Subsea Leak Detection Systems

Recommended Practice DNV-RP-F302

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March 18th 2010

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Agenda

- Field Experience
- Authority requirements in Norway
- How DNV-RP-F302 was developed
- Available technologies
- Detectors design requirements
- System performance requirements
- Design philosophy
- Operating Philosophy
- Challenges for the future

Field Experience

- Statistics and reported experience place majority of subsea leaks at or near templates and manifolds
- Critical components: connectors, flanges, seals, valves and welds, small-bore piping
- To date leaks are detected:
  - As oil slick on surface (Statfjord B 1992, Garn Vest 2003, Statfjord A 2007)
  - At routine inspections by ROV
  - Potentially a large volume is released before leak is detected

Field experience cont.

- First subsea leak detectors in the North Sea installed early 90ies
- Around 40 systems are installed to date
- About 2/3 of the leak detection systems installed are based on the same technology (Capacitance)
- 3 technologies share the remainder (e.g. Acoustic)
- For 40% of the installed systems, the operator claims that false alarms have happened
- 5 to 6 of the installed systems have claimed to positively identified a leak- but only one has provided a case history.
- Further developments and experience with how to best integrate and operate leak detection technologies is needed to get an acceptable function and level of confidence
- There is a need for a common reference and systematic approach

Authority requirements; PSA / KLIF (SFT) Norway

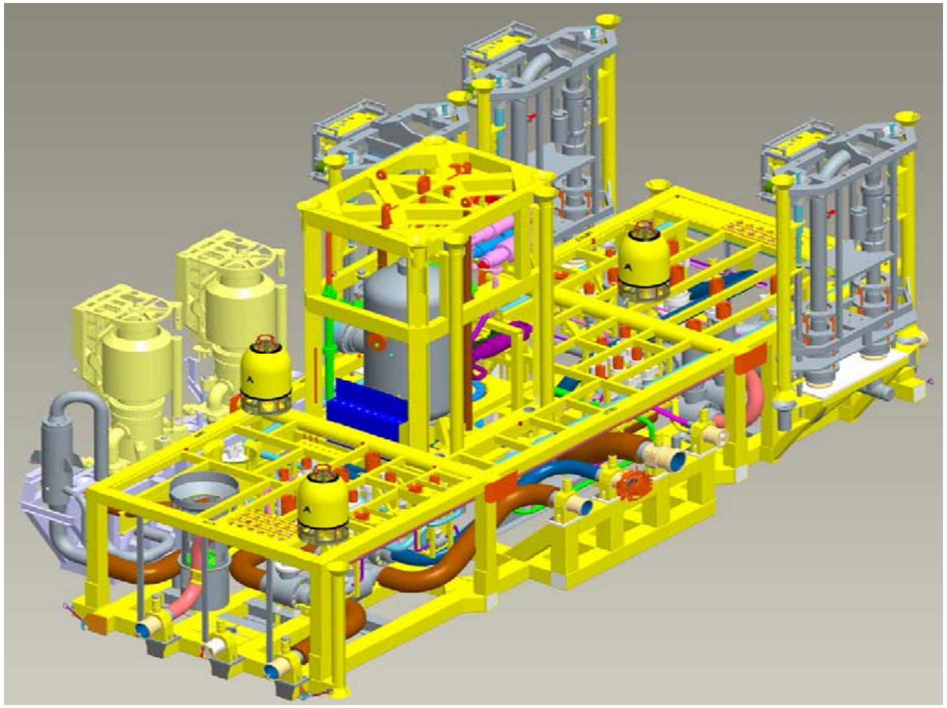
- *'The operator shall establish a remote measurement system that provides sufficient information to ensure that acute pollution from the facility is quickly discovered and mapped'* (AR §52d)
  - There should be a plan for remote measurement based on an environmentally oriented risk analysis
  - Leak detection comprises organizational aspects as well as monitoring technologies
- The party responsible for the petroleum activities must base its planning and operation on the technology and methods that, based on an overall assessment, produce the best and most effective results (the BAT principle). (FR §9, guidelines)
- The BAT (Best Available Techniques) principle stems from the EU IPPC (Integrated Pollution Prevention and Control) directive

How DNV-RP-F302 was developed

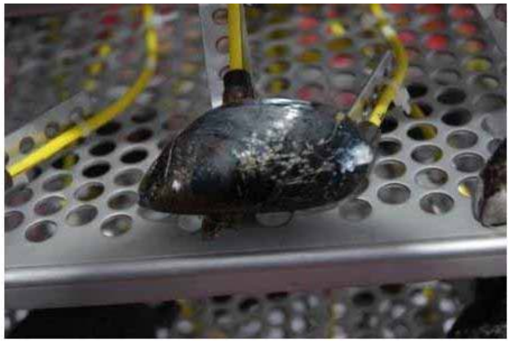
- OLF JIPs sponsored by BP, Exxon-Mobil, ConocoPhilips, ENI, Shell and Statoil
- Phase I: Review of statistics on subsea leakages; pipelines and subsea installations, ExproSoft
- Phase II: Screening of available technologies for leak detection, SINTEF
- Phase III: Laboratory test of 5 technologies, SINTEF
- Phase IV: Development of manuscript for selection and use of equipment for subsea leak detection, DNV and JIP workgroup.
  - Industry involved through questionnaires, review meetings and hearing rounds
  - DNV-RP-F302 issued April 2010
- DNV-RP-F302 focuses on technologies for
  - Hydrocarbon leaks (oil and gas)
  - Continuous monitoring with access to control system and topside warning
  - Coverage of templates and manifolds

Available technologies

- Mass balance
- Point sensing methods
  - Bio-sensors
  - Capacitance
  - Fluorescent detectors
  - Methane sniffers
- Sensing methods with spatial coverage
  - Active acoustic
  - Optical cameras
  - Passive acoustic
- Fibre optic methods
- Maturity varies from concepts to field proven



Subsea Leak Detectors



Bio Sensor

Methane Sniffer

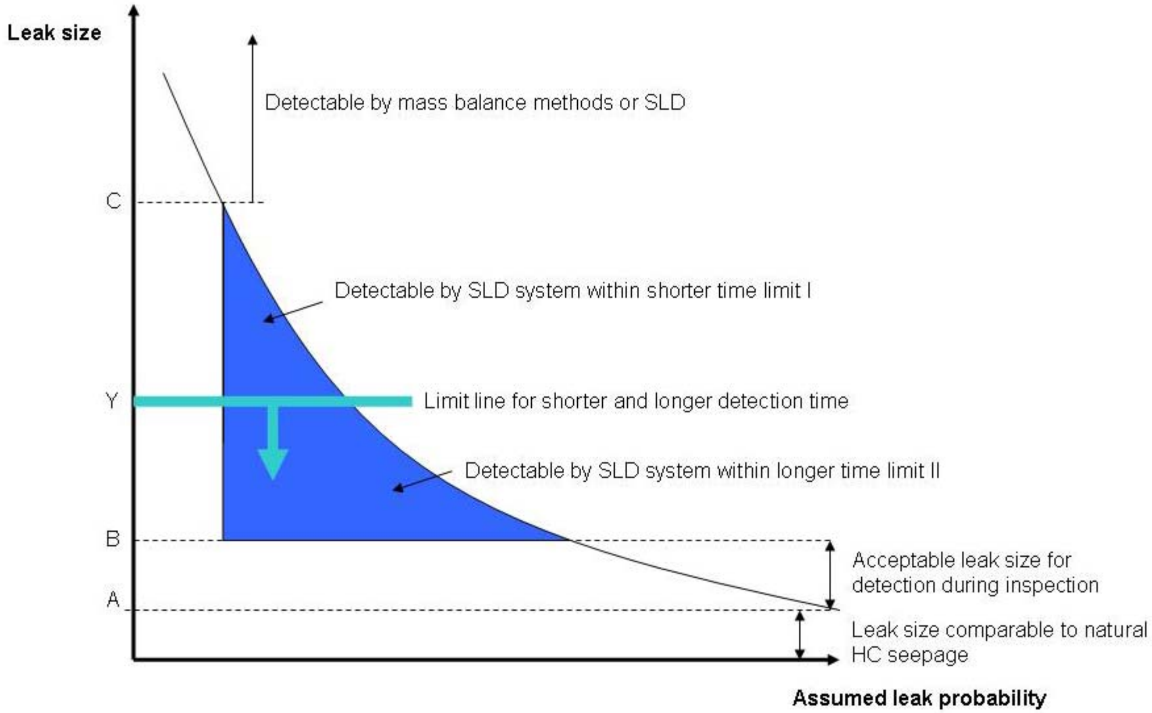
Passive Acoustic Sensor

Field / System performance requirements

- Environmental and safety risk analysis
- Corporate requirements
- Conditions that affect the system performance (process medium, pressure, external environment, etc)
- Interface to the control system
- Risk assessment of the subsea production system, revealing locations of possible leak points
- Technology maturity. Need for complementary technologies, combination of technologies
- Added benefits. Condition monitoring, lifetime extension

Design philosophy

- Mass-balance is an established method for leak detection that picks up the largest leaks
- Other subsea leak detection technologies must target the leaks that mass-balance cannot detect and should have a significantly better accuracy. Detection time should be short
- Regular inspection might be required to detect the smallest leaks



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Operating Philosophy

- Detect:
  - The subsea leak detector sends a warning to the topside control room
- Confirm:
  - Responsible operator checks if the warning is false or real by:
    - Checking parallel system; mass-balance or complementary leak detector
    - Initiating inspection by ROV
- Act:
  - Warning false: Responsible operator cancels warning and initiates investigation
  - Warning real: Responsible operator initiates actions according to emergency preparedness plan

Development needs for the SLD Technology

- Detection
  - Identification, localization, quantification, classification
  - Handling of natural seepage
- Robustness
  - Control of failure modes
  - Built in self diagnosis and redundancy
- Standardisation of interfaces
- Systematic technology qualification, at component and system level.

Further development of SLD Industry Collaboration

- Repeat workshop with operators, engineering companies and vendors, spring 2011 ?
- Statistics update on leaks (ExproSoft report from 2005) and analysis of reported SS leaks (approx 50) since 2005 to assess their “detectability” with proposed LD systems.
- Detailed analysis of a number recent SSLD failures(and successes) to accelerate industry learning from real applications
- Ongoing experience updates to the installed database from LD systems in service
- Case studies on leak probability/consequence graph to quantify leak volumes and probabilities
- Inclusion of SSLD specifications and performance in OREDA

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