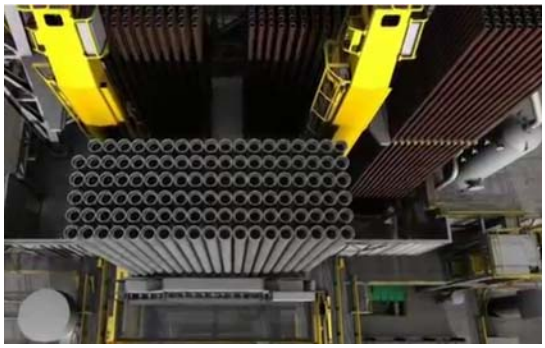
Offshore structures for oil and gas production

Prof. Milan Stanko (NTNU)

1

Components

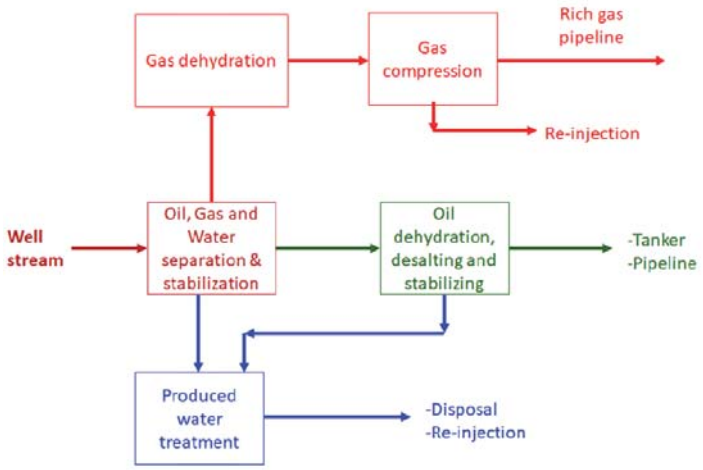
- Facilities for drilling and full intervention. This includes drilling tower, BOP, drilling floor, mud package, cementing pumps, storage deck for drill pipes and tubulars, drilling risers.



2

Components

- Facilities for light well intervention.
- Processing facilities: separator trains for primary oil, gas and water separation, gas processing train, water processing train.
- Gas injection system
- Gas compression units for pipeline transport
- Water injection system



3

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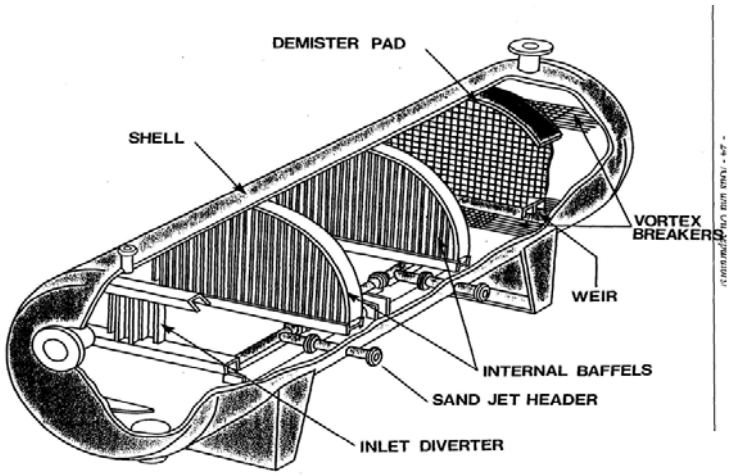

4

Components

- Living quarters
- Helideck.
- Power generation.
- Flare system.
- Utilities (hydraulic power fluid, compressed air, drinking water unit, air condition system, ventilation and heating system)

5

Components

- Bay for wellheads and X-mas trees
- Production manifolds
- Oil storage
- Facilities for oil offloading
- Control system
- Monitoring system
- System for storage, injection and recovery of production chemicals (wax, scale, hydrate or corrosion inhibitors)
- Repair workshop

6

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- Production manifolds
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- Control system
- Monitoring system
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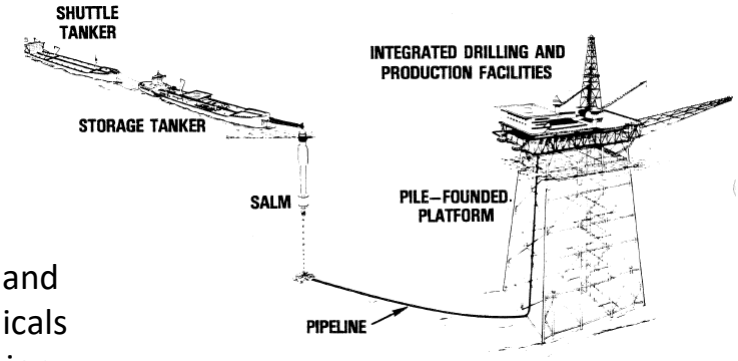

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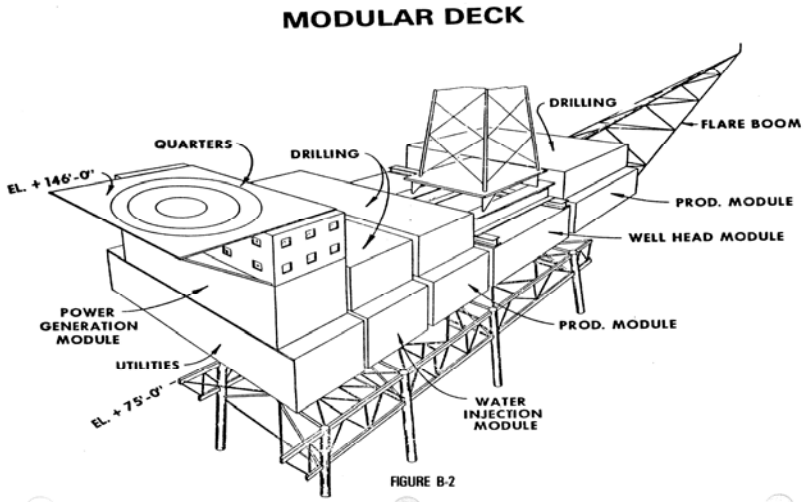
Components



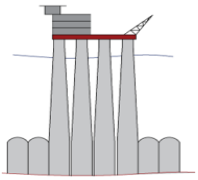
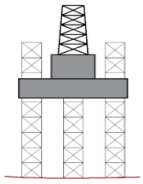
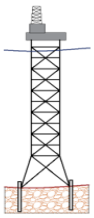
8

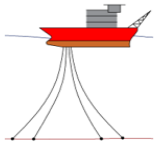
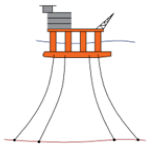
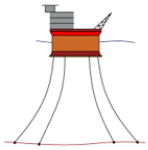
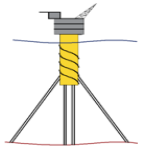
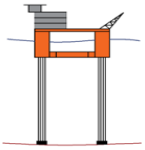
Components – can be spread

https://www.akerbp.com/produksjon/valhall/

9

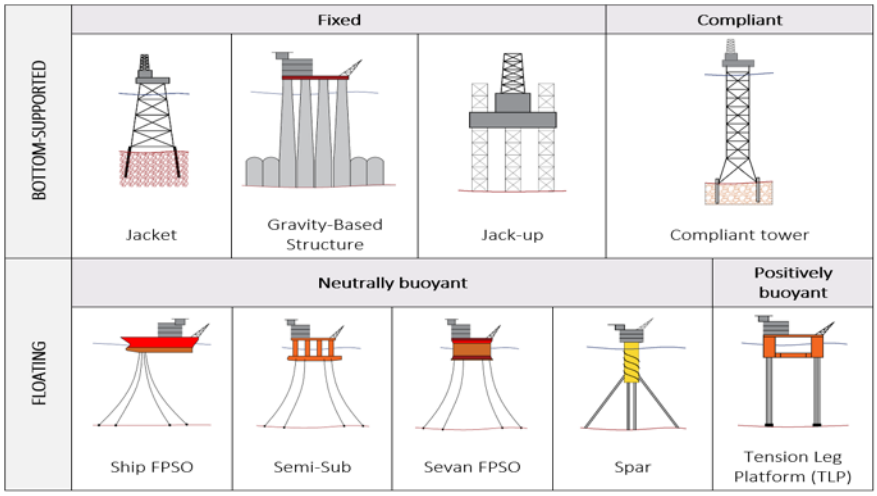
Types

	Fixed			Compliant
BOTTOM-SUPPORTED	 Jacket	 Gravity-Based Structure	 Jack-up	 Compliant tower

	Neutrally buoyant				Positively buoyant
FLOATING	 Ship FPSO	 Semi-Sub	 Sevan FPSO	 Spar	 Tension Leg Platform (TLP)

10

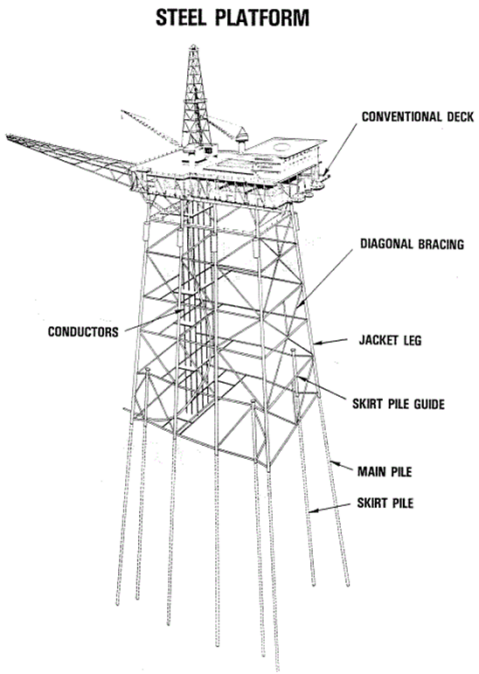
Types



- Have significant movement
- Are usually moored
- Buoyancy is controlled actively with ballast

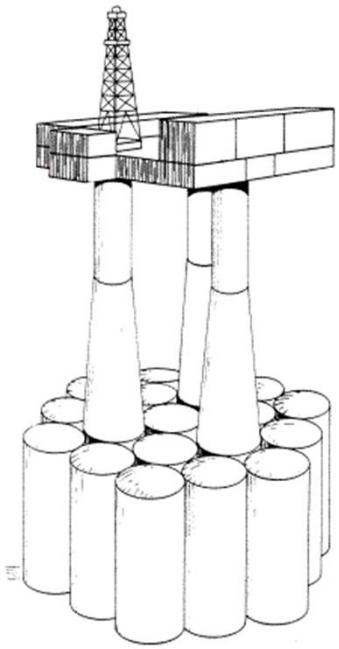
11

Jacket



12

GBS



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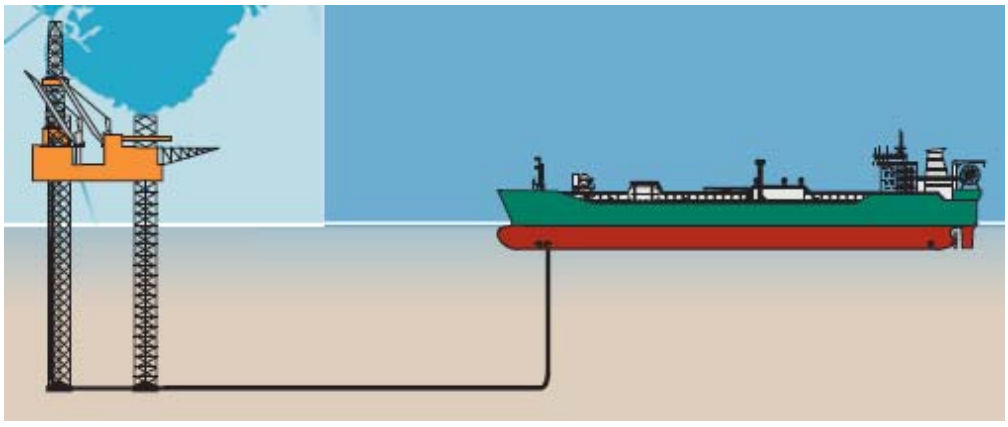
JACKUP



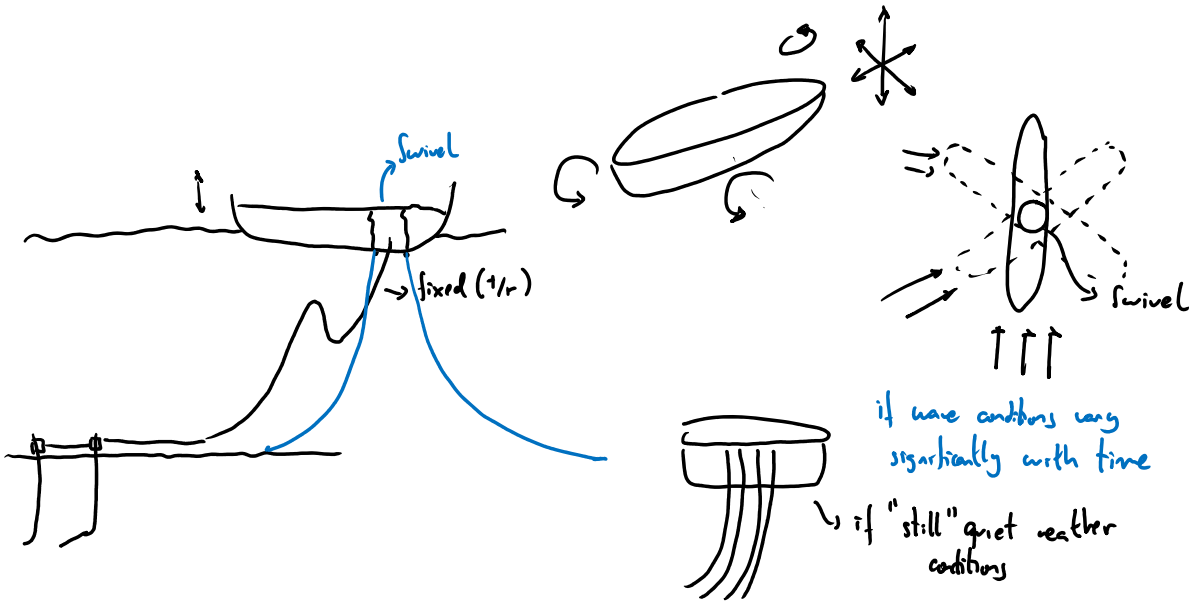
Taken from Volve PDO

14

FPSO

15

FPSO - Comment about swivel



16

FPSO - Swivel

https://www.youtube.com/watch?v=70XwYmmZFWs

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FPSO - Swivel

https://www.youtube.com/watch?v=Sfjay0Rt3hU

https://www.youtube.com/watch?v=cCiUggjUhY0

18

FPSO - Swivel

Swivel might be bottlenecked

https://www.youtube.com/watch?v=HbJh1ar0u1s

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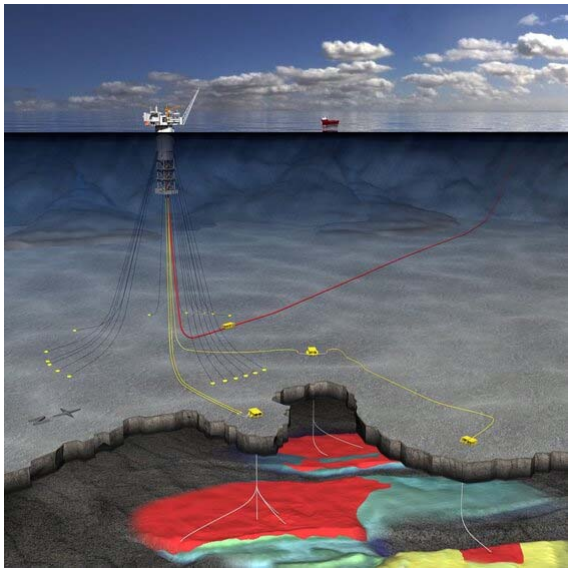
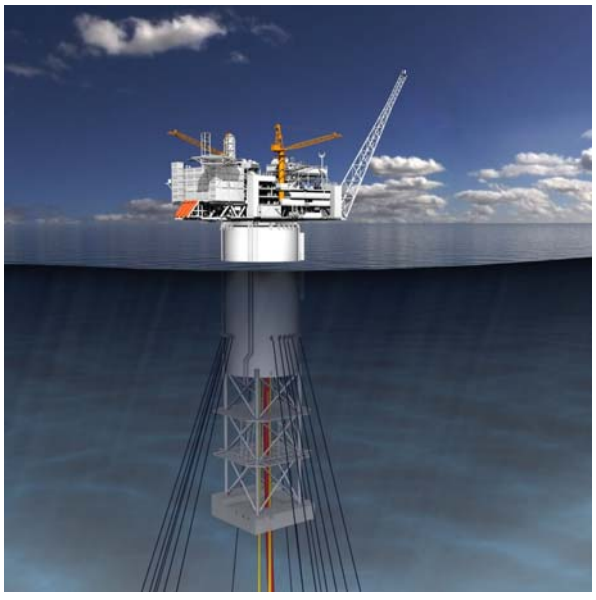
SPAR



https://www.tu.no/artikler/industri-kvaerner-sikrer-enda-et-aasta-hansteen-oppdrag/225940



https://www.tu.no/artikler/industri-kvaerner-sikrer-enda-et-aasta-hansteen-oppdrag/225940

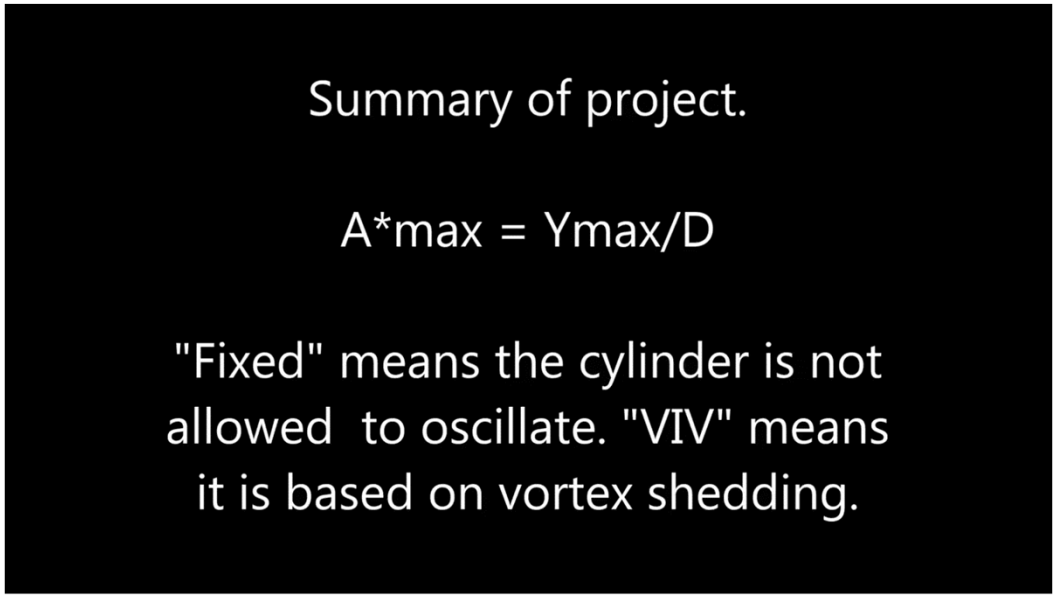
20

SPAR – Vortex induced vibrations

https://www.youtube.com/watch?v=_Hbbkd2d3H8&feature=youtu.be

21

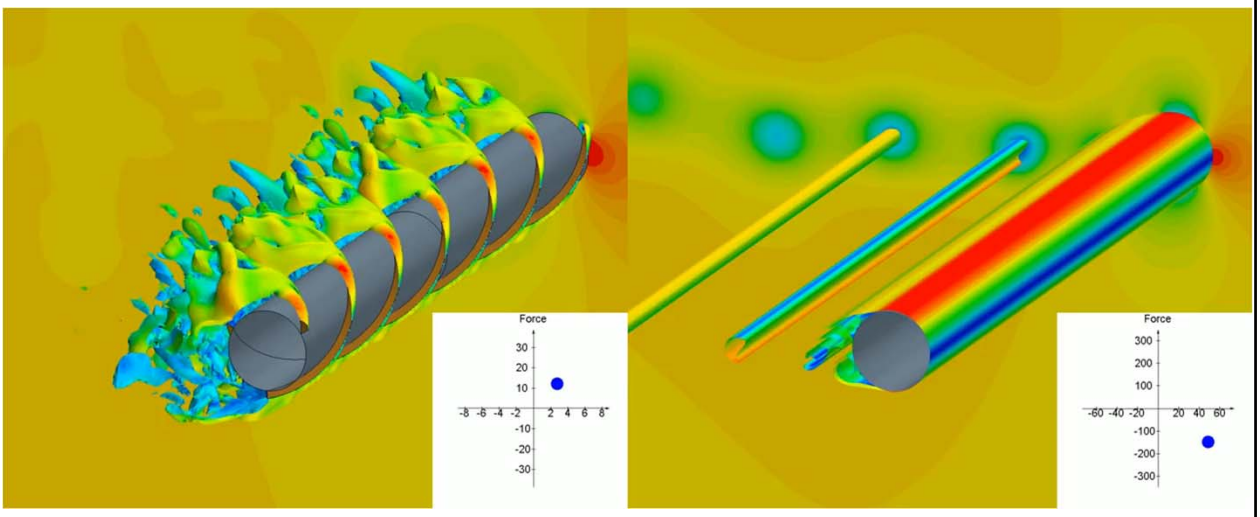
SPAR – Vortex induced vibrations



https://www.youtube.com/watch?v=24tBX_UD3fM

22

SPAR – Effect of helical strakes



https://www.youtube.com/watch?v=W-zXwPT2r14

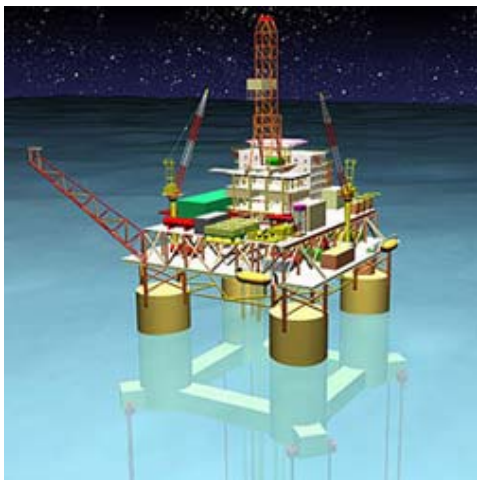
23

SEVAN FPSO

https://www.upstreamonline.com/epaper/sevan-fpso-selected-for-bream/1-1-1160389

24

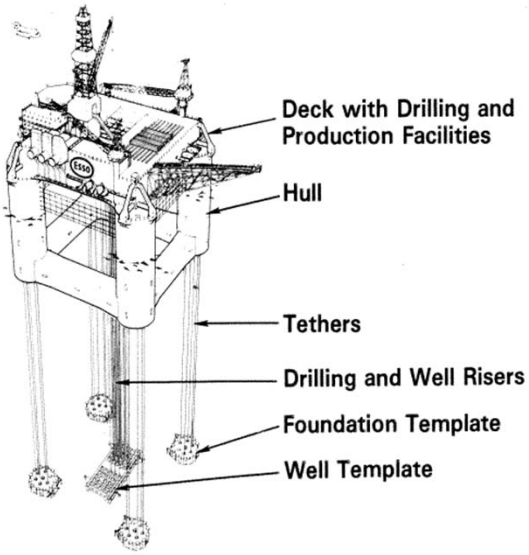
Tension leg platform



https://www.rigzone.com/training/insight.asp?insight_id=305&c_id=

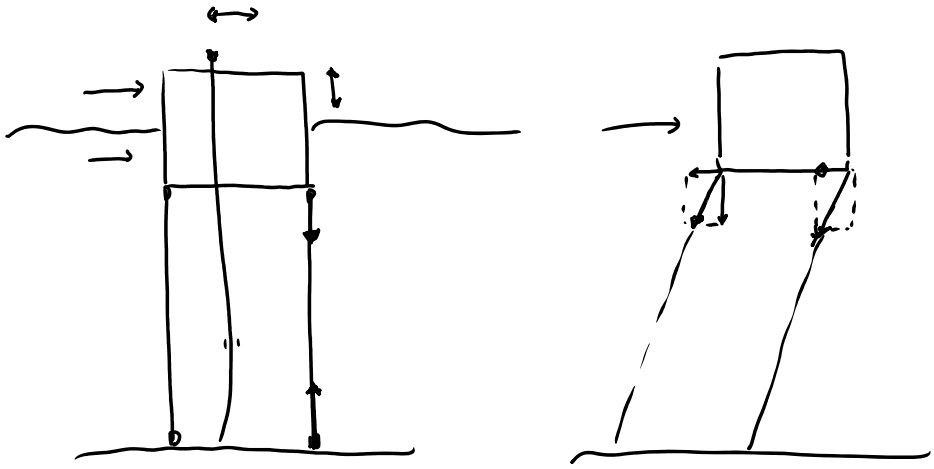
25

Tension leg platform



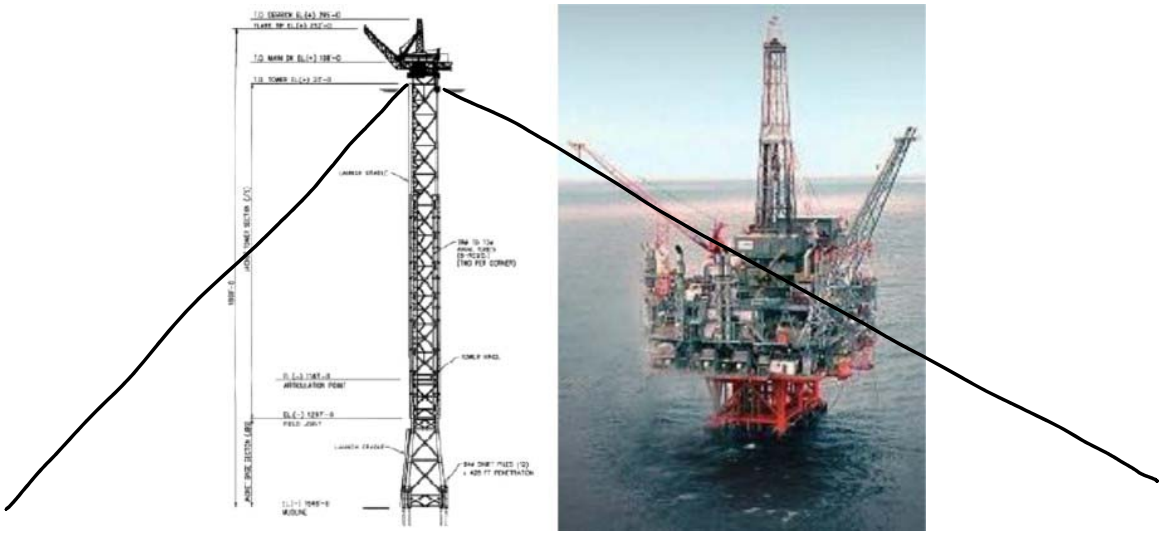
26

Comment about Tension leg platform



27

Compliant tower



https://www.sciencedirect.com/science/article/pii/S0951833914000148

28

Semi-Sub

https://www.oedigital.com/news/453987-jack-st-malo-flows-for-chevron

https://www.bairdmaritime.com/work-boat-world/offshore-world/offshore-extraction-and-processing/offshore-drilling/awilco-orders-second-semi-submersible-drilling-rig-from-keppel-fels/

29

Some selection criteria for offshore structures

- Water depth
- Type of X-mas tree
  - Well intervention needs
    - Tubing replacement
    - Completion modifications
    - Artificial lift (ESP)
  - Infill drilling needs
  - Reservoir spread and structure
- Need for oil/condensate storage
- Marine loads Oceanographic environment
  - Wind, waves, current

30

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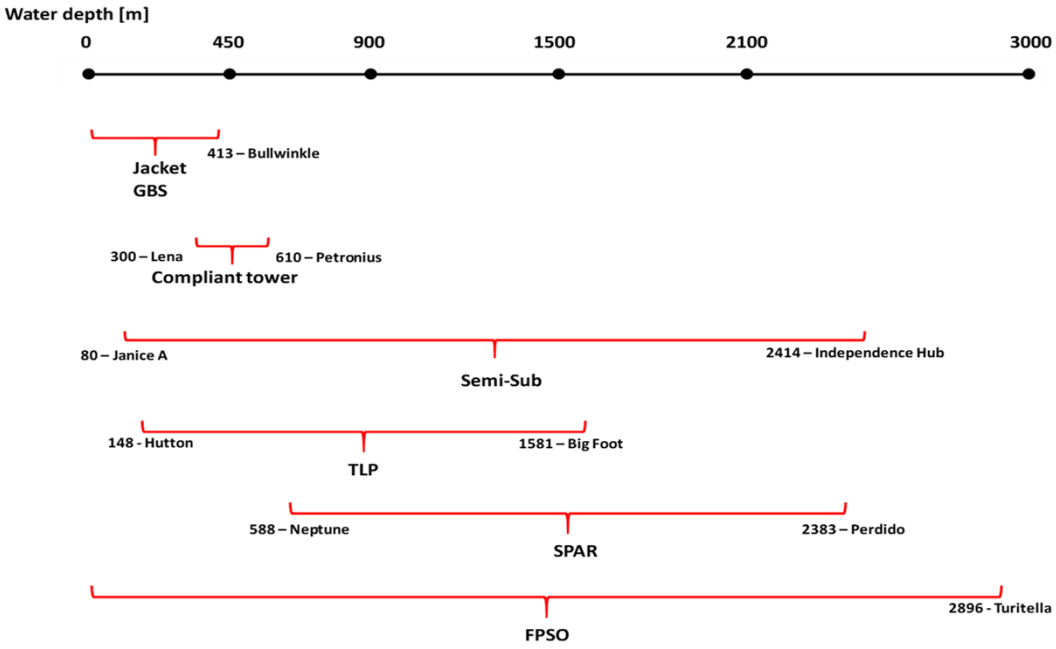
31

Water depth



32

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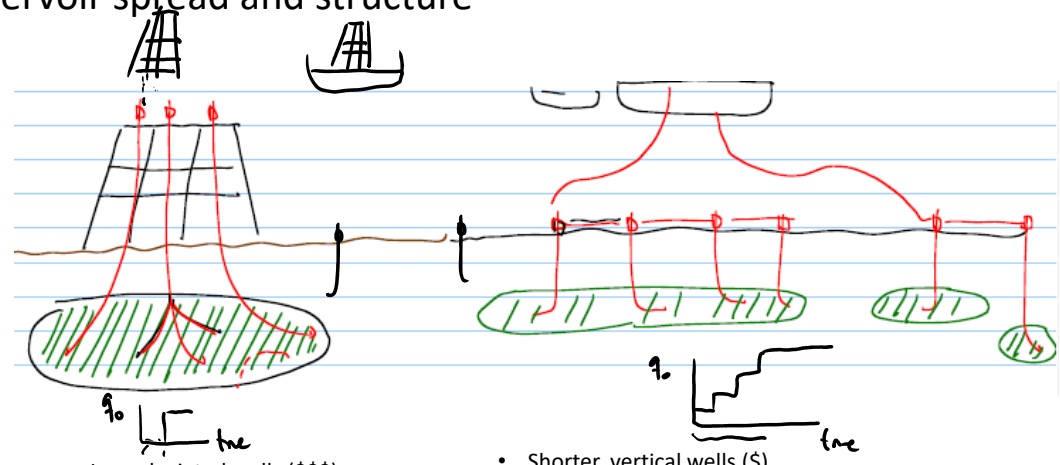
33

Reservoir spread and structure

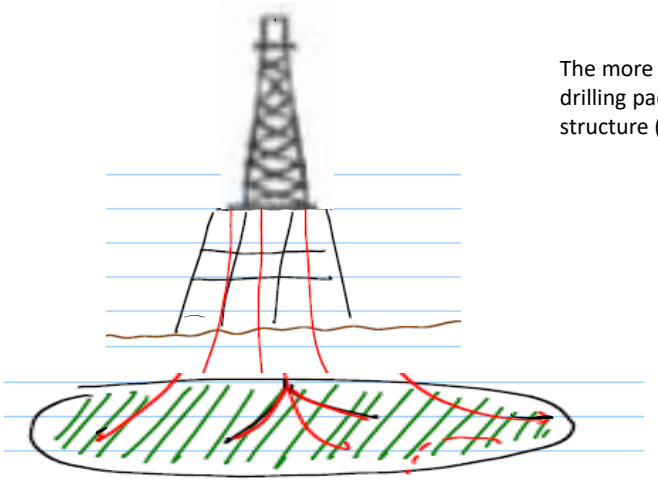


- Long deviated wells ($$$)
- Wells are drilled from one location, no need to spend mobilization time ($$)
- Production startup must be delayed until all wells are drilled

- Shorter, vertical wells ($)
- The drilling rig must be mobilized often which costs money ($$$)
- Production can start in ramp up mode (if topside is in place)

34

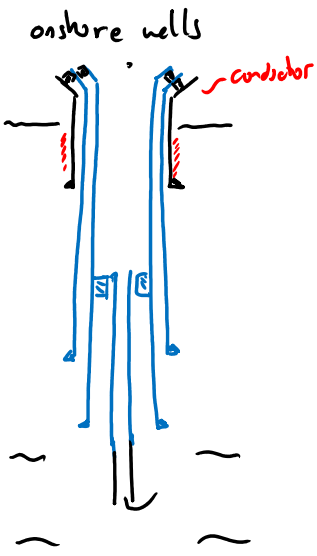
Reservoir spread and structure



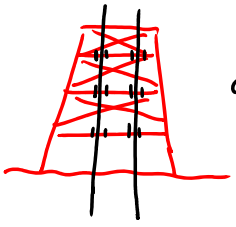
The more spread - requires a bigger and more costly drilling package – more weight on the structure, bigger structure ($$$)

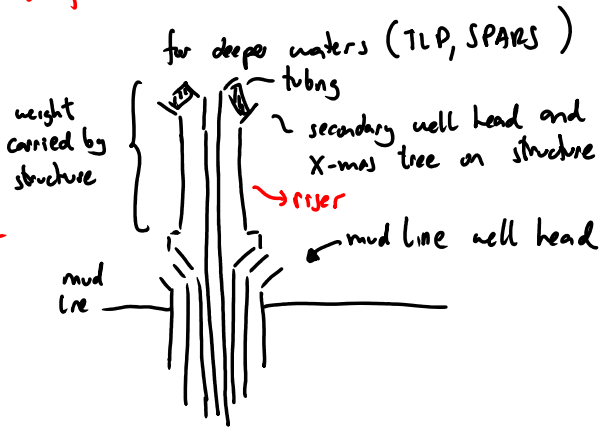
35

Transfer of well weight to soil and to offshore structure



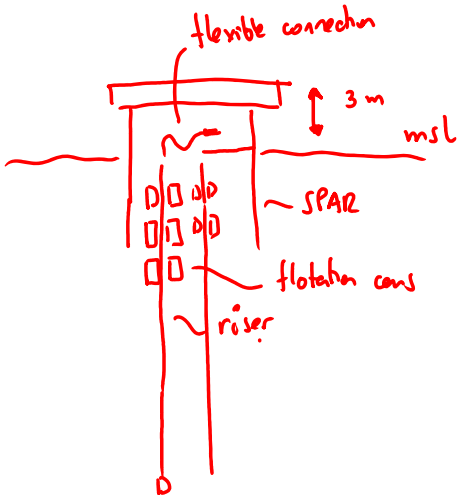
for platform wells and for shallow water depth wells are drilled just like onshore





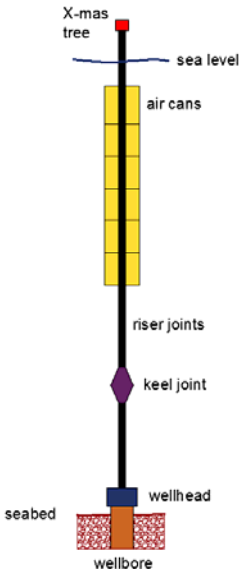
36

Transfer of well weight to soil and to offshore structure



37

Support system for dry X-mas trees – deep water



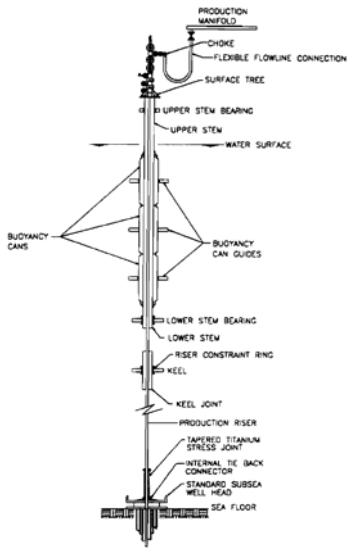


Figure 6 - Well System

OTC 8382

Neptune Project: Spar History and Design Considerations
R.S. Glanville, J.E. Halkyard, R.L. Davies, A. Steen, F. Fimm, Deep Oil Technology, Inc.

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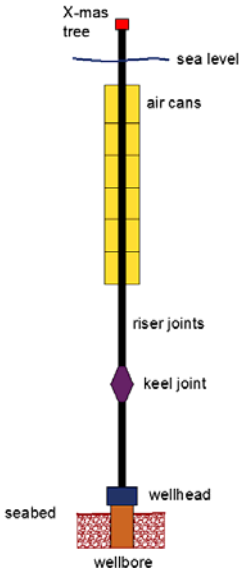
Support system for dry X-mas trees – deep water



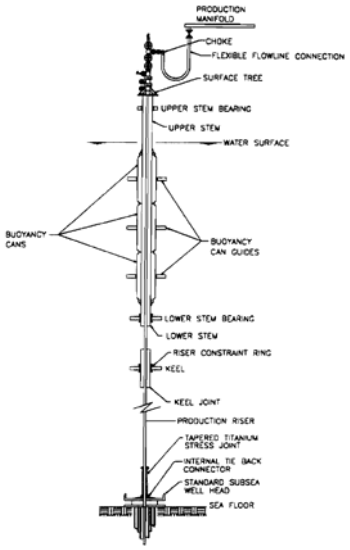


Figure 6 - Well System

OTC 8382

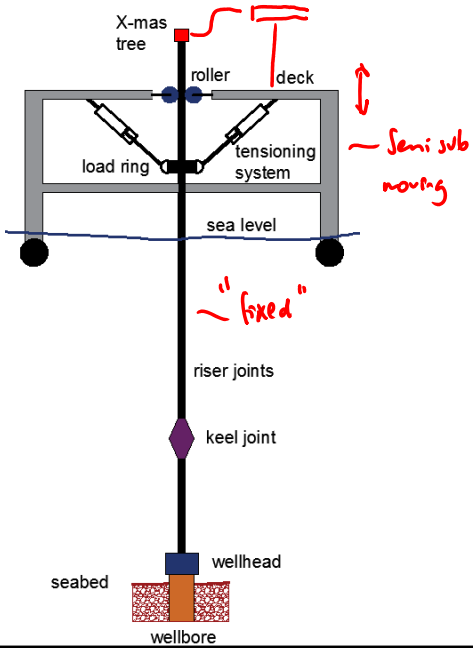
Neptune Project: Spar History and Design Considerations

R.S. Glanville, J.E. Halkyard, R.L. Davies, A. Green, F. Fenn, Deep Oil Technology, Inc.

Real State on offshore structure is critical, not more slots than what is needed!

39

Support system for dry X-mas trees – deep water



40

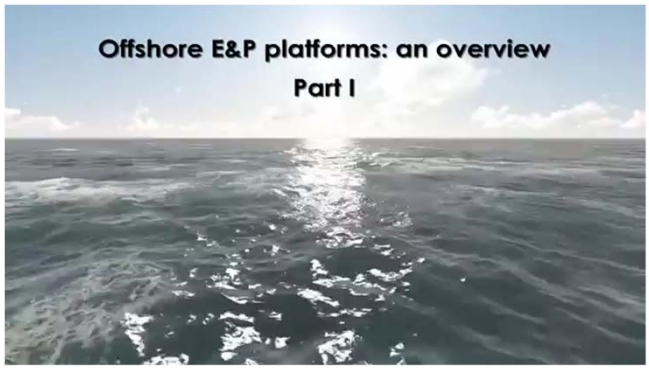
Some selection criteria for offshore structures

- Water depth
- **Type of X-mas tree**
  - Well intervention needs
    - Tubing replacement
    - Completion modifications
    - Artificial lift (ESP)
  - Infill drilling needs
  - Reservoir spread and structure
- Need for oil/condensate storage
- Marine loads – Oceanographic environment
  - Wind, waves, current

Only floating structures SPAR, TLPs and Semi-subs have "small" movement ranges suitable for dry X-mas trees

41

Possibility for jackets without drilling package



https://www.youtube.com/watch?v=-vJmAvqn6dU

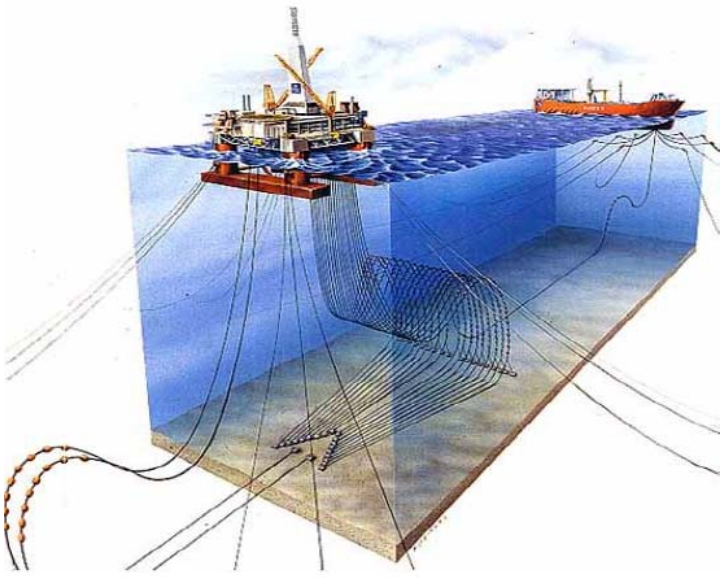
42

Possibility for jackets without drilling package

https://www.offshoreenergytoday.com/offshore-safety-watchdog-to-investigate-maersk-invincible-incident/

43

Njord: subsea wells with well intervention possibility



44

Layout of subsea systems – template wells

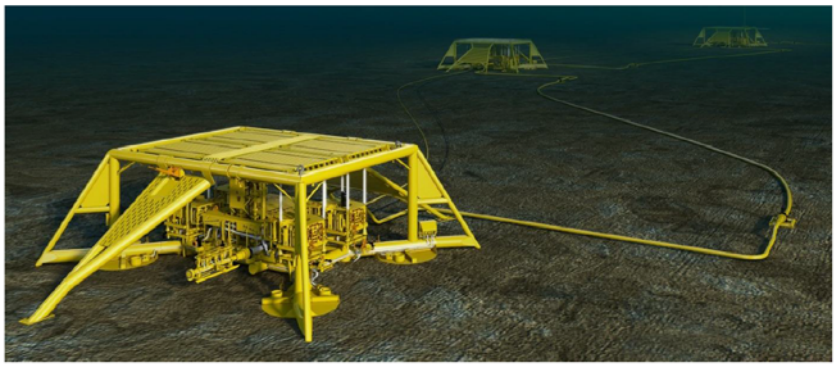
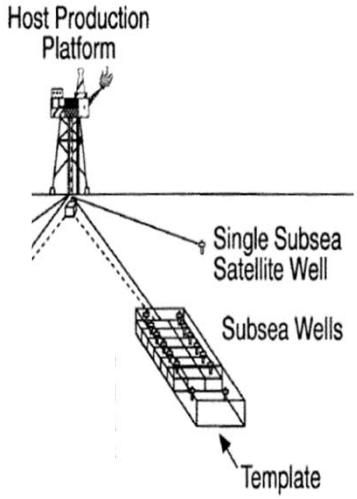


Figure 3.3 Typical NCS tie-back solution (Image: Statoil ASA)

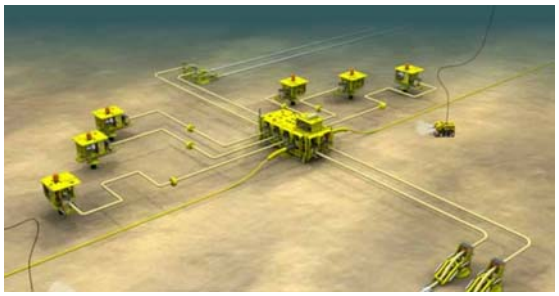
45

Layout of subsea systems – template wells



46

Satellite wells



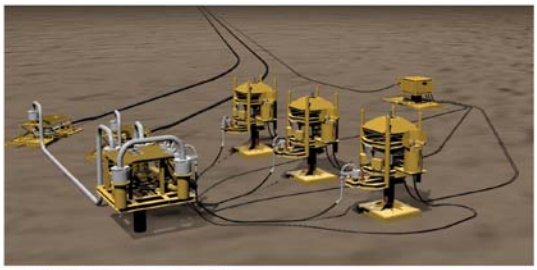


Figure 3.4 Typical GOM subsea tie-back

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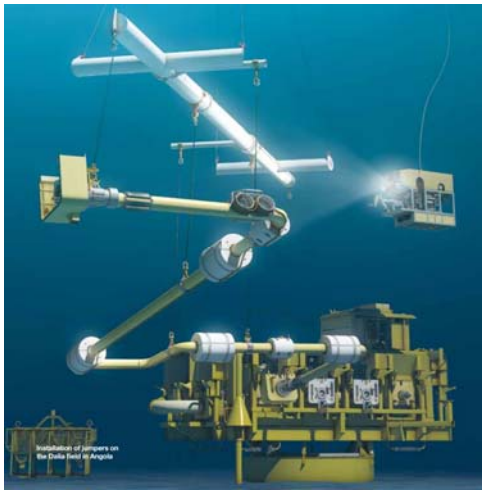
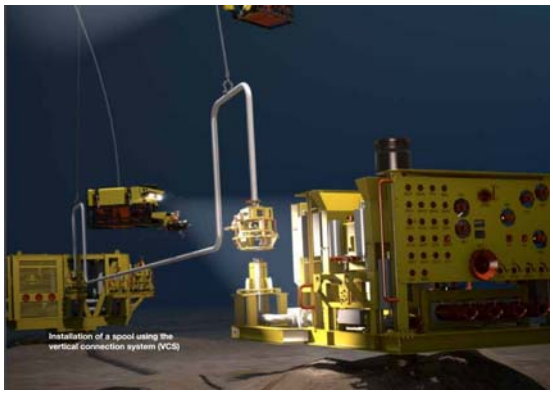
Jumpers for satellite wells (if close)





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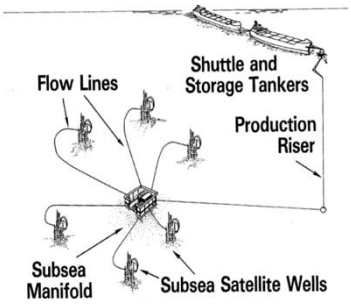
Template wells vs satellite wells – similar dilemma to dry versus wet X-mas tree

Figure 3.3 Typical NCS tie-back solution (Image: Statoil ASA)



- Long deviated wells
- Wells are drilled from one location, no need to spend rig mobilization time
- Less subsea equipment

- Shorter, vertical wells
- The drilling rig must be mobilized often which costs money
- More flowlines, pipelines. Manifolds are required

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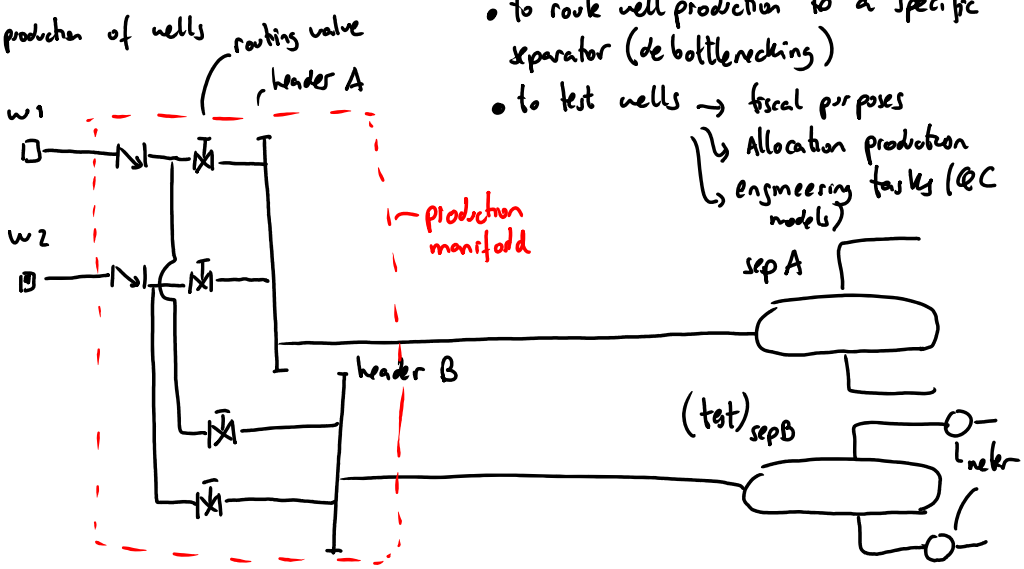
The production manifold

- commingle the production of wells



- to route well production to a specific separator (debottlenecking)
- to test wells → fiscal purposes
  - ↳ Allocation production
  - ↳ engineering tasks (@C models)

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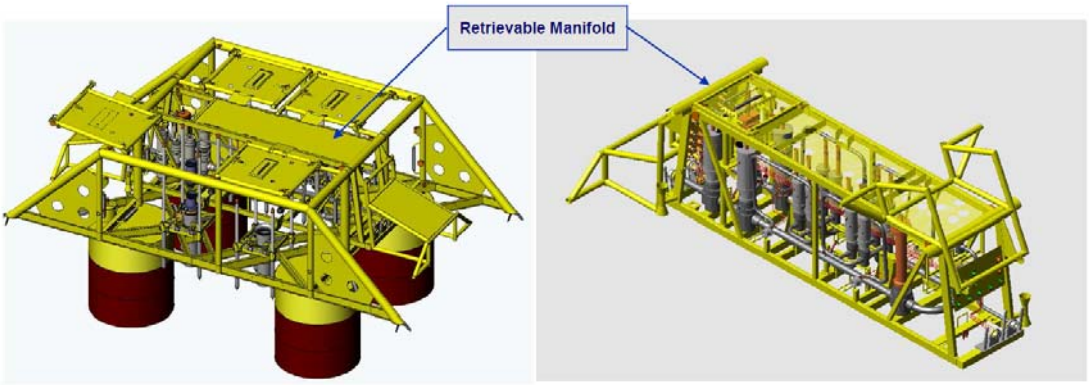
4 well template – the production manifold



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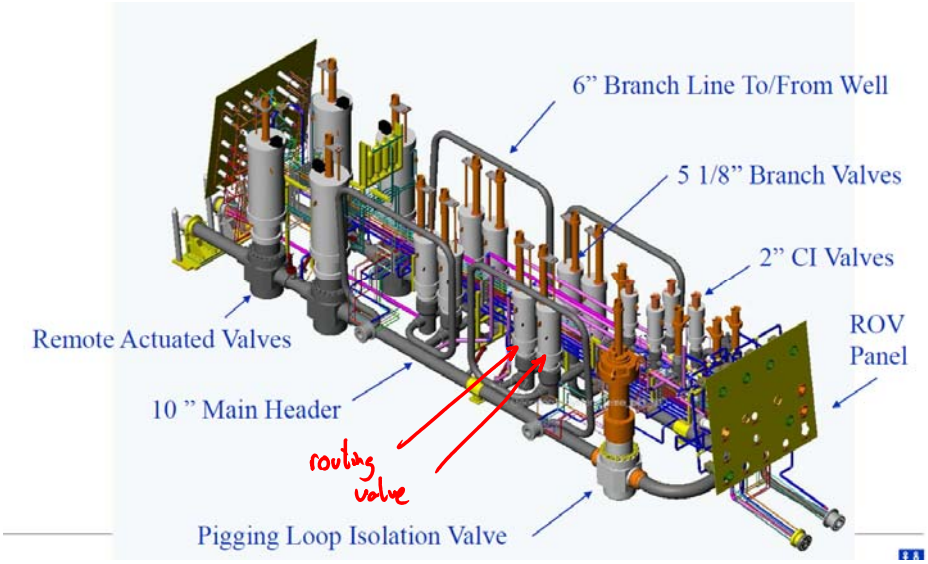
The manifold



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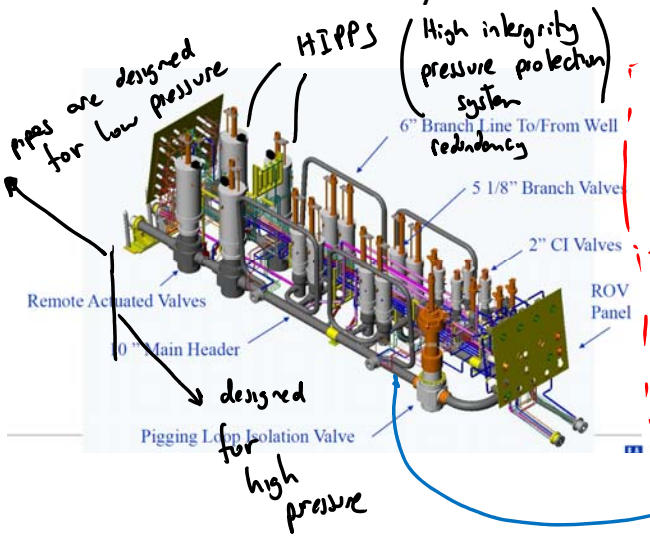
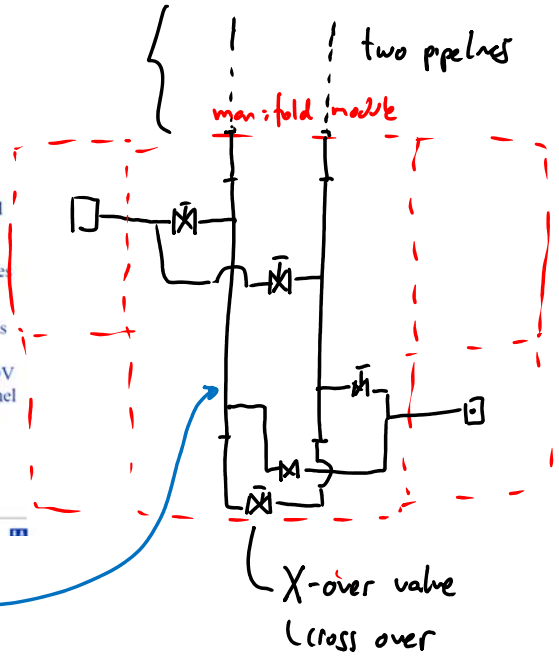
The manifold – reality vs sketch





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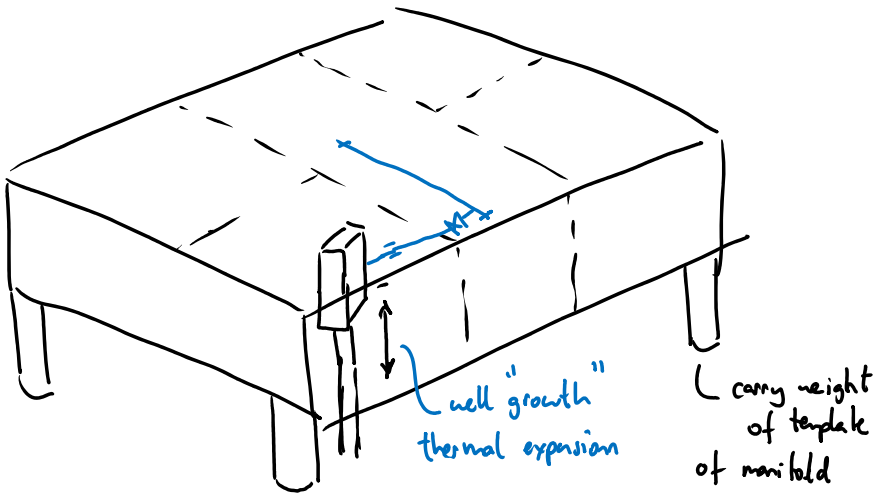
4 well template – weight transfer



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