Introduction to Subsea Production Systems
03 Drilling and Wells

August 2015

Drilling and Well

Photo: U.S. Coast Guard
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

Subsea Drilling and Wellhead Systems

This module will cover:
- Applicable codes and standards
- Reservoir Engineering
- Subsea Wells
- Subsea Well Program
- Wellhead Equipment
- Deepwater drilling
Standards Overview

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 Well integrity in drilling and well operations
- NORSOK U-001 Subsea production systems
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

Different Well Types at Tyrihans

- The Evolution of Wells at Tyrihans
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” (link) 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

Video, Running Wellhead

- Wellhead.avi
Conventional mud circulation system

Relation to Pore/Fracture Pressure Plot

Pressure Gradient SG

Depth

Fracture Pressure Gradient
Pore Pressure Gradient
**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
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:
- GE Oil & Gas (ex. Vetco Gray)
- FMC
- Aker Solutions
- 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 1/2” Packoff (Annulus seal assembly)
- 13 3/8” Casing Hanger
- Drilling Guide Base

Casing Diagram
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.

The following new techniques are considered to have a significant impact on the subsea well construction costs:

- Under balanced drilling
- Riser less drilling or dual gradient drilling system
- Casing while drilling
- Expandable casing strings
**Mono bore drilling**

**Buzz group**

- What are the main principles in order to get the oil and gas?
- Please give details...
  - How do you get to the reservoir?
  - How do you get the oil/gas out?
  - Where does the oil/gas go from there?
  - Think of some safety features in drilling operations...
Drilling and Wells

Key takeaways:
- Reservoir engineering
- Subsea well design and drilling program
- Wellhead equipment
- Deepwater drilling

Safeguarding life, property and the environment

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SAFER, SMARTER, GREENER
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
Subsea BOP

Blowout.wmv