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Integrity Management of Offshore Assets
Opening session

Leif Collberg
05 May 2017
How regulations can solve the challenge of being performance based and prescriptive

$10 Loads, load effects and resistance
Loads that may affect installations or parts thereof, shall be quantified.

To $10 Loads, load effects and resistance
To satisfy the requirements to loads, load effects, resistance and combinations of loads on the pipeline system the following standards should be used: ISO 13623 section 6 and DNV OS-F101 section 3, 4 and 5 for rigid pipelines.

In case alternative methods and procedures to those specified in this Standard are used, it shall be demonstrated that the obtained safety level is equivalent to the one specified herein, see Sec.2 C500. Such Deviations shall be formally and rigorously justified and accepted by all relevant contracting parties.

- Regulation
  - Safety
  - Performance based/prescriptive
- Code
  - Performance based/prescriptive
The Nominal Probability of Failure  
Where did it come from?

How stringent should the requirements be?

- One of the first formal design guidelines was probably given in the ASME standard B.31 (1925).

- This was based on some fundamental elements that still apply:
  - It requested the pipeline to be pressure tested. It expressed this pressure as a fraction of the Barlow hoop stress times the yield stress. This fraction was 0.9.
  - It required that the design pressure should be a fraction of the test pressure; 0.8. And the factor of 0.72 was born.
  - It required a lower fraction where the consequences were more severe. I.e. it had some inherent risk principles.
The Nominal Probability of Failure
Where did it come from?

- The classical 0.72 design factor has shown to give an acceptable track record
- How can we determine design factors that will give similar track record as the classical 0.72 design factor for new failure modes and construction methods?
  - One could calculate the implicit failure probability of these criteria
- This was the basis for the work performed within the SUPERB project, a JIP in the first half of the 1990’ies.
The Nominal Probability of Failure
Where did it come from?

- It resulted in the following recommended nominal target failure probabilities (DNV-OS-F101).

<table>
<thead>
<tr>
<th>Limit State Category</th>
<th>Limit State</th>
<th>Safety Classes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>SLS</td>
<td>All</td>
<td>$10^{-2}$</td>
</tr>
<tr>
<td>ULS</td>
<td>Pressure Containment$^1)$</td>
<td>$10^{-4}$ to $10^{-5}$</td>
</tr>
<tr>
<td>ALS</td>
<td></td>
<td>$10^{-3}$</td>
</tr>
<tr>
<td>ULS</td>
<td>All other</td>
<td>$10^{-3}$</td>
</tr>
<tr>
<td>FLS$^2)$</td>
<td></td>
<td>$10^{-3}$</td>
</tr>
<tr>
<td>ALS$^3)$</td>
<td></td>
<td>$10^{-3}$</td>
</tr>
</tbody>
</table>

1) The failure probability for the pressure containment (wall thickness design) is one to two orders of magnitude lower than the general ULS criterion given in the Table, in accordance with industry practice and reflected by the ISO requirements.
2) The failure probability will effectively be governed by the last year in operation or prior to inspection depending on the adopted inspection philosophy.
3) Nominal target failure probabilities can alternatively be one order of magnitude less (e.g. $10^{-4}$ per pipeline to $10^{-5}$ per km) for any running km if the consequences are local and caused by local factors.
4) See Appendix F Table F-2.
5) The target shall be interpret as “probability that a failure occurs in the period of one year”.

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Why do failures happen?

- One pipeline was severely damaged by an anchor
  - Anchors were not expected there in 215 m water....

- One pipeline broke when a trawl got stuck at a flange
  - The flange was specified to be protected by gravel in the design....

- One pipeline broke when a trawl got stuck at a flange
  - This was inside trawl free zone...

- One pipeline bursted after three years service
  - The pipeline was specified in the design to be been cleaned, inspected regularly and inhibited but was not....

- One pipeline was dragged 6m out of position and scratched the pipe by an anchor
  - No anchors were expected in 150 m water...

- One pipe experienced upheaval buckling in a depression
  - The survey for gravel determination was based on top of pipe...

- ....and so on....
Integrity assessment

Design, PoF = $10^{-4}$

Fabrication and installation

Operation

Detection

Action

Repair

Prevent

Control

PoF $\gg 10^{-4}$
Why do things go wrong?

- What property is the most important mitigation for most of the failures?
Regulations

- These should preferably be performance and prescriptive
- Performance based are good but needs some knobs/piles
What is a standard or standardisation?

- “on the shelf” design
  - Same dimensions
  - Same material

- The same standard
  - The same bases for development of pipelines
Standardisation

- Is a minimum standard, standardization?

ISO 3183

Supplement 1

Supplement 2

Supplement 3

Supplement 4
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Operation and Integrity Management

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05 May 2017
Pipeline Integrity...

- The function of submarine pipeline systems is to *efficiently* and safely transport a variety of fluids

- ... the submarine pipeline system’s ability to operate safely and withstand the loads imposed during the pipeline lifecycle. If a system loses this ability, a failure has occurred.
Pipeline integrity (II)

Pipeline integrity is
- *Established* during the concept, design and construction phases.
- *Transferred* from the development phase to the operations phase. This interface involves transfer of vital data and information about the system.
- *Maintained* in the operations phase

![Pipeline Integrity Diagram](image-url)
The Integrity Management (IM) System

- Company Policy
- Organisation and Personnel
- Reporting and Communication
- Operational Controls and Procedures
- Risk Assessment and IM Planning
- Mitigation, Intervention & Repair
- Integrity Assessment
- Inspection, Monitoring & Testing
- Management of Change
- Contingency Plans
- Audit and Review
- Information Management
Risk assessment and integrity management (IM) planning

- Risk based pipeline integrity management takes into account:
  - identification of threats and failure modes
  - estimation of probabilities of failure (PoF)
  - estimation of consequences of failure (CoF)
  - estimation of risk level (CoF × PoF).

- Risk assessments are used to focus on the right issues to prioritize and schedule activities.

- Provides long term plans / high level plans
Improving

- Good planning and quality control is very important when improving integrity
Inspection, monitoring and testing

- **Inspection and Monitoring**
  - are activities carried out to collect parameter data and information that give indications to the condition / state of the equipment

- **Testing**
  - are activities carried out to test if the system or inherent safety systems have the required structural integrity or are working properly

- The “Inspection, Monitoring and Testing” activity includes:
  - Detailed planning
  - Execution
  - Evaluation
  - Reporting and documentation

- Potentially unacceptable mechanical damage or other abnormalities detected shall be reported as input to the Risk Assessment and Integrity Management Planning activity (where overall plans for more detailed integrity assessments / re-qualifications shall be developed)
Integrity Assessment Activities

Within the Integrity Management Process cycle, the “Integrity Assessment” step comprises:

- Planning
- Data management
- Evaluation of integrity
- Evaluation/identification of corrective actions
- Report
Mitigation, intervention and repair

- **Mitigating** actions are preventive maintenance actions, mainly related to internal conditions of the pipeline.

- Pipeline **intervention** actions are mainly rectifying actions related to the external pipeline constraints.

- Pipeline **repair** are mainly rectifying actions to maintain compliance with requirements related to structural integrity and/or pressure containment of the pipeline.

These actions shall not impair the safety level of the pipeline system below the specified safety level, as defined by the design process.
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Integrity Management of Offshore Assets

Break out groups session

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Break-out topics

- Current regulatory perspective
  - Performance based. But...
  - Safety is not only about design...

- Standards currently available in regards to subsea pipeline design
  - We should aim for ISO in the long run.
  - But they need to be sufficiently complete.
  - Design standards applying limit state based design should “converge”
  - Should have some “corner stones” in common

- Integrity management methodologies
  - Shall fulfil objectives, not specific requirements
Break-out topics

- **Welding & material issues**
  - Do we become so specific that we rule out more innovative solutions?
- **Non-destructive testing**
  - The accuracy should be linked to the utilization of the weld.
- **Pipeline decommissioning**
  - Pipeline engineers mean other things by decommissioning than other offshore people?

- The requested length of life extension (shorter vs. longer)
  - There is a need to differentiate between consequences (economic, safety and environmental)
  - The safety and environmental requirements should apply for any day, irrespective of where and when.
- **Effectiveness of inspection to decrease uncertainty of failure**
“They wish for a faster horse, but they really want a car”

(The title refers to that innovation should be based on needs, but the needs may be wrong! (They were not aware of cars!) This may also apply to pipeline operators, continue with pigging and video, when there may be new alternatives)

- Inspection improvements
- How to account for corrosion, wall loss, or wear without inspection
  - There is a need to differentiate between an onshore asset and an offshore asset