



Johan Sverdrup – 4 man bell-run during Johan Sverdrup phase 1

The Bergen International Diving Seminar 14th November 2019

Jan Henrik Hatlestad. Equinor.

Tie-ins and construction

- Agenda
- General Scope of Work
- Divers Scope 30 tie-ins ++
- 4 men bell run

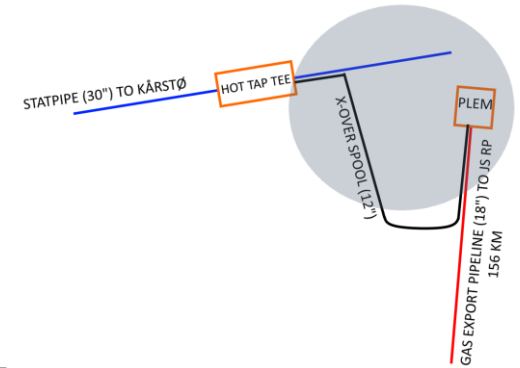
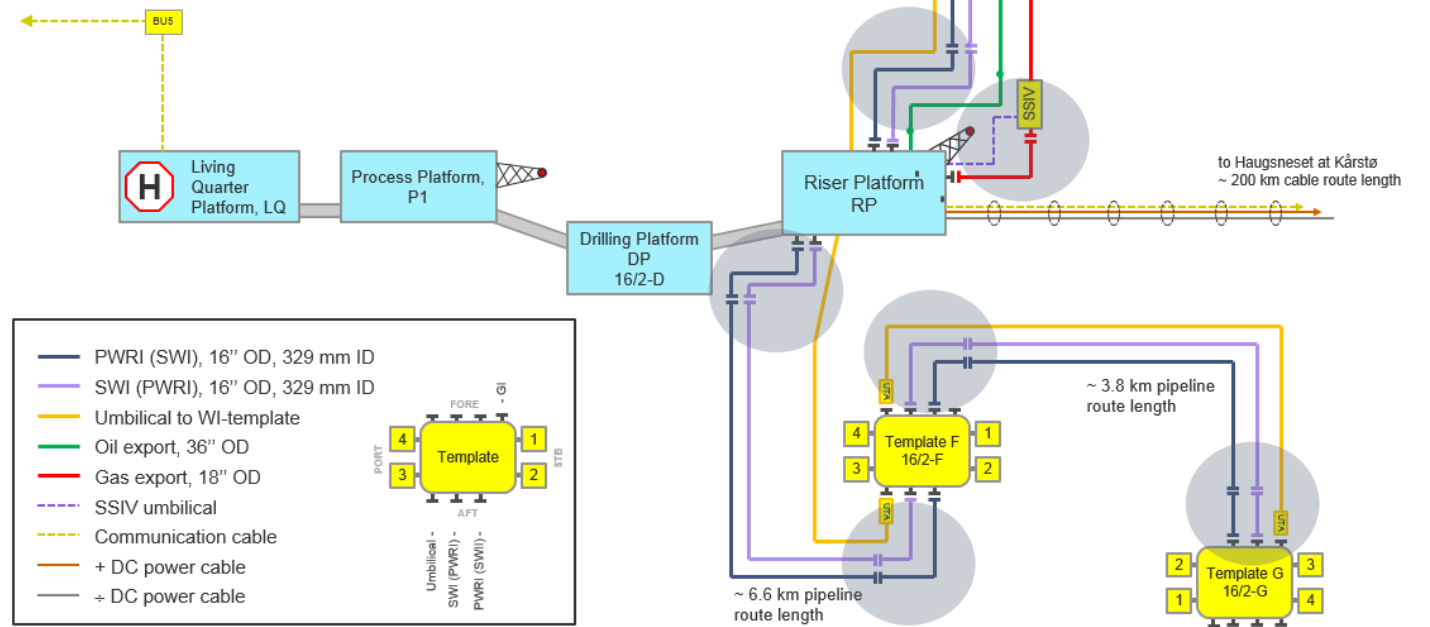
Manhours in Saturation : 13000
Manhours in water : 1000



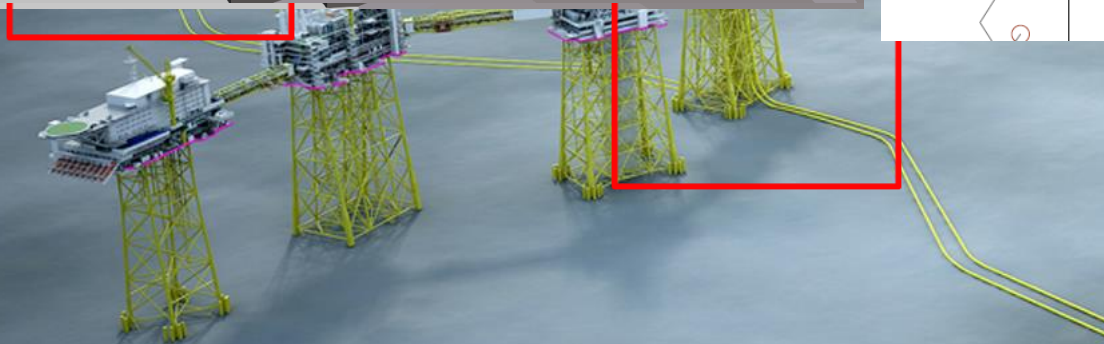
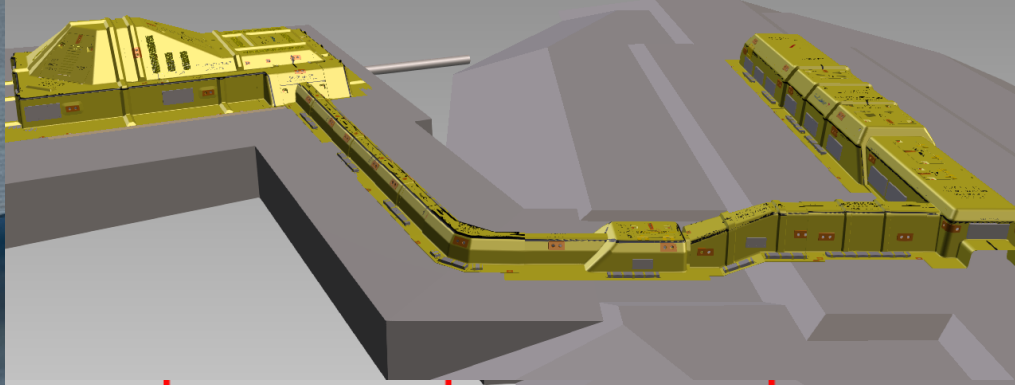
Johan Sverdrup Field Schematic Development Phase 1

23th October 2016, ver. 1.4

to Edvard Grieg
~ 17.7 km cable route length

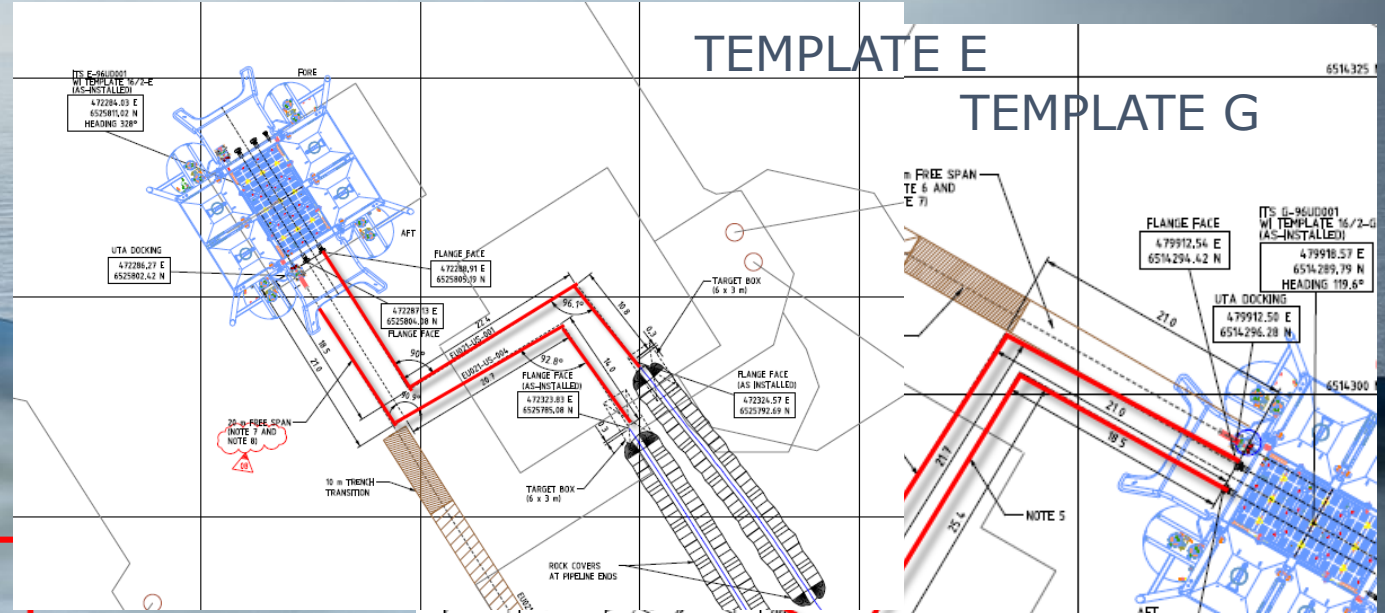


HOT TAP

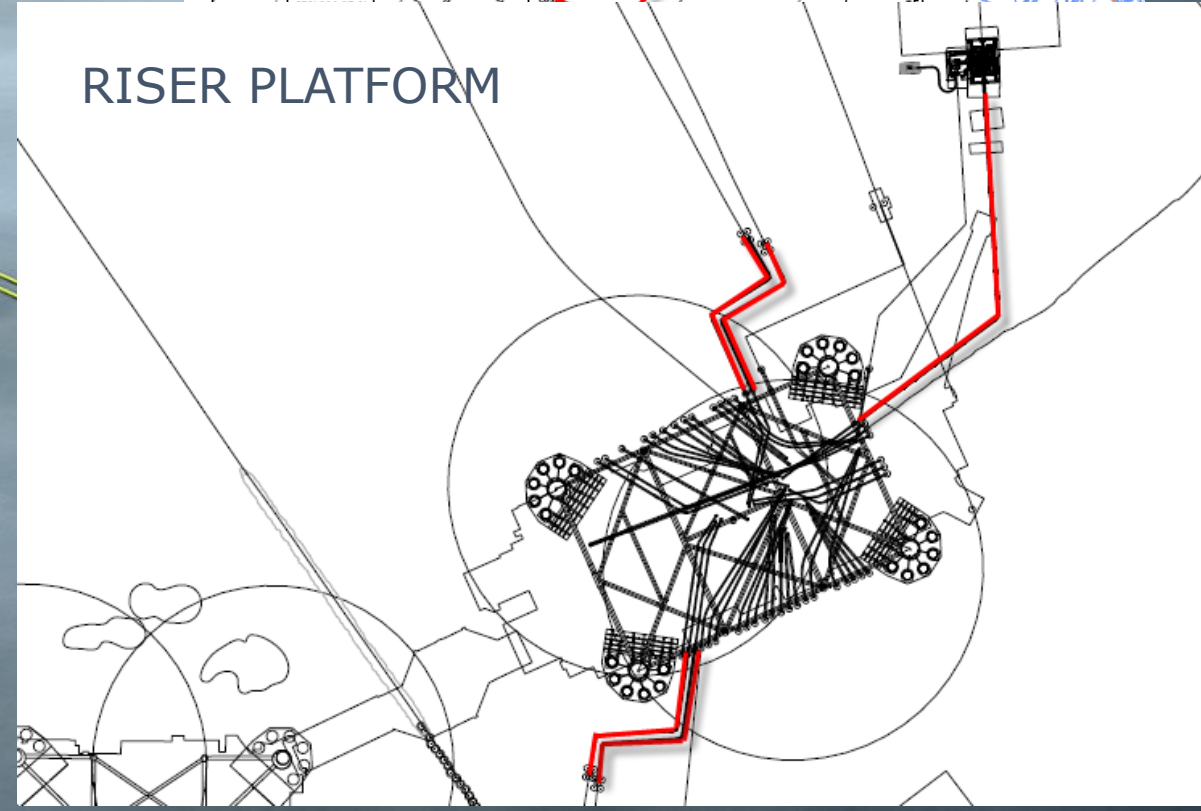


TEMPLATE E

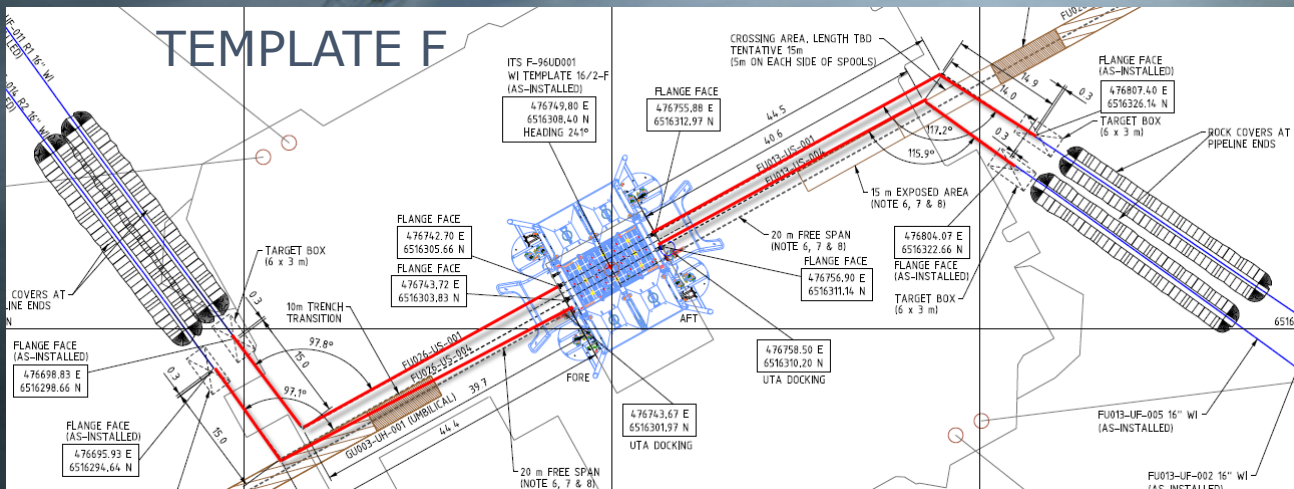
TEMPLATE G



RISER PLATFORM

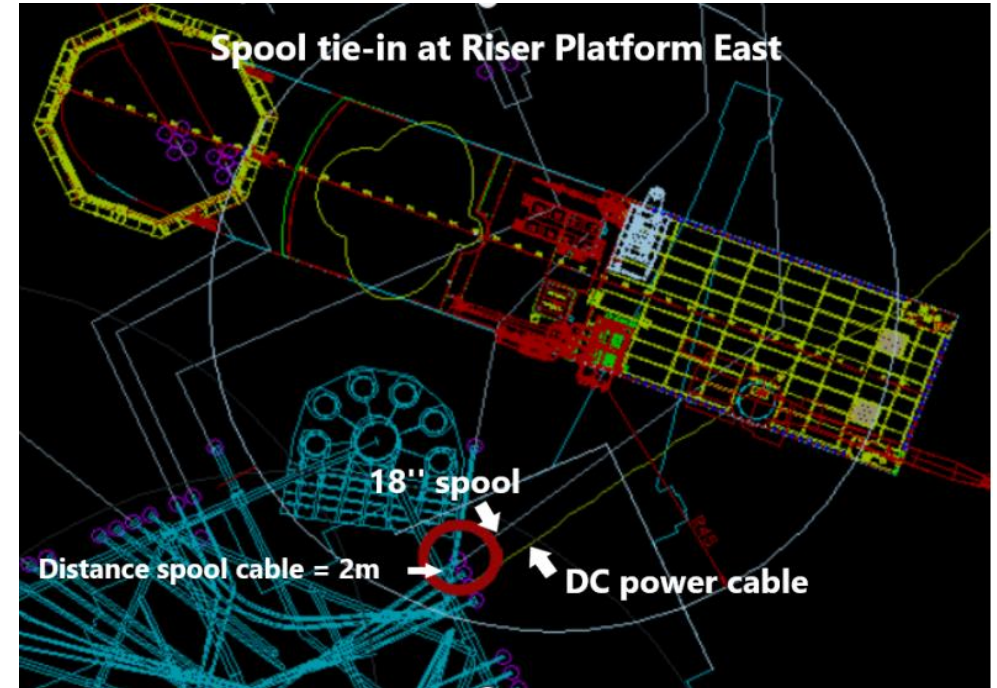


TEMPLATE F

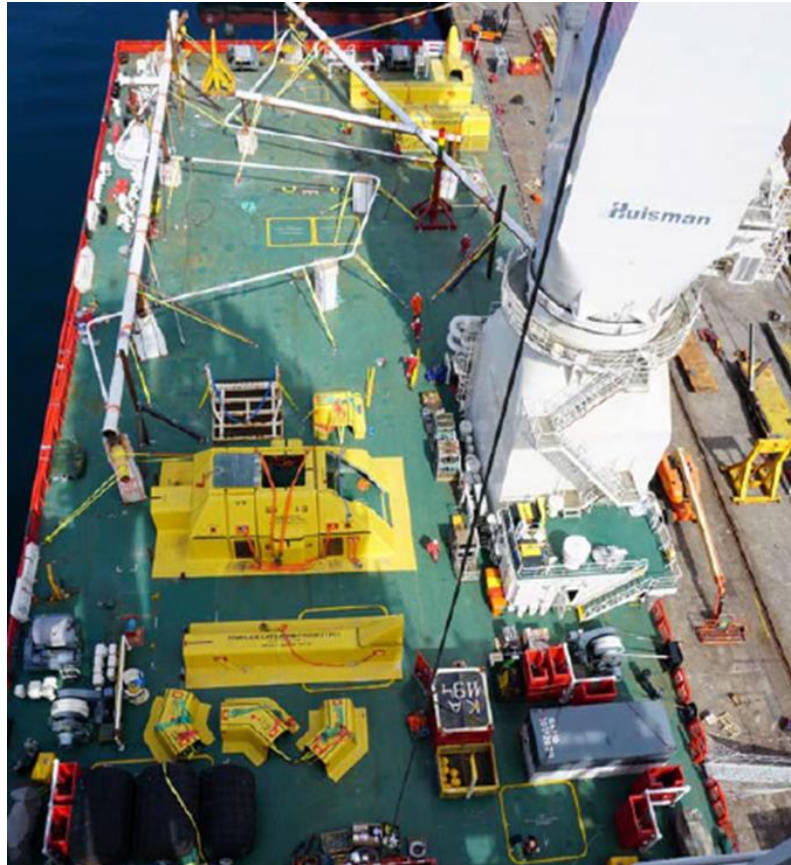


Electrical DC Cable – Challenge/Experience

- Challenges due to non compliance to IMCA requirements regarding safe distance to divers during tie on JS RP East.
- PSA was questioning the fact Equinor was compromising IMCA Safety Distance for Divers.
- Risk was requirement to turn off power supply to Johan Sverdrup Field during tie-in of 18" spool at RP East side

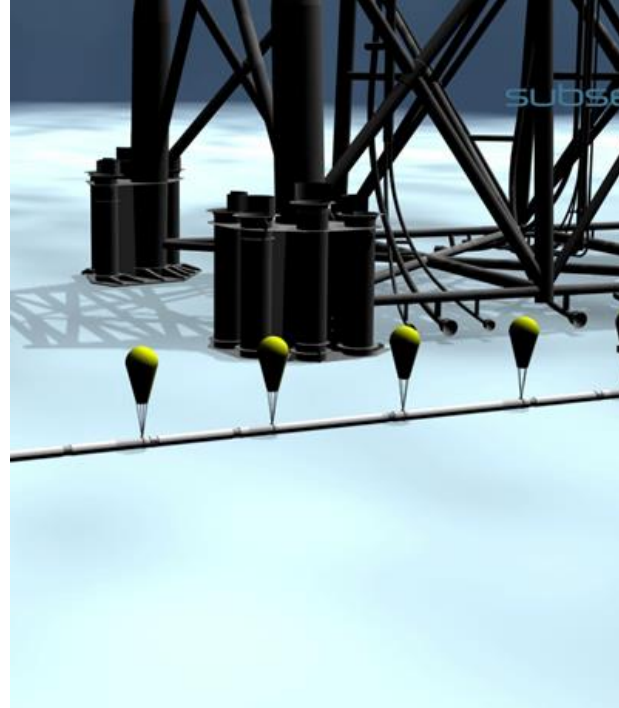
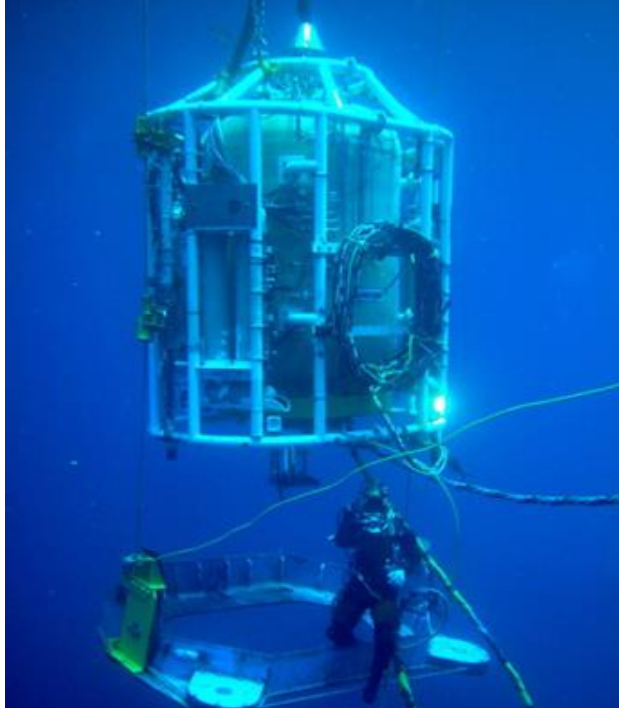
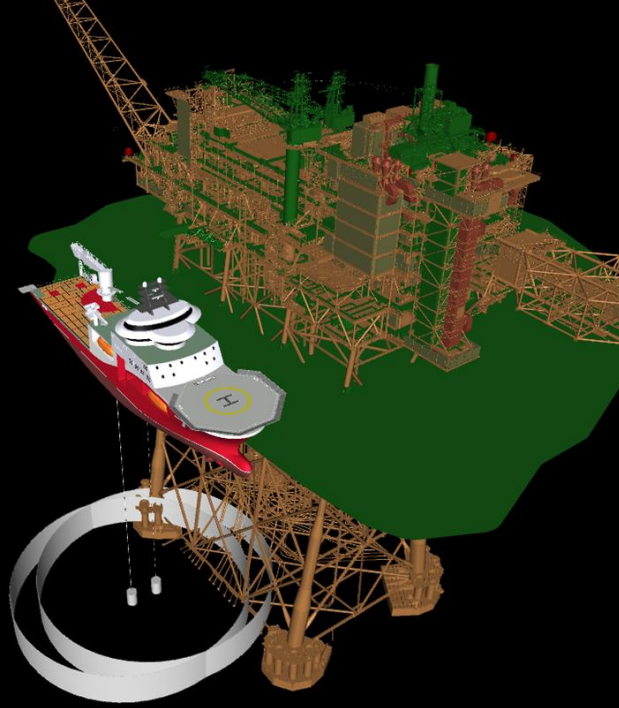


- By support of «DNV-GL Probability Study Report», Equinor could document Divers Safety not was compromised regarding operation closer to DC powercable than accepted by IMCA D-045 as safe distance for divers.
- HRR rate of 0,4 used as documented value for probability of failure
- As comparison to FAR value to flight transport, which is 15,1
- An IMCA Specific Risk Assessment concluded tie-in of 18" spool was feasible and safe by use of divers.



Good teams on- and offshore to prepare and carry out the work.
One dedicated vessel for wet parking.
Stored as close as possible to work location

Wet parking by Seven Arctic

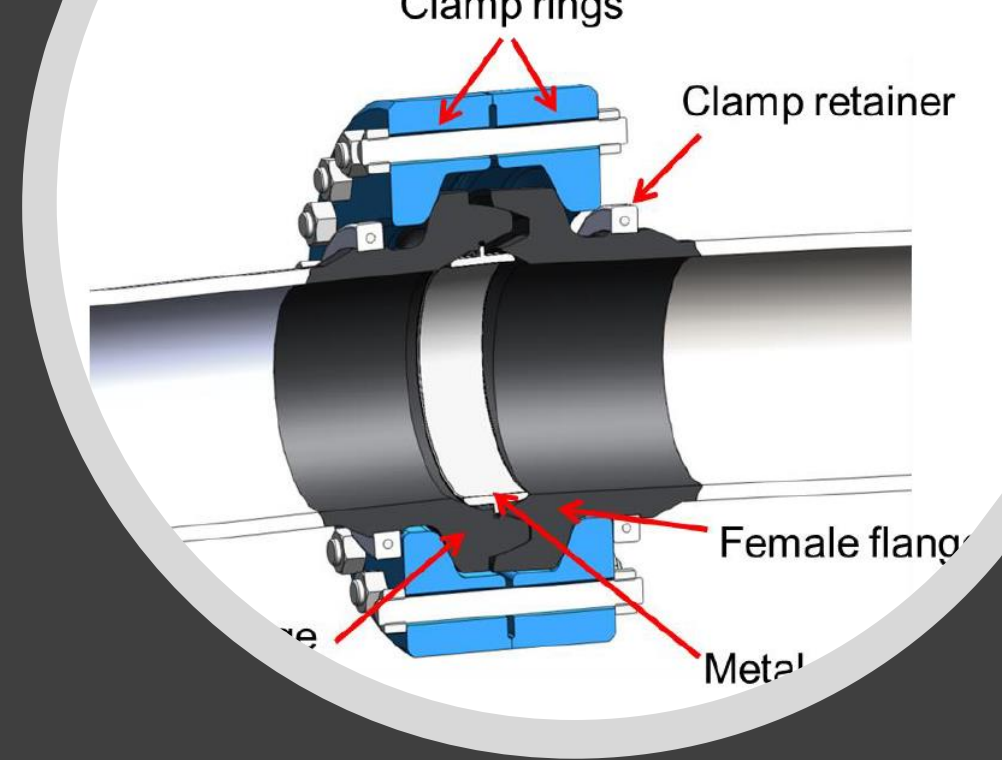


Typical diving work

- Diving bell constantly submerged and at working depth.
- Divers restricted to 45 m umbilical from the bell.
- Frequent work with Air Lift Bags → Air dump to surface.
- Several downlines to site w/hydraulics, air, MEG.

SeAlign spool flanges

- First time used in subsea operations for Equinor, 12 to 18inch. (One remote installed at Bauge)
- Some skepticism in the beginning, but good feedback from divers and supervisors after use.
- Testing/training onshore/offshore before subsea work.
- New tool for bolt tensioning. Significant improvement of efficiency.



Hydra 8100 tool and tension jacks

- Tool developed by kNm / AtlasCopco / Fastlane with support from Equinor and Subsea 7, started autumn 2018 via Equinor.
- New precise continuous rotating hydraulic torque tool developed for use for torquing SeAlign flanges.
- Several tests and verifications on actual SeAlign flanges during winter/spring 2019.
- Hydra tool put to the test during Johan Sverdrup Tie-in Campaign on Seven Falcon (April-May 2019).
- SubseaDesign is the supplier of the SeAlign flanges and was involved in all stages in the testing and lending out test jig and did calculations during the testing.

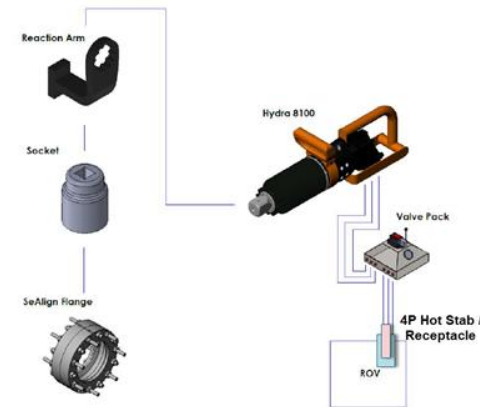
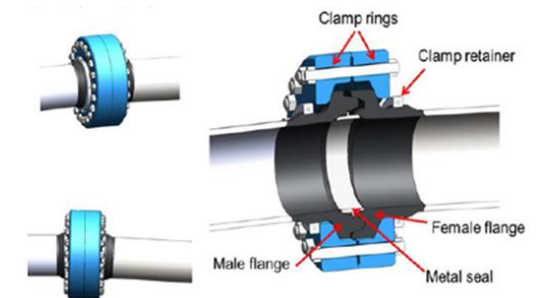


Figure 3

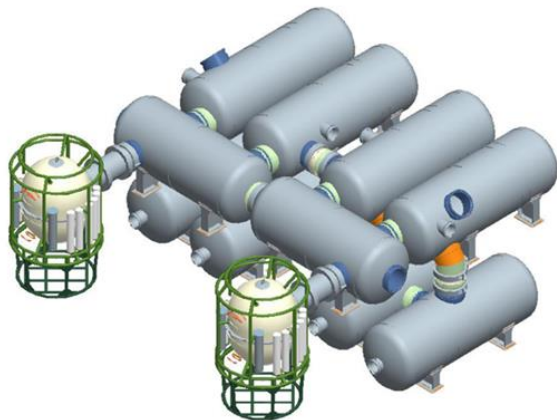




4 men bellrun - DSV Seven Falcon

Meeting with PSA upfront for operation

- PSA had question regarding diving close to Electrical DC Cable
- PSA had questions regarding lifting operations and qualifications for all involved (including the divers)
- PSA asked for status of Divers Emergency Gas System (bail-out)



Mitigations for challenges - 4 man bell-run

- **Vessel is designed for 4 man bell-run**
- **Offset trunking and large bottom door**
- **Individual colour coding of umbilicals**
- **Emergency Diver recovery exercise to be performed by each team.**
- **Communication protocol established,**
- **Gas and Hot Water supply independence**
- **2 divers working 5 hrs 30 min and 1 diver 4 hours, give 2 divers in water all time, hence increased back up at scene.**
- **Additional diver is available to assist the bellman while recovering umbilical to the guide weight and bell as required.**
- **Awareness of additional monitoring requirements for diver three.**
- **Plan for this project to run 2 shifts with 3 man and 2 shifts with 4 man bell-run.**

4 man bell-run. Technical and Operational challenges.

- Gas supply to divers
- Hot water supply to divers
- Communication to one extra diver
- Additional monitoring



Umbilical handling

Return to bell in an emergency

Communication with one extra diver

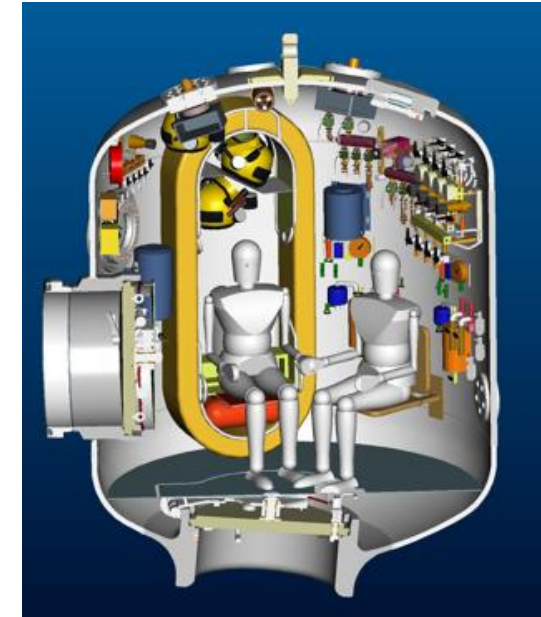
Increased manual handling for bellman

Human factor – Variation from normal 3 man bell-run

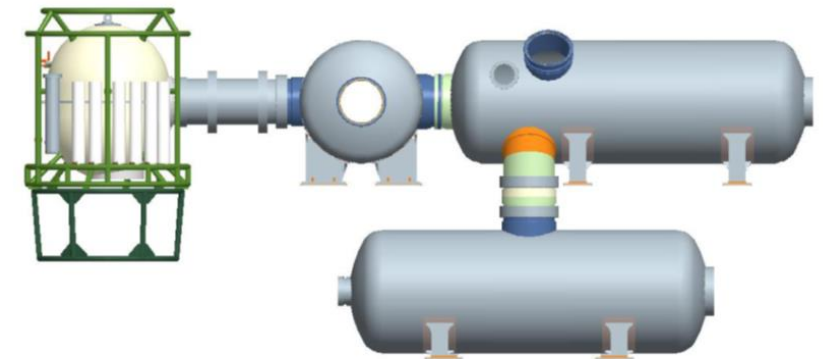
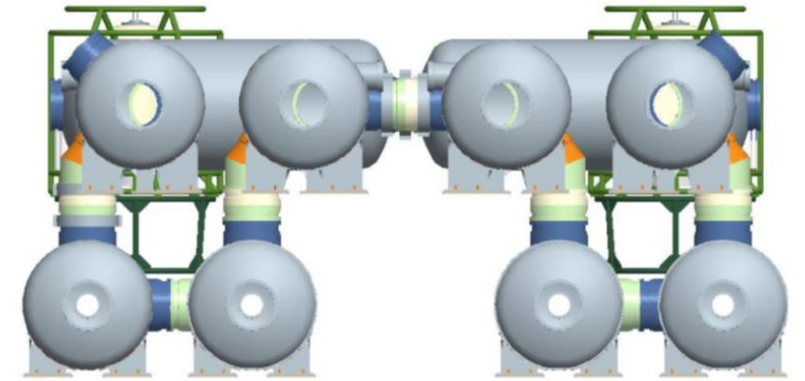
In water time and drinking breaks. – ref Norsok regulations.

Lessons learned - 4 man bell-run

- Increased man hours in water with neglectable extra cost
- Always at least 2 divers in water also during drinking brakes
- 3rd diver can bring tools and perform tidy up work with minimum need for communication.
- Suitable for training of unexperienced divers without loss of efficiency
- 3. diver returned to bell earlier to assist bellman for divers recovery for increased efficiency of bell turnaround – change of teams.
- Some operations like PRS power tool handling, diving inside structures requires 2 divers at site. Such work can continue also during the required drinking brakes.



- At Johan Sverdrup phase 1 each second bell-run was with 4 divers. The limitation is beds in sleeping chambers.
- For Johan Sverdrup phase 2 the number of beds in each sleeping chamber will be increased from 6 to 8. Water depth close of 150 meters will allow 2 bells 4 divers with handover at work site.
- 4 man bell-run with efficiency increased is strongly recommended for JS phase 2 with many vessel days and double Diver's Scope compare to phase 1.



- single bell, 2 man bell runs:
1diver outx3bell run/dayx6hrs per bell run
18hrs bottom time per day
- single bell, 3 man bell runs:
2diver outx3bell run/dayx6hrs
36hrs bottom time per day
- twin bell, 3 man bell runs
2diver outx4x6hrs
48hrs bottom time per day
- twin bell, 4 man bell runs
3diver outx4x6
72hrs bottom time per day



Johan Sverdrup phase 2

Example on SIMOPS

