Subsea Power Distribution

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HV Supply - Principle

HIGH VOLTAGE SUPPLY: 2 options

- Umbilical length < 200 km
- Fibre optic cables in same or other umbilical

On Shore HV Substation

Off Shore HV Substation

Subsea Transformer

Subsea Power Distribution
Subsea Electrical Distribution & Control
Architecture principle — Ring or Radial configuration
Automation architecture

SEPCS: Substation Electrical Power Control System:
Dual Ethernet TCP/IP redundant rings (A&B)
Full hardware redundancy up to sensors

Schneider Electric
Real case: Subsea project
Ormen Lange Norway
The entire Process on the Seabed

- As the search for oil moves into deeper waters and harsher environments production is moving onto the seabed.

- Offshore oil and gas production has seen a significant trend in recent years: the elimination of offshore surface facilities, with the entire production system for some of the more advanced fields located on the seabed and connected back to a terminal on the shore.

- The Ormen Lange is a good example of this approach, and is significant because it will supply 20 per cent of the UK’s gas consumption in coming years.
ORMEN LANGE - Norway

Subsea Compression System Station

- 4 compression trains
- Tie-back 120 km
- Waterdepth 860 m
- 60 MSm³/d of gas production
- 7 200 Sm³/d of condensate production
- 58 MW total electrical power
- Target availability: 97.5%
- Dimensions:
  - Length 70 m
  - Width 54 m
  - Height 25 m
- Total weight 5200 tons

Subsea Compression Station
installed at Ormen Lange © StatoilHydro

Possible project execution: 2012-1015
SE contribution to Subsea?

ORMEN LANGE - Compression Pilot

- Control system
- Compressor VSD
- Pump VSD
- Transformer

- Anti surge cooler
- Separator
- Condensate pump
- Compressor
- UPS

Circuit Breaker

Actual SE Supply
Subsea Processing Power Distribution

Subsea Switchgear Module – Key Enabling Component in Subsea Installations
Inside the Subsea Switchgear Module

Main functions
• One 22 kV / 3 ~ / 1000 A Incoming from main step-down transformer
• Two 22 kV / 3 ~ / 450 A Feeders supplying VSD transformer module
• Two 620 V / 3 ~ / 140 A Feeders supplying UPS module
• Protection & monitoring of these feeders

Auxiliary functions
• Insulation resistance monitoring 22KV interconnexions
• Premagnetization of VSD transformers

Overall Dimensions:
Length external  17.550 mm  Volume external  100 m3
Diameter external  2.750 mm  Weight total  140 T
Thickness  75 mm
Single-line Diagram

- 22kV power to 2 process trains
  - Energization via premagnetizing transformer
- LV power to 2 UPS
  - Dual feed auxiliary power back from UPS
- Identical equipment for train 1 and train 2
- Full redundant LV auxiliary power
The Switchgear Rack

1 – Penetrator for incoming supply
2 – Penetrator for 22kV cable to train 1
3 – Transformers for train 1
2 – LV Power, protection, control Train 1
Reliability Study

- **Stringent performance requirements:**
  - No access for 5 years
  - No increase in external diameter nor height
  - Meet handling constraints (30° roll, 15° pitch)
  - Allow access to all devices after assembly

- **Electromagnetic Compatibility is key requirement**
  - Avoid nuisance tripping or unwanted actions
  - Strong influence of design of switchgear rack
Calculations

**Mechanical calculations**
- Displacement, stress

**Thermal calculations**
- Test conditions
- Final installation conditions
- No forced ventilation required
Assembly Procedure
Switchgear Rack FAT

- Completely assembled for test
- Functional tests
- Full interconnection of all equipment
- HV dielectric test
Access to all Devices
Conclusion

System Design

- Complete system from supply to loads must be looked for:
  - protection system design (fault location and isolation)
  - control of voltage at loads under steady state & transient conditions
  - harmonic resonance
  - installation and connection constraints

- Results of system design are inputs for equipment design
  - maximum steady state & transient voltage operating conditions
  - worst case scenarios for thermal & mechanical calculations
  - location and types of connectors, penetrators, ROV access points

Qualification of components

- Basic philosophy - leave nothing to chance
  - Every type of component selected down to the last nut and bolt
  - Shop drawings with all details provided for all mechanical parts
  - Assembly drawings:
    - include all components to be used
    - provide testing procedures used during fabrication

- Components selection based on similar applications such as military
- Type testing of any components designed specifically