OIL & GAS

40 years of offshore pipeline design codes

Taking a broader view
Looking Back
Historical Perspective (I)

- 1000 B.C. - The first known pipeline made of bamboo in Japan
### Historical Perspective (II)

- The first oil pipeline made by the Nobel brothers in Baku, 1878
- From Balakhany field to Nobel's Refinery in Cherny Gorod (10 km)
- 76 mm diameter
- Reduced transport cost by 95%
- Fully down paid after one year
Historical Perspective (III)

- Built in 1905, from Baku to the Black Sea:
  - 8” diameter
  - 800 km
Historical – Codes

- Development of a national pressure piping code was discussed in US 1915
- In 1926, the American Standards Association initiated project B31
- The American Tentative Standard Code for pressure piping, B31, was published 1935
- In 1951, B31.4 & B31.8 were published
- Principle:
  - Limit hoop stress to fraction of the yield and reduce hoop stress in populated areas

“Mother of all codes” e.g. BS8010, NEN3650, DIN standard, DNV Submarine Pipeline Rules 1976
From Rules to standard...
..from stress based to limit state

DNV Rules, 1976
- First complete code for offshore pipelines
- Based on allowable stress format

DNV Rules, 1981
- Update of 1976 version, became a widely spread code

DNV Rules, 1996
- Completely new version
- Limit state format with calibrated safety factors based on the SUPERB JIP work

DNV-OS-F101:2000
- Converted to pure technical standard

DNV-OS-F101:2007
- General Improvement
- Aligned with ISO 3183 (linepipe)

DNV-OS-F101:2012
- General improvement
- Aligned with ISO 21809 (coating)

DNV-OS-F101:2013
- “Quick fix” of Appendix A

DNV-OSS-301:2000
- First publically available detailed offshore pipeline Certification Scheme

DNV-OSS-301:2013
- General improvement and restructuring

Ungraded
Overview of ongoing JIP’s and code revisions

- DNV GL-ST-F101 Submarine Pipeline Systems
- DNV GL-RP-F101 Corroded Pipelines
- DNV GL-RP-F102 Pipeline Field Joint Coating and Field Repair of Linepipe Coating
- DNV GL-RP-F103 Cathodic Protection of Submarine Pipelines
- DNV GL-RP-F104 Design and operation of CO2 pipelines
- DNV GL-RP-F105 Free Spanning Pipelines
- DNV GL-RP-F106 Factory Applied External Pipeline Coatings for Corrosion Control
- DNV GL-RP-F107 Risk Assessment and Pipeline Protection
- DNV GL-RP-F108 Fracture Control for Submarine Pipelines
- DNV GL-RP-F109 On-Bottom Stability of Submarine Pipelines
- DNV GL-RP-F110 Global Buckling of Submarine Pipelines
- DNV GL-RP-F111 Interference Between Trawl Gear and Pipelines
- DNV GL-RP-F112 Duplex Stainless Steel Subsea Equipment Exposed to HISC
- DNV GL-RP-F113 Pipeline Subsea Intervention and Repair
- DNV GL-RP-F114 Pipe-soil interaction for submarine pipelines
- DNV GL-RP-F115 Pre-commissioning of pipelines
- DNV GL-RP-F116 Integrity Management of Submarine Pipeline Systems
- DNV GL-RP-F117 Design of Pipeline Systems with Over Pressure Protection Systems
- DNV GL-RP-F118 Pipe Girth Weld AUT System Qualification and ...
- DNV GL-RP-F119 Thermoplastic composite pipes
- DNV-RP-F1XX Installation of submarine Pipeline systems
- DNV-RP-F1XX Horisontal drilling
- DNV-RP-F1XX Design Criteria for Spools
What is the “best” pipeline code
The “best” pipeline code

- Which one is the best design code?
  - The one that gives the thinnest wall?
  - The one that gives the thickest wall?
The “best” pipeline code

DNV GL view:

- The premises for the “best” pipeline code is:
  - First, to provide acceptable risk level
  - Second, to give the lowest Life-Cycle Cost
- And preferably also contribute to standardization
The “best” pipeline code

- What is acceptable risk?
The “best” pipeline code

What is Risk?
The “best” pipeline code

- Risk (R) is a combination of
  - Probability of failure (P)
  - Consequence of failure (C)

- Risk/Safety
  \[ R \sim P \cdot C \]

- EXAMPLE
Consistent design
Pressure containment, ISO (0.83)

ISO 3183-3 Mill test pressure requirements:

- Mill pressure test
- Operation
- System pressure test

D/t vs. Hoop/SMYS plot showing the pressure containment requirements according to ISO 3183-3.
Consistent design
Pressure containment, DNV(0.80)

Mill test pressure requirement:
40 Years of Pipeline Excellence
A great example of what industry collaboration can achieve

65%
The recipe for success

Knowledge

Competence

Research

Collaboration

Experience

Recognition

GLOBAL PIPELINE AWARD 2009 WINNER
DNV OS-F101: A standard that creates value

Set standard

- Simplification of company requirements and specifications
- Standardization across companies
- Challenging over-conservatism of codes

Find cost-efficient solutions

- Lifecycle cost
- New innovative technology
- Innovative field concept selection

Assure technical performance

- More precise guidance
- Quality assurance
- Preparedness and planning for the unexpected
DNV GL has in cooperation with the industry developed DNV OS-F101 to meet and address new technical demands in the industry over the past 4 decades.

With the trust of the industry we will continue to do so for the next 4 decades as well!
Looking Forward
DNV GL-ST-F101:2016/2017 major changes

- Improvements and more guidance on the shore crossing based on the CrossWay JIP, will be included in section 3 and Appendix F.
- Guidance on fracture assessment will be moved from Appendix A to a new revision of DNVGL-RP-F108. Only premises for fracture assessment will remain.
- Fixed risers will be removed and be covered in DNVGL-ST-F201.
- Requirements to load effect analyses will be clarified and compiled into one subsection in section 4.
- Dimensional tolerances and measurements of linepipes have been re-visited by an industry workshop.
- The linepipe requirements to smaller pipes, in particular coiled pipes, has been revisited and complemented to make it a more complete.
- Supplementary requirements P has been re-visited.
- The use of DNV GL-RP-0034 for forged components has been acknowledged.
- An informative section on documentation may be included.
Standardization cuts complexity

Share of respondents that agrees that operators will push to standardize their global delivery in 2017

GLOBAL

61%
A broader view on standardization

Streamlining standards

From corporate to global standards

Project replications/repeat-execution

Simplify documents and document flow

Collaboration

Governance
Cost pressure will force greater collaboration to maintain innovation

Top strategies to maintain innovation in 2017

- Increased collaboration with other industry players: 45%
- Greater involvement in joint industry projects (JIP): 30%
Future – A step change in the way of working

Design:
Integrated analyses

New materials:
Application of e.g. Thermoplastic Composites

Sensors:
• Subsea sensor development similar to onshore sensor trend
• Cost efficient operations based on sensor data

Digitalization and Smart use of data
• 3rd party anomaly detection
• Corrosion aspects – use of operational & inspection data worldwide
• Monitoring of environmental loads
Summing-up

- Necessary tough cost cutting measures have been implemented
- We need to move beyond traditional cost cutting to be sustainable
- Standardization, collaboration and innovation will move us in the right direction – the DNV GL Pipeline Standard is a prime example
40 years of pipeline excellence well positioned for today’s industry challenges

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SAFER, SMARTER, GREENER

Ungraded