Umbilicals – Experience and Challenges, Tie-Back installations

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Petronas - Petrad - Intsok – CCOP
Deepwater Subsea Tie-back

24TH - 26TH January, 2011
At the core of performance: a worldwide presence

- Industrial presence in 39 countries and commercial activities worldwide
- 22,400 local experts
- Mastery of national and international standards
A submarine history as long as applied electricity

- 1500 submarine power cables in 100 years
- Submarine Cables ranging from 12 to 550 kV
- Power cables and umbilicals for the offshore industry for 35 years

Offshore exploration in challenging coastline, deeper (500 m)

- 35 years
- Water depth >2000 m
Nexans Norway AS

- Employees - approx. 1175 (2009)

Locations:
- Rognan
- Namsos
- Karmøy
- Langhus
- Halden
- Oslo (HQ)

- Telecom and Building
- Energy Networks
- Energy
Halden Plant overview...

- Established 1973
- Employees: 530
- 100 engineers
- 170.000 m²
- purpose-built for long lengths
Products and services (1)

- Power cables
  - XLPE – 420kV AC
  - Paper insulated DC
Products and services (2)

- Cables for interplatform & offshore wind farms
  - XLPE – 245kV AC
Products and services (3)

- Steel tube umbilicals
  - 2316 m water depth
  - 145 km without joints
  - OD 250 mm
  - 35 elements
Nexans umbilical history

Milestones

- Delivered umbilicals with Thermoplastic Hoses since 1986
- Delivered hybrid umbilicals with Thermoplastic Hoses and Steel Tubes since 1999
- Market Introduction of:
  - the Steel Tube Umbilical (1993)
  - the DYNAMIC Steel Tube Umbilical (1995)
  - the DYNAMIC Center Tube Umbilical (1995)
  - the Steel Tube Power Umbilical (2007)
- Heidrun, 1994: 350m
- Macaroni, 1999: 1 126m
- Crosby, 2001: 1 341m
- Thunder Horse, 2004: 1 890m
- Roncador, 1999: 2 000m
- Atlantis, 2005: 2 150m
- NaKika, 2003: 2 316m
- Pre-salt

-Nexans have qualified umbilical and power umbilical for 3000 m waterdepth, and we aim to qualify the technology for 4000m water depth.
Nexans strengths

- All components manufactured in-house
- All component testing at site
- All full scale testing at site
- All required engineering capabilities in-house
- Strong engineering teams. Follow the projects from start to end.
- In-house welding capability
- Electrical & fibre optic elements manufactured in-house.
• Qualification testing is used to build confidence and meet new challenges

• Nexans has complete range of test facilities in-house
In-house Test Facilities

- Tensile bending test (Cigré)
- Torsional balance test
- Tensile test
- Dynamic flex test
- Lateral load test
- Rotation fatigue test
- External water pressure test
Technical Data

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<td>Wheel diameters</td>
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Technical Data

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<td>Revolutions per minute</td>
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• Lateral load test
HV Cable & Umbilical R&D and Testing

- High Voltage Test Laboratory for R&D, type testing, routine testing and final testing
HV & Umbilical Manufacturing
Vertical lay-up machines (1)
HV & Umbilical Manufacturing
Vertical lay-up machines (2)

- Computer controlled large and flexible vertical lay-up machine built for offshore products
Terminated Umbilical on Turntable
• Significant shore tieback projects by Nexans:
  
  • 2001: Corrib umbilical, 87 km – Ireland
  • 2002: Scarab Saffron umbilical, 2 x 90 km - Egypt
  • 2005: Snøhvit umbilical, 145 km – Norway
  • 2006/7: Ormen Lange umbilical, 2 x 120 km – Norway
  • 2007: Dolphin umbilical, 75 km + 90 km - Qatar
Project awarded 2001

One of the first large shore tieback umbilicals

At that stage world’s longest electro hydraulic umbilical 87 km

Client Enterprise (Shell)

Umbilical manufactured in one continuous length completed in 2003

Project still awaiting approval
- 145 km Umbilical supplied in one length
- 3 kV power/signal triads
- Delivery to base on barge
2x120km Ormen Lange Umbilical

2 OFF FIBRE OPTIC CABLES FROM NEXANS ROGNAN
5 OFF ELECTRIC QUADS (3 kV) FROM NEXANS ROGNAN
6 OFF HYDRAULIC TUBES FROM SUMITOMO JAPAN
WELD TUBE STRINGS IN HALDEN
LAY UP (2 PASSES) IN HALDEN
OUTER SHEATH IN HALDEN
TERMINATE, TEST AND LOADOUT FROM HALDEN
For ultra-long umbilical lengths

- Amplification of electrical and fiber optic signals required every 200 – 300 km
- This coincides with the boosting interval for hydraulic and injection fluids

- There are challenges related to handling during manufacturing and installation
- Nexans total turntable capacity: 40,000 tons
- The largest turntables: 7,000 tons
- This limits the maximum delivery length without splices to 150 – 300 km depending on umbilical design
- For longer lengths splices must be introduced

- The capacity of installation vessels can also be a limiting factor in delivery length
Significant shore tieback projects by Nexans:

- 1995: Troll 52kV, 67 km – Norway
- 2002: Horns Rev offshore wind farm 170 kV, 21 km – Denmark
- 2006: Ormen Lange processing plant grid connection, world’s first 420 kV XLPE – Norway
- 2009: Ormen Lange Pilot 145kV HVDC – Norway
- 2009/10: Valhall 150 kV IRC, 292 km – Norway
Experience and technological status for AC XLPE insulated submarine cables

- The AC submarine cable to the Troll A platform
- The longest HVAC submarine cable link installed in 1995
  - 67 km cable
  - 52 kV voltage level
  - 18 MW power rating
  - Excellent service experience
Experience and technological status for AC XLPE insulated submarine cables

- The world's first 170 kV XLPE insulated submarine cable
  - Cable from shore to Horns Rev offshore wind farm in Denmark
  - Distance 21 km
  - Power rating 160 MW
  - Installed and commissioned in 2002
  - Excellent service experience

- Nexans delivered Horns Rev Phase II with 45 km of 170 kV submarine cable in 2008
Experience and technological status for AC XLPE insulated submarine cables

- The world's first 420 kV XLPE insulated submarine cable system installed in Norway
  - Cables from land to the Ormen Lange processing plant on the island Gossen
  - Submarine distance approx. 2.4 km – 4 cables
  - Power rating 1000 MW
Valhall IRC shore tieback project

- Turn key project
  - Cable Supply
  - Installation w hook up (2009-10)
  - Trenching/rock dump

- Key characteristics
  - 292 km HV 150 kV IRC cable
  - 292 km 12 G12 SAH FO cable
  - Tieback to Lista
  - Max water depth 385 meters
  - 1 HV subsea joint
Transmission alternatives

- **HVDC**
  - Converters require large space offshore
  - No practical length limitation

- **HVAC**
  - Require much less space offshore for electrical equipment
  - Charging current cause higher cable transmission losses
  - Reactive power limits the lengths
Limits of transmission capacity, Submarine HVAC cables

400kV:
>1000 MW
up to
100 km.

230 kV:
✓ 200 MW
to 250 km.
- Conventional three-core XLPE submarine cable
- Capacity ≈ 300 MW at step-out length ≈ 200 km (50 Hz)
- Conductor is sized either thermally or by voltage drop
The experience with long AC XLPE insulated submarine power cables is excellent and the systems for extra high voltages are under development.

Modern XLPE insulated submarine power cables can be used for distances up to 250 km.

HVAC submarine cables are an attractive alternative to HVDC for transmitting power over long distances.