SubSea Modeling Example

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Abstract

This presentation provides an example of modeling in the subsea domain.

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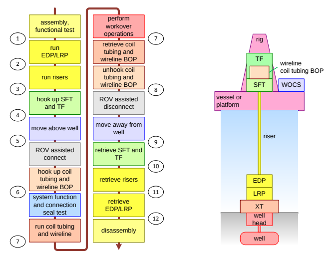


Colophon

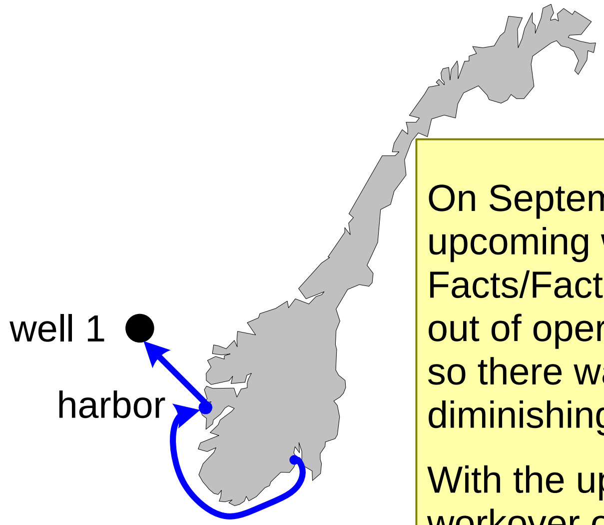
The examples in this presentation are based on the work of SEMA participants: Martin Moberg[a], Tormod Strand[a], Vazgen Karlsen[f], and Damien Wee[f], and the master project paper by Dag Jostein Klever[f]. Sensitive and confidential information is removed or obfuscated.

All mistakes are to be blamed to the author.

Gunnar Berge stimulated the creation of a subsea example.

[a]Aker Solutions
[f] FMC Technologies

Story: Workover Anno 2015



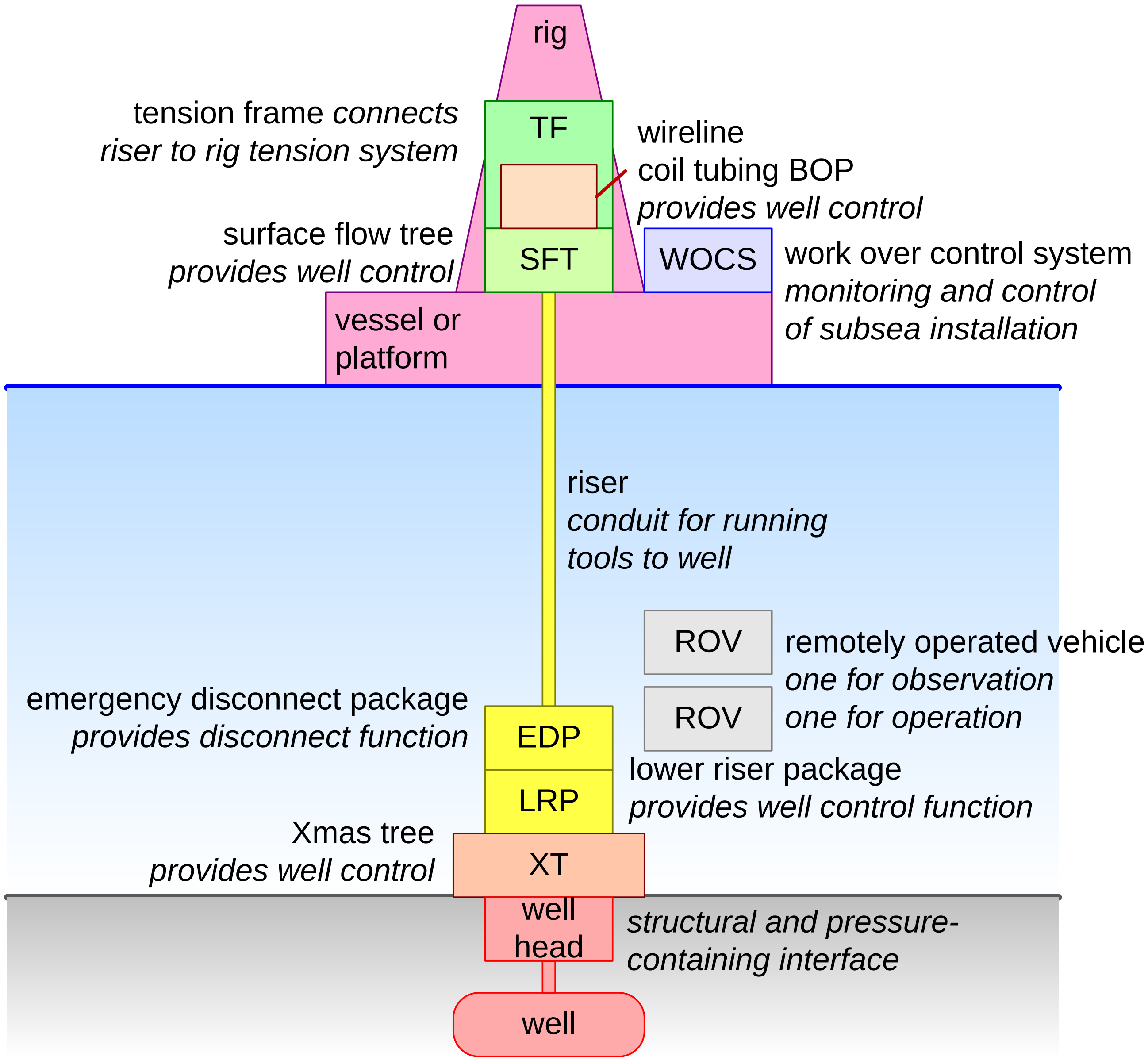
On September 4, Captain Frode Johansen was discussing the plans for the upcoming workover of South Gulfaks (see http://www.npd.no/en/Publications/Facts/Facts-2011/Chapter-10/Gullfaks-Sor-/) with his crew. Their vessel had been out of operation for recertification of the equipment much longer than anticipated, so there was a lot of pressure from Statoil on their schedule. Statoil sees diminishing production in several of the wells, so workover operations are urgent.

With the upcoming fall and winter storms, Frode hopes to finish the next three workover operations in a new record time. The equipment supplier had not only recertified all equipment, but also renovated parts of the riser system allowing for faster deployment and retrieval. The supplier tested and installed equipment in Horten. Tomorrow they will arrive in Sotra, their company support station. Here they will stock their fuel, food, coiled tubing, and other material.

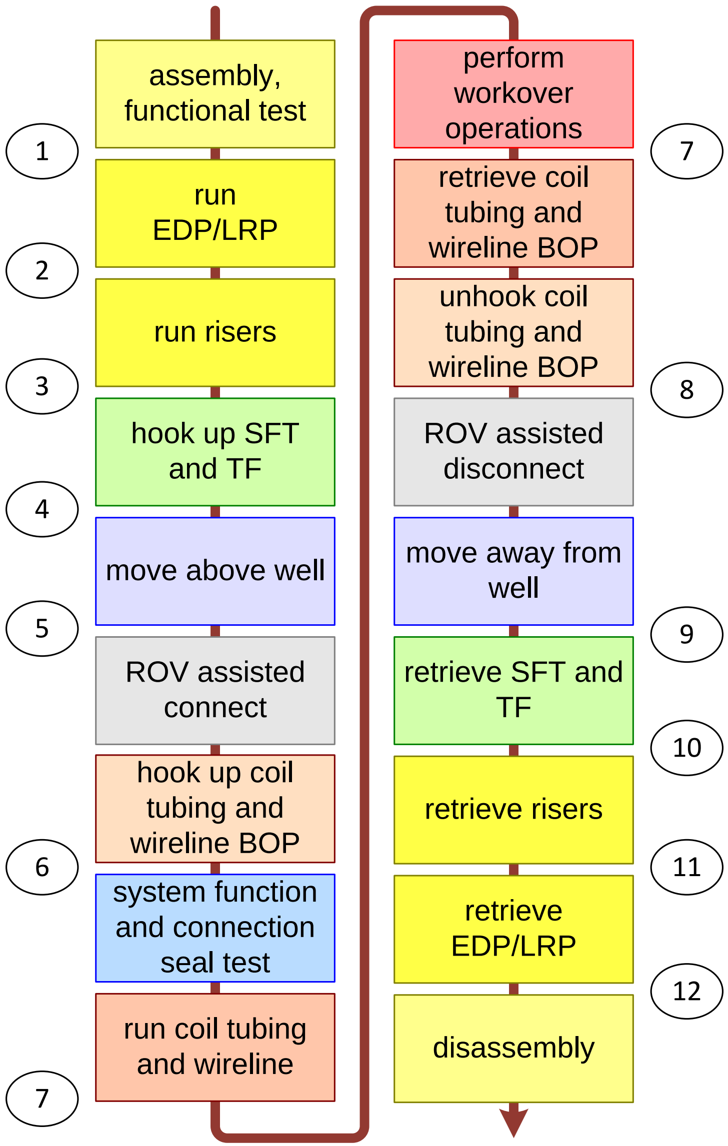
The weather forecast shows a depression close to Iceland that moves slowly in Norway's direction. If they can start deployment of the riser on September 7, then they probably finish the workover before the storm associated with the depression is too severe.

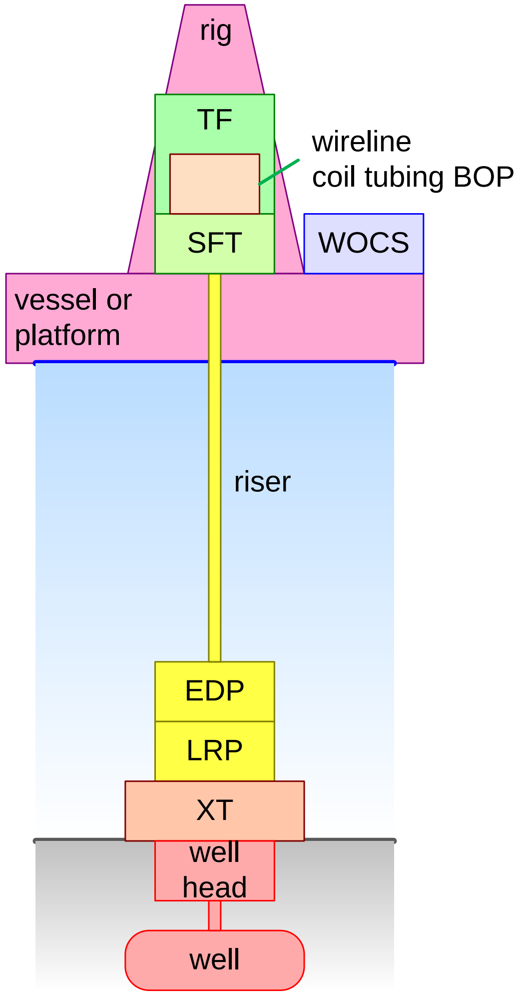
Since the schedule is so tight, the captain proposes to preassemble the riser system as far as possible while traveling. In addition, the accumulators can already be charged. The captain asks the foreman to make a schedule and to allocate tasks to the crew. Safety will be a key attention point, since working with such equipment with sea state 3 provides risks.

Annotated Physical Diagram of WorkOver System

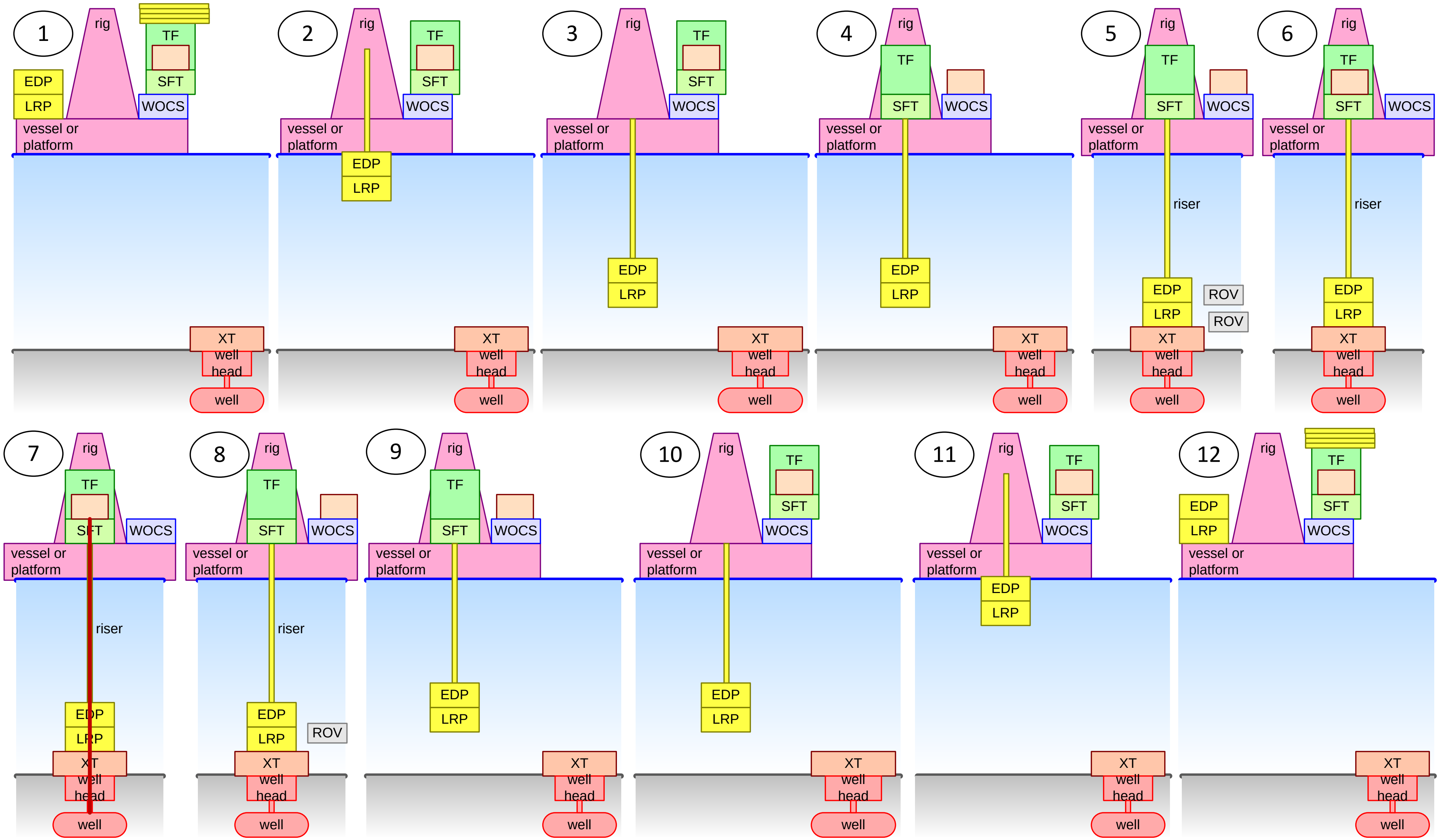


Typical Workover Operation





Typical Workover Operation as Cartoon



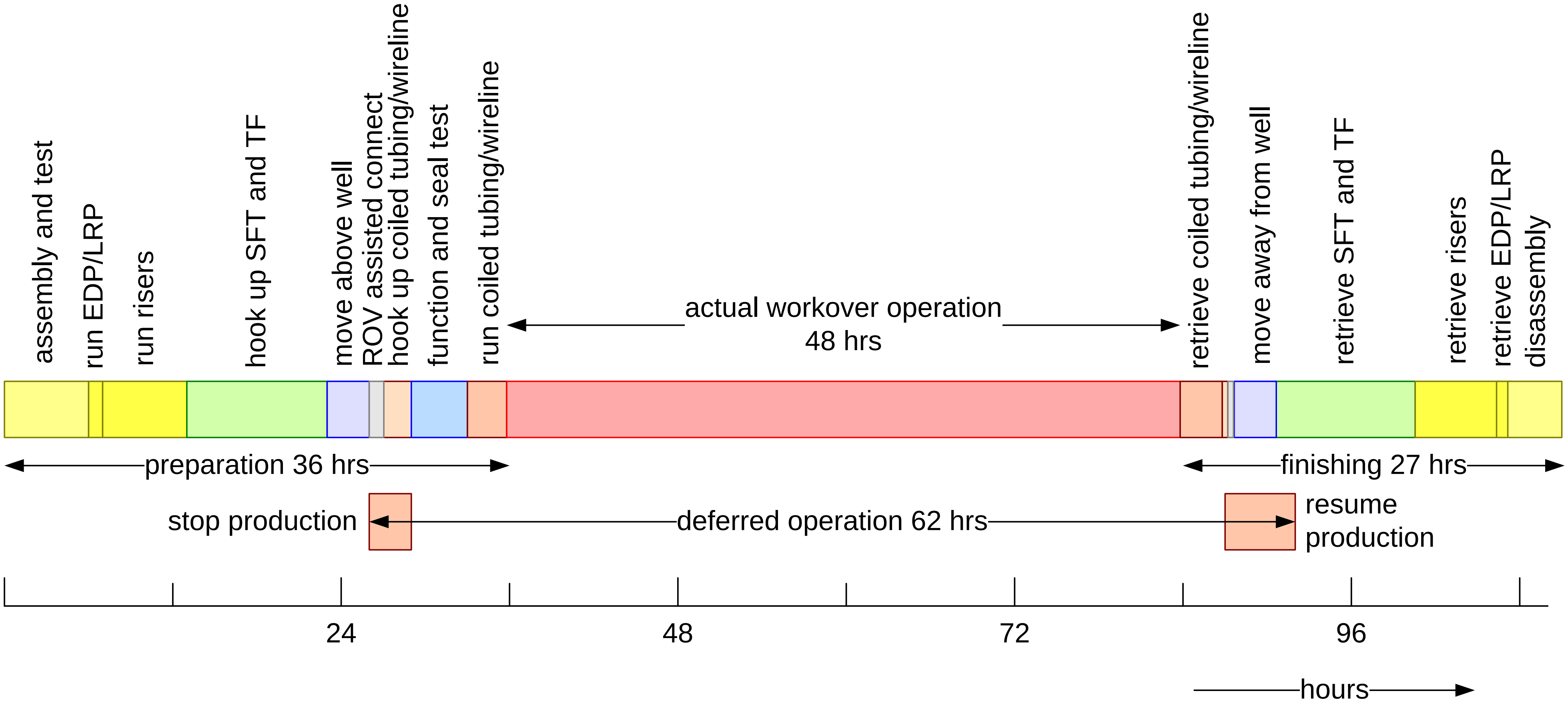
Typical Workover Operation on Timeline

assumptions:

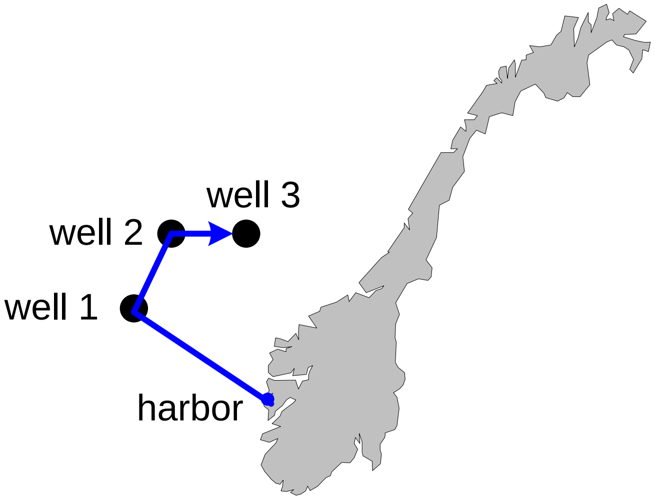
running and retrieving risers: 50m/hr

running and retrieving coiled tubing/wireline: 100m/hr

depth: 300m



Typical Workover Operation Context

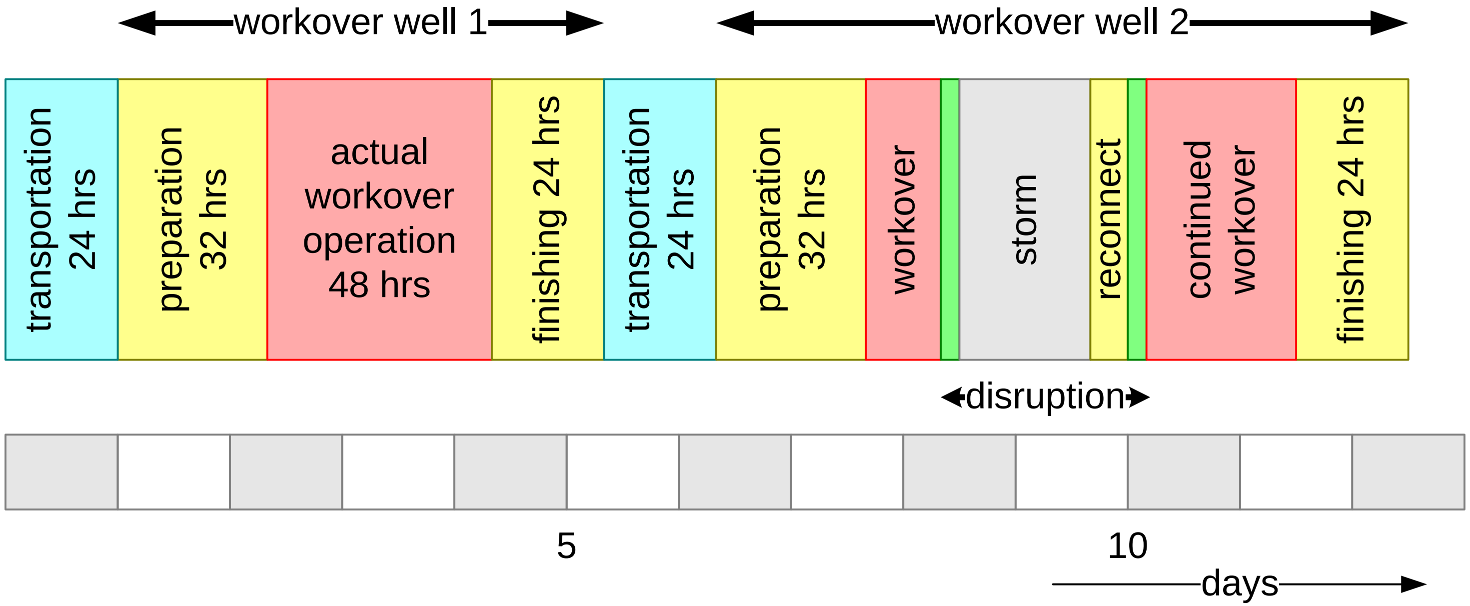


zero order model

$$t_{workover} = t_{transportation} + t_{preparation} + t_{workover} + t_{finishing}$$

first order model

$$t_{workover} = t_{transportation} + t_{preparation} + t_{workover} + t_{disruption} + t_{finishing}$$



0-order Cost Model Workover Operation

workover cost per day	*assumed cost (MNoK)*
platform, rig	2
equipment	0.2
crew	0.1
total	2.3 MNoK/day

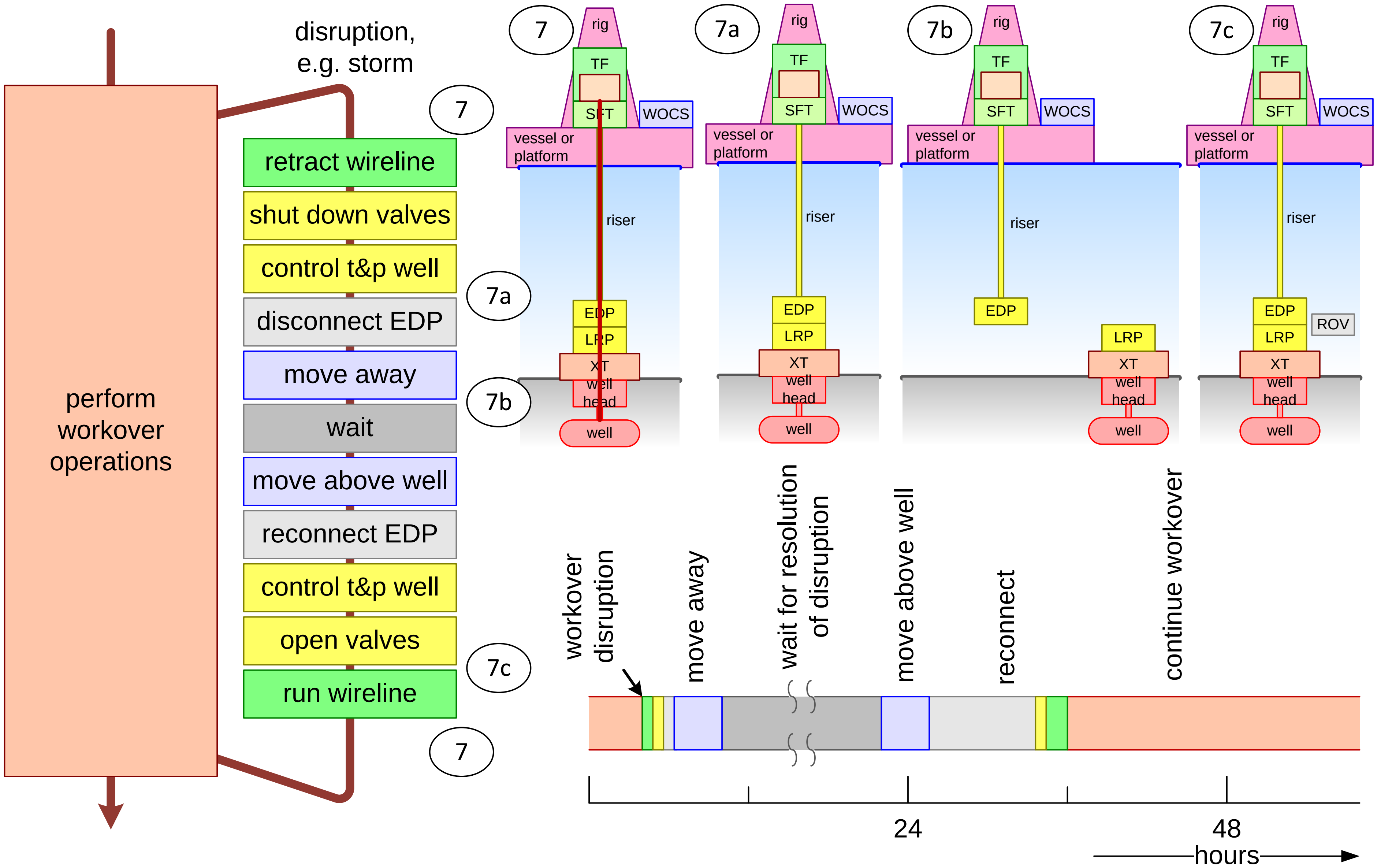
deferred operation per day	*assumed cost (MNoK)*
production delay	0.1
ongoing cost operation	0.2
total	0.3 MNoK/day

workover duration	*estimated duration (hours)*	*production loss*
transportation	24	
preparation	36	6
workover	48	48
finishing	27	8
total	135 (5.6 days)	62 (2.6 days)

$$cost = cost_{workover/day} * t_{workover} + cost_{deferred\ op./day} * t_{deferred\ op.}$$

$$\sim= 2.3 * 5.6 + 0.3 * 2.6 \sim= 14\ MNoK / workover$$

Disruption Workover Operation



1^{st} order Cost Model Workover Operation

workover cost per day	*assumed cost (MNoK)*
platform, rig	2
equipment	0.2
crew	0.1
total	2.3 MNoK/day

deferred operation per day	*assumed cost (MNoK)*
production delay	0.1
ongoing cost operation	0.2
total	0.3 MNoK/day

workover duration	*estimated duration (hours)*	*production loss*
workover 0-order	135 (5.6 days)	62 (2.6 days)
average disruption		
duration	72	
overhead	11	
disruption frequency	0.3	
1^{st} order disruption correction	83*0.3= 27	27
total	162 (6.7 days)	89 (3.7 days)

1^{st} order cost = $cost_{workover/day} * t_{workover} + cost_{deferred\ op./day} * t_{deferred\ op.}$

~= 2.3 * 6.7 + 0.3 * 3.7 ~= 16.5 MNoK / workover

0-order cost ~= 14 MNoK ; disruption cost ~= 2.5 MNoK

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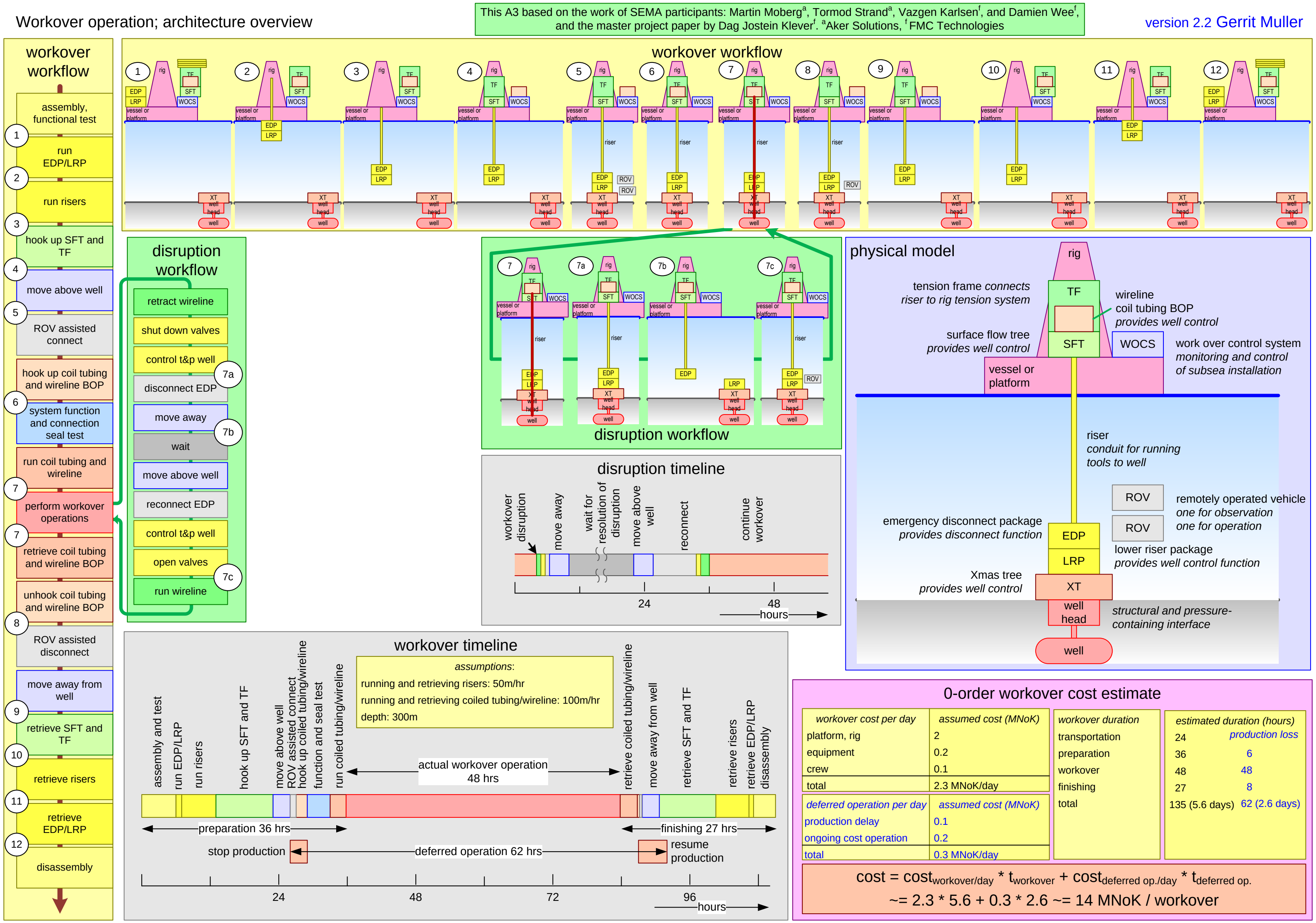
SSMEcostModelWorkoverOperation1stOrder

A3 Architecture Overview



Levels of A3s