Introduction to Subsea Production System

02 Drilling and Wellhead System

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Subsea Drilling and Wellhead Systems

This module will cover:

- Applicable codes and standards
- Reservoir Engineering
- Subsea Wells
- Subsea Well Program
- Wellhead Equipment
- Running Tools
- Deepwater drilling
Goals

- Understand the premises and interfaces to the drilling activity
- To understand the main building blocks in a well
- To be able to participate in debates regarding drilling activity and well architecture
Applicable codes and standards

Main codes for wellhead and drilling:

- API 6A/ISO 10423 Specification for Wellhead and Christmas Tree Equipment
- API 17D/ISO 13628-4 Subsea wellhead and tree equipment
- API 16A / ISO 13533 Specification for Drill-through Equipment
- + ASME, ISO, BS +++
- NORSOK D-010
- NORSOK U-001
Reservoir Engineering

Ormen Lange Reservoir, 350 km$^2$ 2000 meter below seabed:
Reservoir Engineering

Ormen Lange Reservoir:

Påviste forkastninger

6305/1-1
6305/4-1 boret våren 2002
GIIP prognose bekreftet

6305/5-1
6305/8-1
6305/7-1
Subsea Wells

The main development well types:

- Exploration wells
- Production wells (oil, gas)
- Injection wells (water, gas)

Well design through the reservoir:

- Vertical
- Deviated
- Horizontal
- Multi branch (side-track)

Enhanced Recovery:

- Water injection
- Gas injection
- WAG; water alternating gas injection
- Artificial lift
Subsea Well Program

Typical Subsea Well Program:

- Drill 36” hole to ~80m
- Run and cement 30” Conductor
- Drill 26” hole to ~800m
- Run and cement 20” casing with 18 3/4” WH
- Run Blow-out-preventer (BOP)
- Drill 17 ½” hole to ~1300m
- Run and cement 13 3/8” Casing
- Drill 12 1/4” hole to ~1700m
- Run and cement 9 5/8” Casing
- Drill 8 ½” hole to ~2000m
- Clean up well
- Abandon well (run plug or close valve)
- Proceed to completion operations

This program can be a 100 days plan
Xmas Tree Systems

**Typical Tree Installation Sequence:**

- Install Xmas Tree on Wellhead using drill string and Tree Running Tool (TRT)
- Recover TRT
- Run BOP and marine riser
- Remove down hole plugs
- Run completion / production tubing
- Perforate tubing at reservoir depth
- Inhibit well and prepare to abandon
- Install internal tree cap
- Retrieve marine riser and BOP
- Drill rig moves to next well
- Flowlines and flying leads installed by Rig or installation vessel
Well Completion

18 3/4" X 7" X 2" tubing hanger
18-3/4" wellhead
18 3/4" X 13 3/8" casing hanger
36" conductor housing

36"/30" conductor at 940 mTVD
2 x 7" TRSSSV's

20" surface casing at 1600mTVD

9-5/8" production tubing, with production packer set below 9 5/8" liner lap.
7" tail pipe available for deep set plugs and downhole gauge positioning.
9-5/8 x 7" production packer.
9-5/8 x 7" full bore isolation valve

13-3/8 x 13-5/8" intermediate casing set in
17 1/2" hole at 2100 - 2200m TVD.

9-5/8" x 7" lower completion packer
9 5/8" liner in 12 1/4" hole to top reservoir at
2705m TVD over sail section, to prevent shale
7" formation isolation valve
7 " lower completion.
Well Completion
Wellhead Equipment

The wellhead system suspends the casing and serve as a barrier for well fluids against the environment.

There are 5 main suppliers of subsea Wellhead systems:
- Vetco Gray
- FMC
- Aker Kvaerner Subsea
- Drill-Quip
- Cameron

The wellheads are usually designed according to API 17D (ISO13628-4) and API 6A (ISO10423).

The 18 3/4 " Wellhead Housing often has a H4 Vetco external profile for subsea wells.

The internal seal and locking profiles are supplier specific.

Main Components:
- 18 3/4" Wellhead Housing
- 30" Conductor Housing
- 9 5/8" Casing Hanger
- 18 3/4" Packoff
- (Annulus seal assembly)
- 13 3/8" Casing Hanger
- Drilling Guide Base
Wellhead Equipment
Deepwater Drilling

An increasing number of the subsea wells worldwide are located in deepwater. Deepwater is usually defined as water depths from 300 – 1500 m, with greater than 1500 m water depth classified as ultra deepwater. These depths impose significant challenges with respect to subsea drilling.

Existing drilling rigs allow for drilling in water depths in the order of 2400 m. New generation drill rigs and drill ships are being designed for water depths beyond 3000 m.

In deep water, drilling requires very heavy equipment, drilling operations and well control procedures are more difficult and well costs can rise dramatically.

http://www.youtube.com/watch?v=9PNMDV2v9oA&feature=related
Mono Bore Drilling
Buzz group

- What are the main principles in order to get the oil and gas?
- Please give details…
30” Conductor Housing

- Wellhead Locking Profile
- Running Profile
- Flow by Port
- Guidebase Landing Shoulder
- Conductor Extension
18 3/4” Wellhead Housing

Vetco H4 Profile

Lockdown ring
13 3/8” Casing Hanger

13 3/8” Casing Pup Joint
9 5/8” Casing Hanger

Landing Shoulder

9 5/8” Casing Pup Joint

Fluted Centraliser
18 3/4” Pack-off

- Locking Mandrel
- Metal Seal
- Wellhead Lock Ring
Drilling Guide Base
Casing Diagram
Subsea BOP
Safeguarding life, property and the environment

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