td>Choose the name</td>
</tr>
<tr>
<td>Type of installation(s)/field</td>
<td>offshore pipeline</td>
</tr>
<tr>
<td>Current project phase</td>
<td>Operation</td>
</tr>
<tr>
<td>Type of production</td>
<td>Oil</td>
</tr>
<tr>
<td>Gas/Oil Ratio (GOR)</td>
<td>Text</td>
</tr>
<tr>
<td>Type of leakage medium to be discovered (mainly) and type (name)</td>
<td>Gas</td>
</tr>
<tr>
<td>Field status</td>
<td>Existing installation</td>
</tr>
<tr>
<td>Water depth at site (and unit)</td>
<td>100 ft</td>
</tr>
<tr>
<td>Distance to shore (and unit)</td>
<td>10000 ft</td>
</tr>
<tr>
<td>Will the SCADA system have an accurate algorithm allowing small leaks?</td>
<td>yes</td>
</tr>
</tbody>
</table>

Buried pipeline segment:
- Buried > 2m in soil sediment
- Shallow water near shore

Unburied pipeline segment:
- Shallow water

Case study did not include economic aspects of the selection
## Case Study for MyLDS (Pipeline Scenarios)

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Leak description - Area/Equipment</th>
<th>Potential main causes for leak</th>
<th>Special conditions</th>
<th>Leakage medium/media to be discovered</th>
</tr>
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<tbody>
<tr>
<td>Scenario 1</td>
<td>Small leaks on a buried pipeline segment: The pipeline is buried into the bottom sediments in the shallower near shore segments.</td>
<td>• Corrosion on pipe metal or girth welds&lt;br&gt;• Overpressure</td>
<td>Buried pipeline &gt; 2m deep&lt;br&gt;Shallower near shore&lt;br&gt;Water turbidity and pollution</td>
<td>Gas leakage &lt; 5% of flow rate&lt;br&gt;Oil leakage &lt; 5% of flow rate</td>
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<tr>
<td>Scenario 2</td>
<td>Small Leaks on unburied pipeline: The pipeline is uncovered on the bottom surface at average water depths of about xx meters.</td>
<td>• Corrosion on pipe metal or girth welds&lt;br&gt;• Third party damages (anchor hooking or strike, fishing, dropped objects)&lt;br&gt;• Pipe span under over stress&lt;br&gt;• Fatigue due to VIV&lt;br&gt;• Fatigue due to over stress&lt;br&gt;• Rupture due Overpressure</td>
<td>Unburied pipeline&lt;br&gt;Average water depth</td>
<td>Gas leakage &lt; 5% of flow rate&lt;br&gt;Oil leakage &lt; 5% of flow rate</td>
</tr>
<tr>
<td>Scenario 3</td>
<td>Medium to major leaks on buried pipeline: The pipeline is buried into the bottom sediments in the shallower near shore segment.</td>
<td>• Corrosion on pipe metal or girth welds&lt;br&gt;• Rupture due to Overpressure</td>
<td>Buried pipeline up to 2m deep&lt;br&gt;Shallower near shore</td>
<td>Gas leakage &gt; 5% of flow rate&lt;br&gt;Oil leakage &gt; 5% of flow rate</td>
</tr>
<tr>
<td>Scenario 4</td>
<td>Medium to major leaks on unburied pipeline: The pipeline is uncovered on the bottom surface at average water depths of about xx meters.</td>
<td>• Corrosion on pipe metal or girth welds&lt;br&gt;• Third party damages (anchor hooking or strike, fishing, dropped objects)&lt;br&gt;• Pipe span under over stress&lt;br&gt;• Fatigue due to VIV&lt;br&gt;• Rupture due to overpressure</td>
<td>Unburied pipeline&lt;br&gt;Average water depth</td>
<td>Gas leakage &gt; 5% of flow rate&lt;br&gt;Oil leakage &gt; 5% of flow rate</td>
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Conclusions

- **Safety** - Selecting the most suitable leak detection system ensures early leak detection, that could potentially avoid an uncontrollable release.

- **Comprehensiveness** - DNV GL RP F302 provides guidance on selecting and implementing LDS which considers all relevant parameters that are key to the selection process.

- **Time and Cost Savings** - MyLDS tool helps operators shortlist LDSs best suitable for their application without elaborate studies. The time and cost can then be focused on the shortlisted techniques and integrating them to the field.