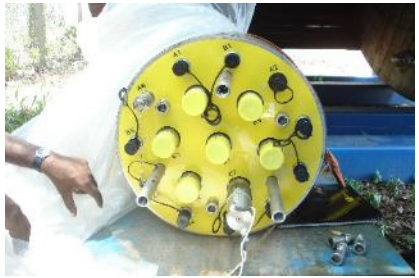
Subsea Corrosion Experiences

Material durability of Cables and Moorings

Jan Kenkhuis – Principal Engineer Mooring & Subsea



Workshop Front End Engineering

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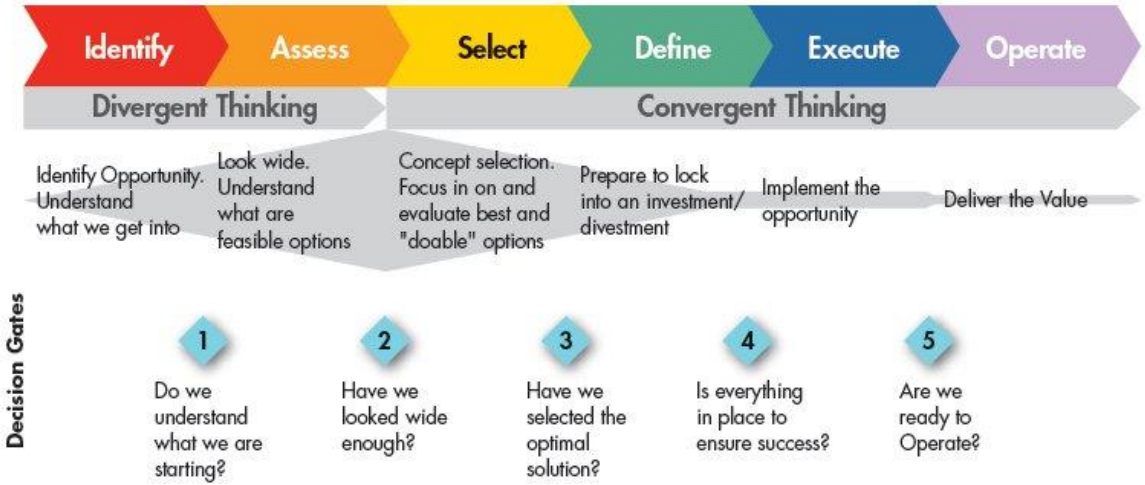
Agenda of this Presentation

1. Introduction
2. DNV code
   Subsea Facilities
3. Umbilical's Oil & Gas
4. Moorings Oil & Gas
5. Bluetec Texel practice
6. Engineering
7. Conclusion
8. Questions



Bluewater at a glance

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- Privately owned, independent group of companies founded in 1978
- > 35 years of marine engineering and operations of permanently moored systems
- Close to 1,000 employees (onshore & offshore)

Core business:

- Design, Build, Own & Operate Floating Production, Storage and Offloading Vessels (FPSO)
- Turnkey supply Single Point Mooring Systems (SPM)
- Other: Turrets, Swivel stacks, Cryogenic LNG offloading hose, **BlueTEC**

FPSO

SPM

Turret

BlueTEC

Introduction- World known Example of 2002

Story of the
US Navy Littoral Combat Ship
Aim Easy to Maintain over their lifespan

http://www.nace.org/CORROSION-FAILURE-LCS-2-USS-Independence-Naval-Ship-Engine-Corrosion.aspx

Ships were made of Aluminium with

- First ship suffered galvanic corrosion (2003)
- Second ship crack through the hull (2013)

Cause of Failure ---Design Flaws (2014)

- Corrosion concentrated in the ships propulsion system where steel impeller housing came in contact with the aluminium vessel (Nov 2013)
- The specification lacked the requirement for a Cathodic protection system
- 2 dissimilar metals come into electrical contact
- Electrical continuity not established

DNV-GL code – Subsea Facilities(2014)

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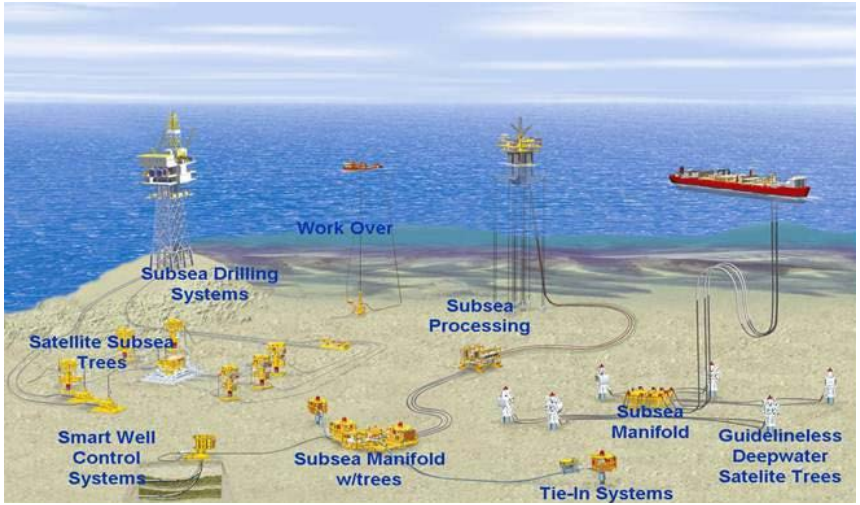
Oil & Gas Technology Developments ; Incidents and Future Trends

- Technology - Historical trends, future trends and developments
- Integrity management (from design to operation).
- Degradation mechanisms and failure modes.
- Inspection, maintenance and monitoring methodologies.
- Recommendations for improvements and knowledge sharing.



The threat of corrosion
corrosion is a material degradation;
depends on the exposed environment and the material or a combination of materials in question

DNV-GL code – Degradation mechanism

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The threat “material degradation” mechanism occurs either:

- ❑ Abrupt degradation

  brittle facture of ceramics; glass; fasteners

- ❑ Slow over time

  CO2-corrosion of alloy steel and fatigue;

  ageing of elastomers;

  loss of spring capacity

Bluewater SPM System (2008)

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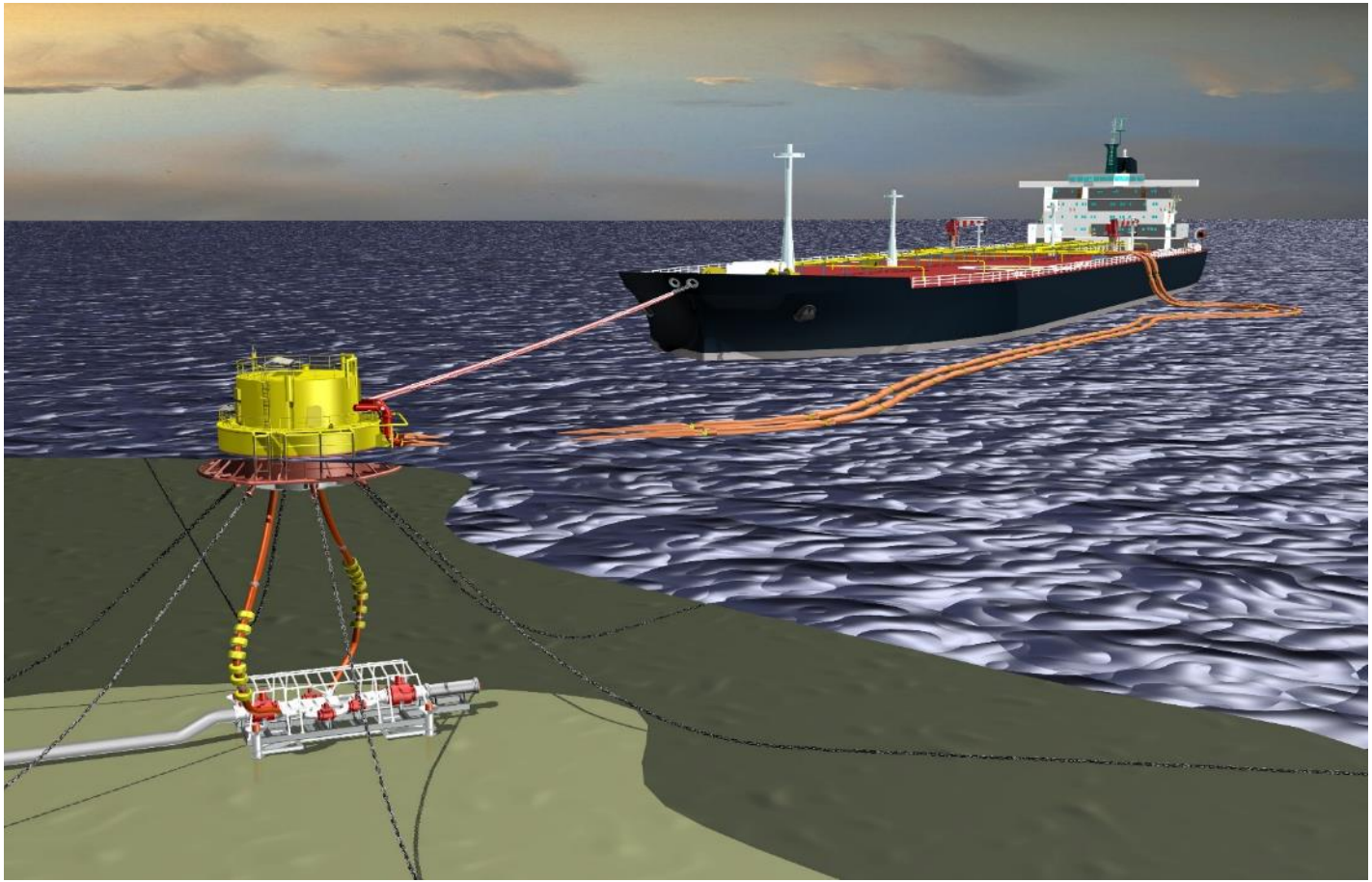

Umbilical SUTU example

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At time of installation in 2008

At time of repair in 2009

SUTU after recovering

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Open SUTU

Hydraulic connectors

Cause of the rapid corrosion

- No electrical continuity guaranteed between connectors and bulkhead plate.
- Connectors supplied from 1.4418 stainless grade. Equals to 304 grade
- The specification asked for 316L grade
- Concerns raised about the uncertainty of the isolation between SUTU and PLEM

2nd example Bluewater Haewene Brim

Non Sheathed Spiral Strand Wire

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Bird cage detection

close up picture

Cathodic Protection on Sockets

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Anode new

Anode after 5 years

Cathodic protection of chain stopper

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Orkot bushes to achieve electrical discontinuity

chain stoppers with CP system

Bluewater Texel Project Experiences

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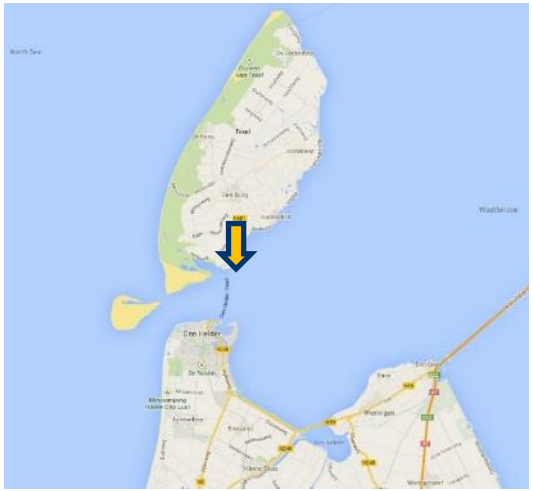

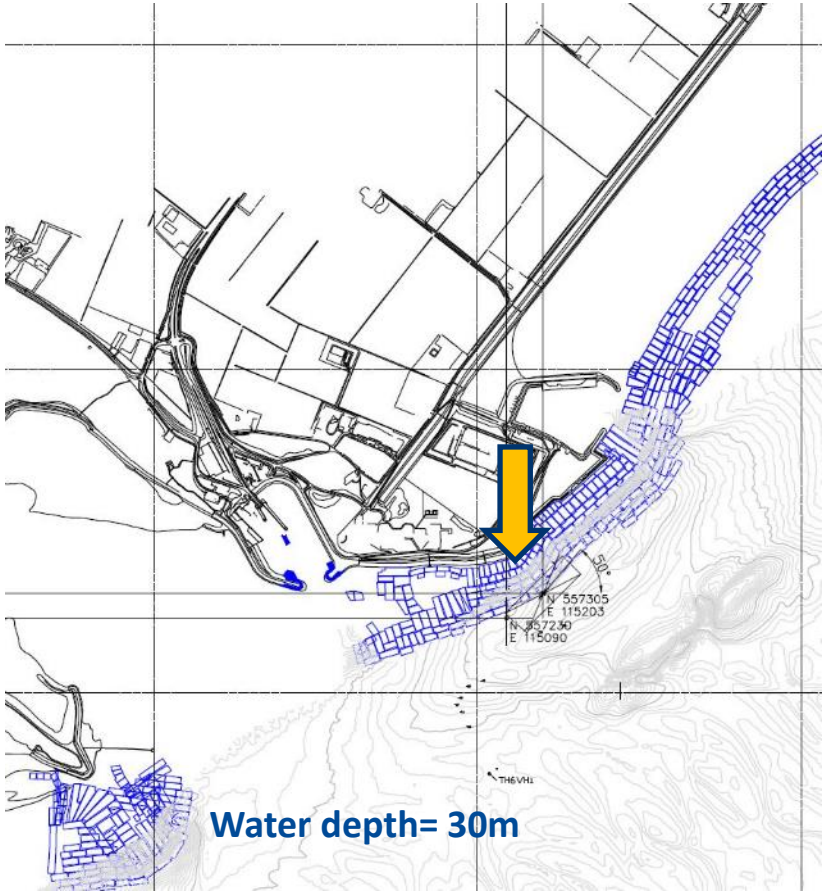

BTT in Operation

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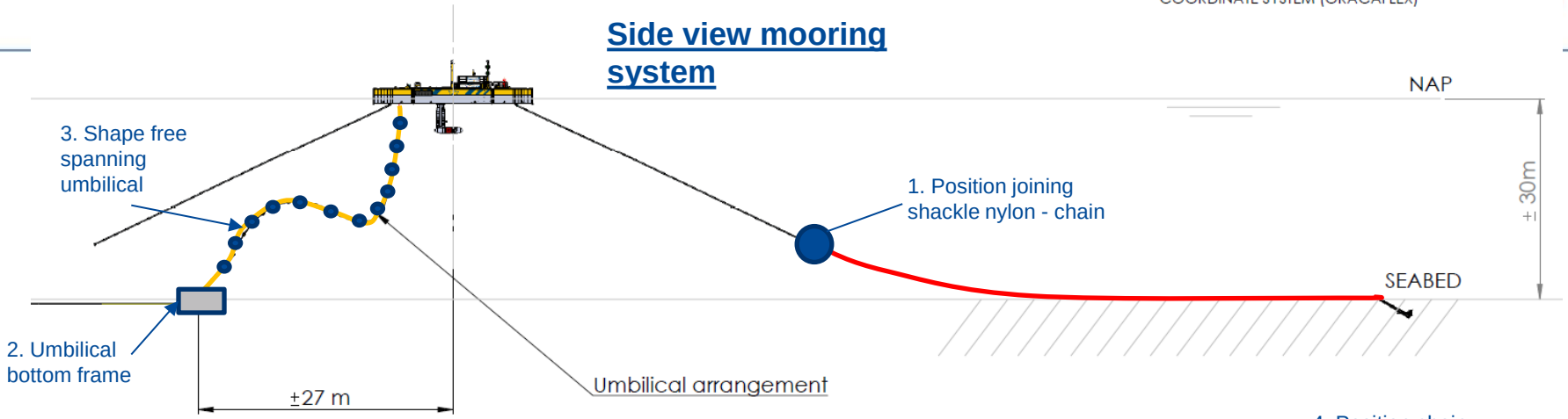
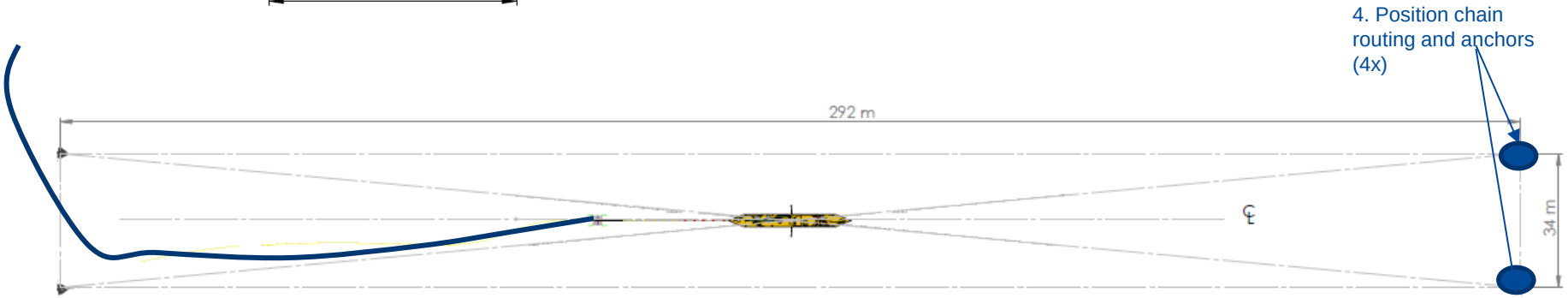
BTT platform Oct 2015

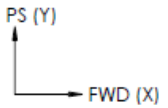
Side view mooring system





5. Umbilical routing bottom connector - shore

TOP VIEW (Footprint)



Visual Inspections

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Mooring Lines: prior installation

Mooring Lines: after 0.5 years

BTT underwater, non-coated

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BTT floater out of the water

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Before cleaning

After cleaning

BTT Cathodic Protection

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Lifecycle of a Development Project

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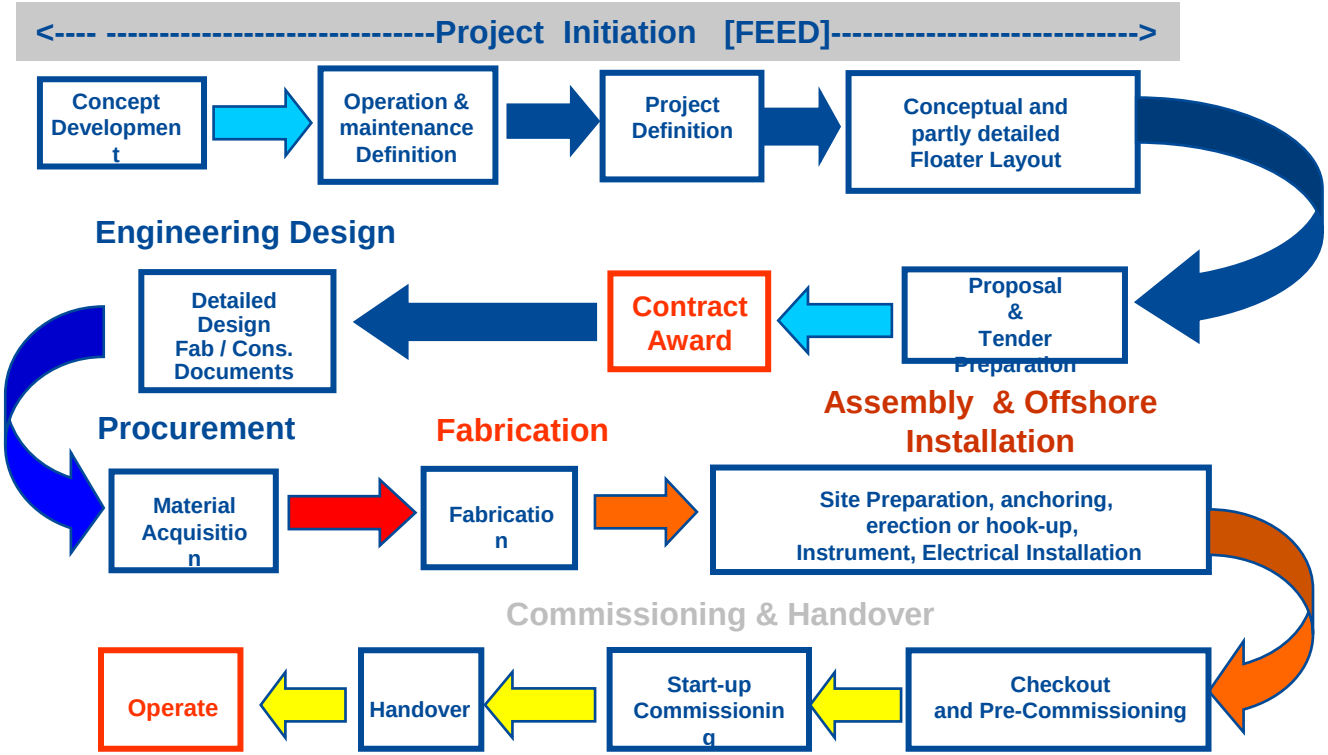

Development Risk Assessment

- The first step in assessing feasibility is the risk assessment review result for:
  - Manufacturing
  - Assembly on site
  - Foundation Installation
  - Mooring spread pay-out
  - Hook-up
  - Cable Installation
  - Operation
  - Day to Day maintenance

Integrity Management of Subsea Systems

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ESTABLISH INTEGRITY	MAINTAIN INTEGRITY
Concept, design and Construction (incl. pre-commissioning)	Operations (incl. Commissioning)
INTEGRITY MANAGEMENT PROCESS	
Risk Assessment and Integrity Management (IM) Planning	
	Inspection Monitoring and Testing
	Integrity Assessment
	Mitigation, intervention and repair

Based on sound engineering practice the following can be concluded:

1. The mooring or cable design spec should included external coating protection combined with CP systems.// electrical continuity etc.
2. Request verification of a corrosion expert as part of risk assessment program
3. The materials provided by supplier should be traceable [MRB]
4. Acceptance test of batches of components could be included to check on suitability for subsea applications
5. Often if the proposed components are mature and proven this has an advantage
6. Avoid damage to the coating (sheathing) as much as possible in installation stage.
7. Execute electrical continuity checks prior lowering overboard.
8. Use sheathed steel wires only (offers an extra of 5-8 years of service life)
9. Develop in engineering stage an Subsea Integrity management plan.


Thank you!
Questions?