NEXANS NORWAY 100 1915 - 2015

Direct Electrical Heating of Flowlines

Moving boundaries

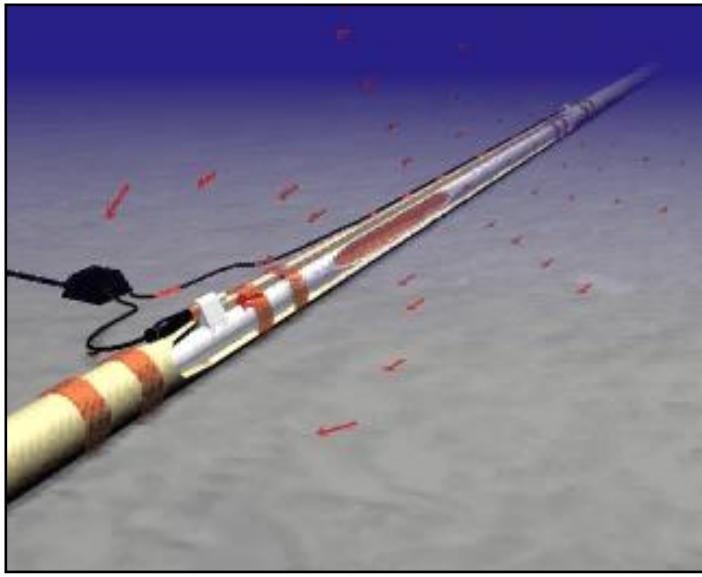
OUTLINE

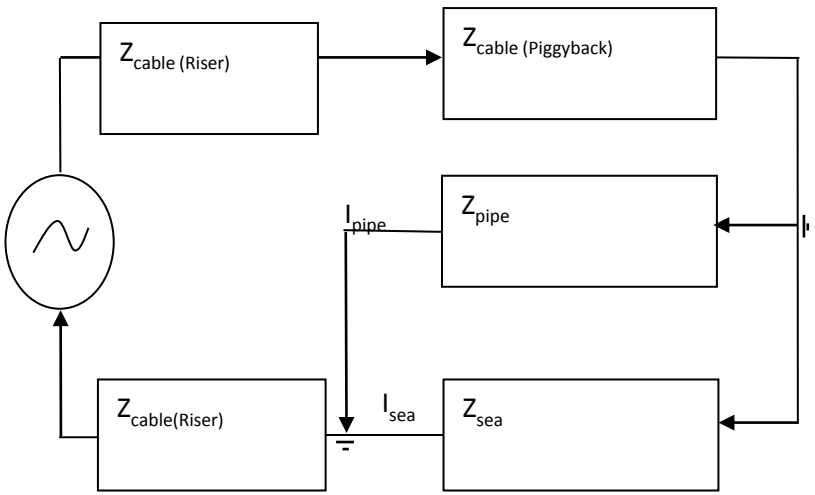
1. History of DEH
2. Design of a DEH system
3. Components and Cables in a DEH system
   - DEH specific design criteria
4. Systems with complex subsea architecture as for Shah Deniz
5. Deep water projects – Lianzi

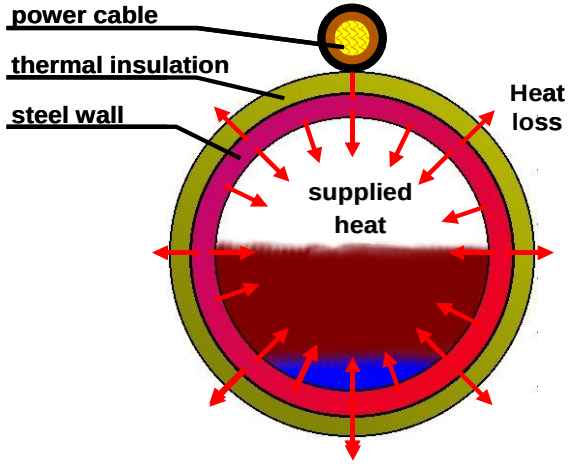
What is DEH?

Principle of Direct Electrical Heating

- High Efficient Electrical Heating System
  - Due to topside compensation of reactive load
- Utilizes conventional wet insulation
  - Efficiency of DEH pending on U-value
- Field Proven
- Intermediate use, heat-up or continuous use of DEH
  - Based on aging tests carried out







Project experience – implementation of DEH

- Total: Nexans delivered all subsea cables and equipment to more than 25 flowlines with DEH.
- DEH projects often associated with pushing boundaries.
- Current technology, up to 100-150 km
- Flowline dimensions: 8 – 18 inch (30 inch for retrofit)
- U-value: 2.5 - 8 W/m2K
- Steel material: Cr13%, Carbon, Carbon w/ clad,
- Delivered DEH to 1050 meter water depth

Cable Design

Ageing Properties at High Temperatures

- Ageing of HV XLPE (and any type of insulation system) depends on:
  - Temperature
  - Electrical stress. I.e voltage rating as 6, 12, 24, 52 kV is not relevant. Electrical gradient is important.
  - Ageing media

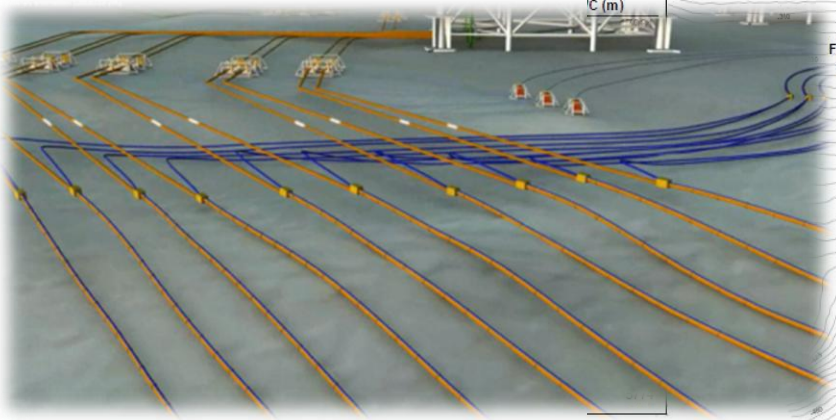
- Substantial test data following DEH qualification – material and process.

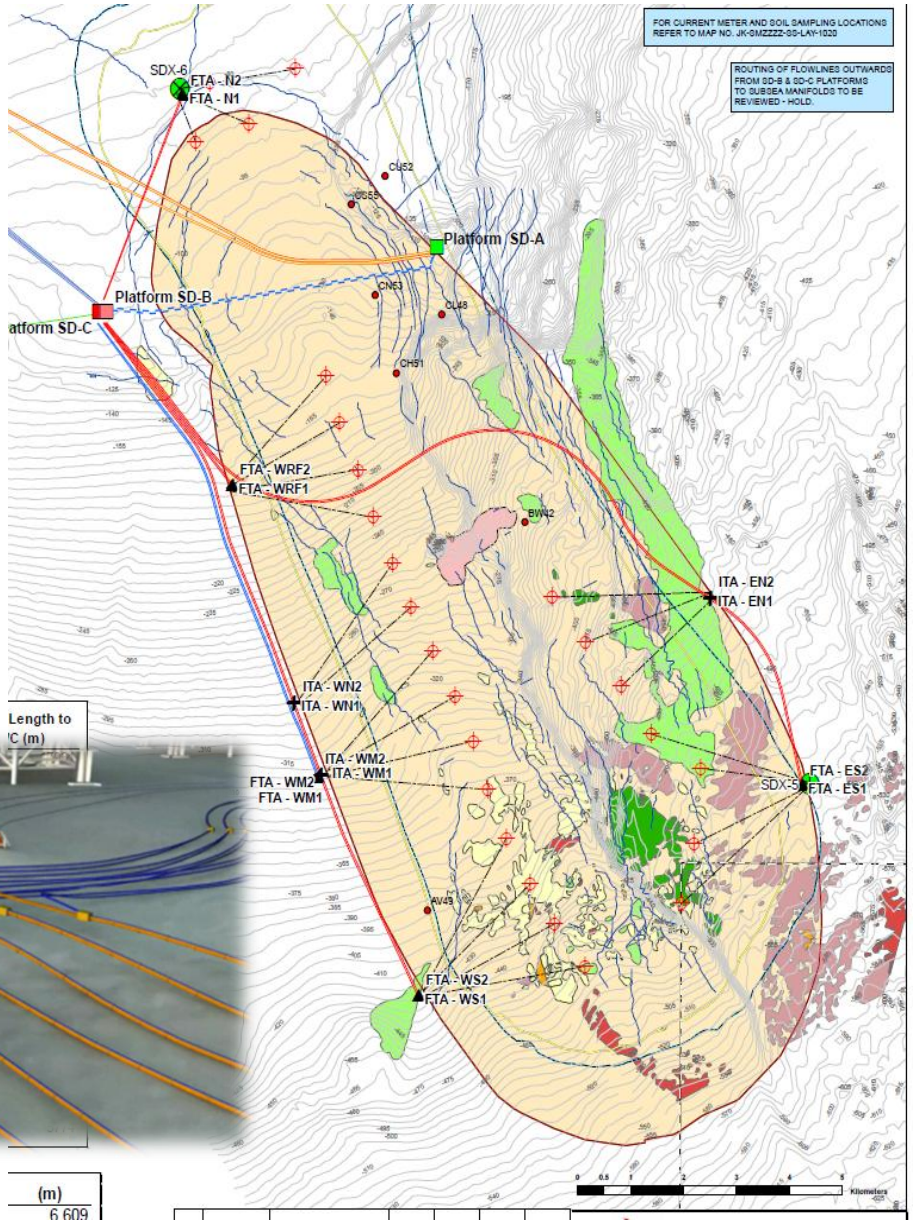
- Note that testing includes verification of exact material as well as production process. Every supplier need to document the product!

- Life time testing need to be carried out for any type of cable – independent if it is for DEH or not.

SHAH DENIZ

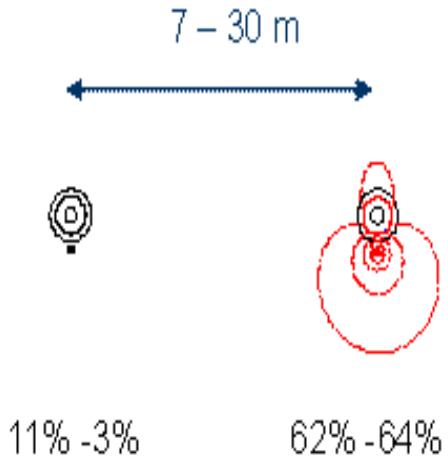
- The worlds largest DEH system
  - 120 Km - approx
  - 10 - 14” flowlines (+2)
- Extensive FEED study in order to optimise subsea architecture and investigate effect of brackish water
- Complex multi-flowline system in congested subsea arcitecture



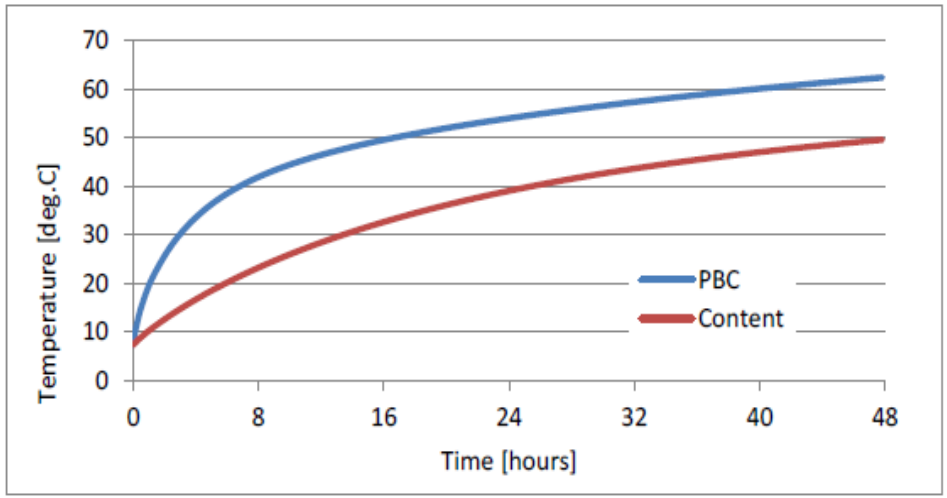


Complex multi flowline systems

- Power rating in complex DEH systems
  - All projects before SD2 rely on approx 30 m separation to flowlines
  - All heated flowlines interact and add up according to superposition principle. Need to check max temperature in cable accordingly
- Close interaction for design of power req. and anodes



Sea
29% - 34%



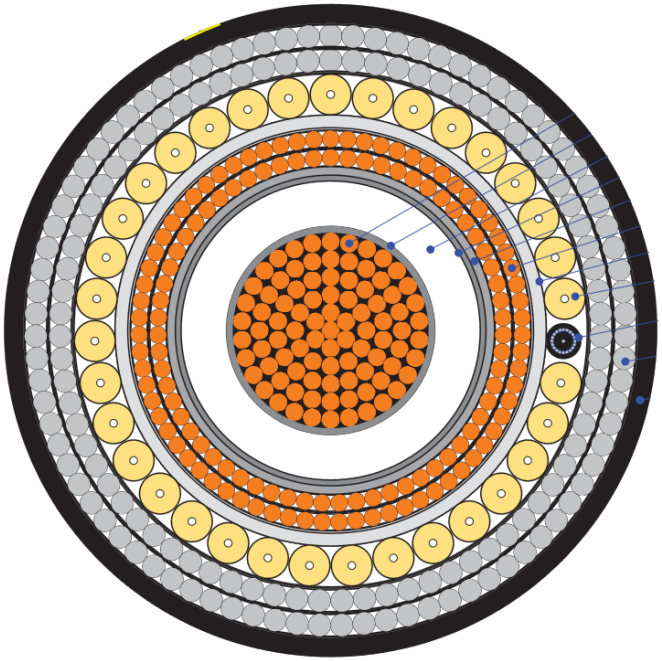
Example on power rating

- Maintaining temperature during shut-in.
  - Numbers are pr flowline

14" OD, 2.5 W/m^{2}K, heat from ambient to 26 °C Including interaction to other flowlines			
	2 parallel flowlines	8 parallel flowlines	8 parallel flowlines
Length	4 km	8.3 km	18 km
I [A]	1110 (up from 1080)	1174 (up from 1080)	1174 (up from 1080)
U_0 [kV]	1.6	3.25	7.1
P [MW]	0.47	1.1	2.3

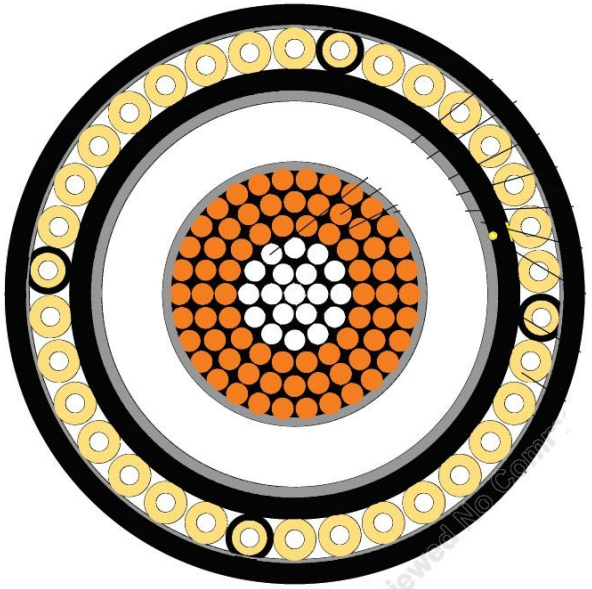
Lianzi – Deepwater DEH

DEH Riser Cable & AFC



-1600 mm^2/ 1800 mm^2
- 52 kV
- 1 off armoured F.O. element

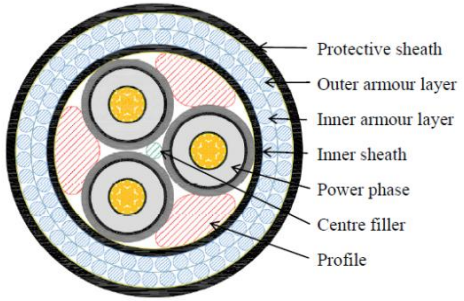
Piggyback Cable
1050 m water depth



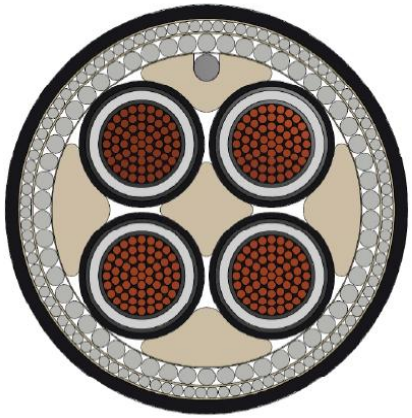
- 1400 mm^2
- 52 kV
- 1 off FIMT
- Delivery length: 43027meter

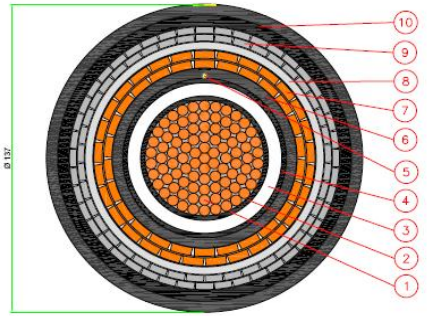
New development - DEH

- Deep water qualification
  - Cable design and UFLEX2D verified to be applicable for 3000 m water depth – 30 years service
    - Qualification based on DNV-RP-A203
  - Field study carried out for DEH project
    - Dynamic analysis verified design for 2200 meter
  - Prototype undergoing manufacturing based on modified SD2 delivery – target : 4000 meter



TFVE 12 kV 4x630 mm2KQ w/FO cable





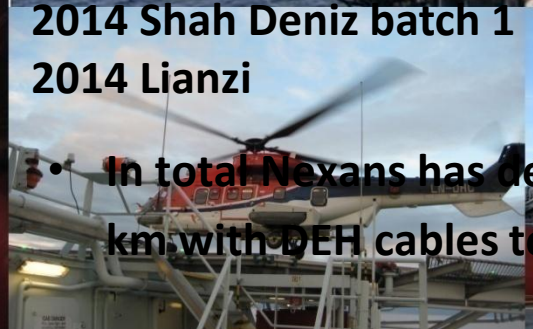













1987-1998 Participated in development and qualification of the DEH technology

2000 Åsgard
2002 Huldra
2004 Kristin
2005 Norne
2006 Ormen Lange
2007 Tyrihans
2008 Alve
2009 Morvin
2010 Skarv
2012 Skuld
2014 Shah Deniz batch 1
2014 Lianzi

- In total Nexans has delivered more than 200 km with DEH cables to heat 18 pipelines

Nexans

Nexans –
total DEH knowledge,
engineering, production and
testing in house.

Thank you for your attention!

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