

SubSea Modeling Example

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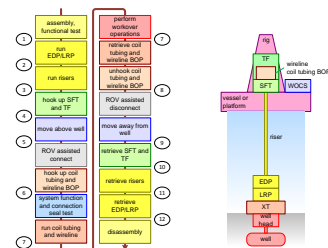
Abstract

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

Distribution

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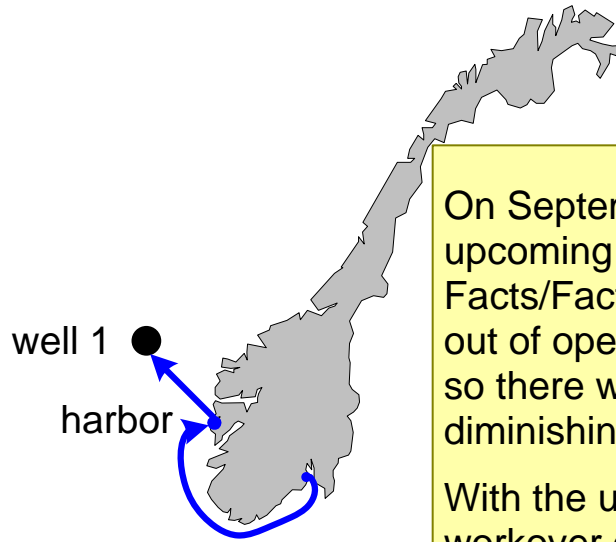
The examples in this presentation are based on the work of SEMA participants: Martin Moberg^a, Tormod Strand^a, Vazgen Karlsen^f, and Damien Wee^f, and the master project paper by Dag Jostein Klever^f. Sensitive and confidential information is removed or obfuscated.

All mistakes are to be blamed to the author.

Gunnar Berge stimulated the creation of a subsea example.

^aAker Solutions
^fFMC Technologies

Story: Workover Anno 2015



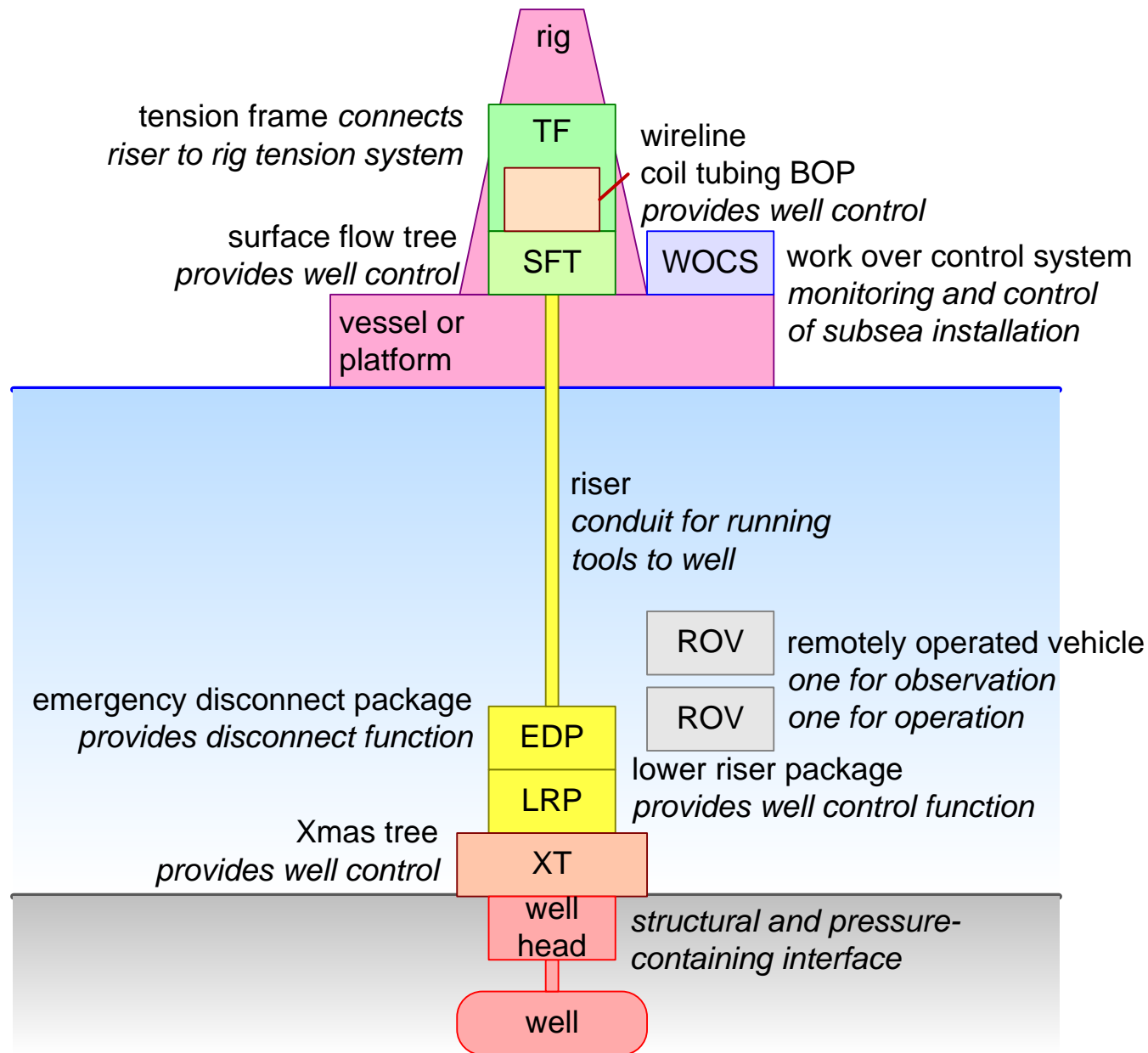
On September 4, Captain Frode Johansen was discussing the plans for the upcoming workover of South Gullfaks (see <http://www.npd.no/en/Publications/Facts/Facts-2011/Chapter-10/Gullfaks-Sor-/>) with his crew. Their vessel had been out of operation for recertification of the equipment much longer than 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.

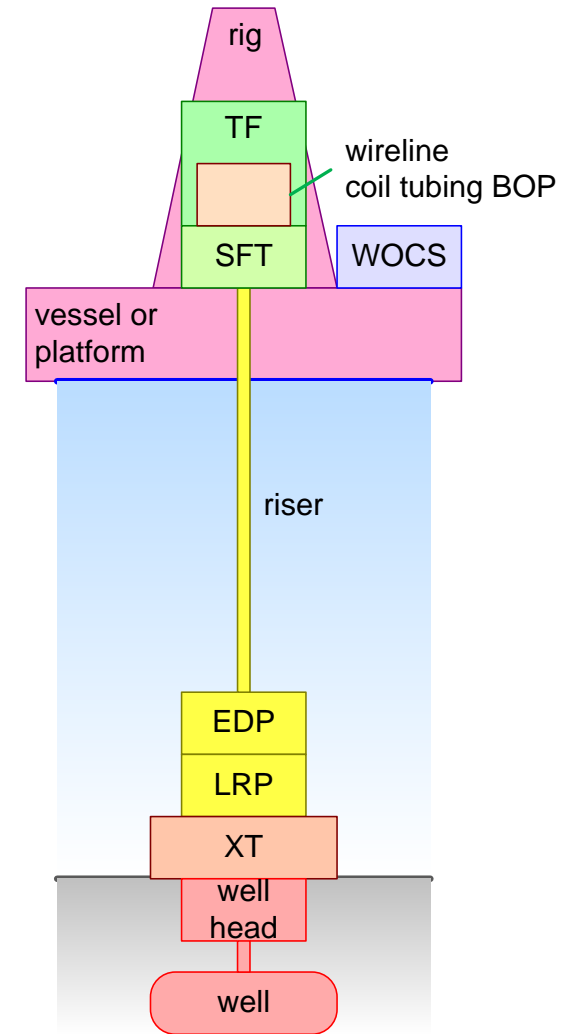
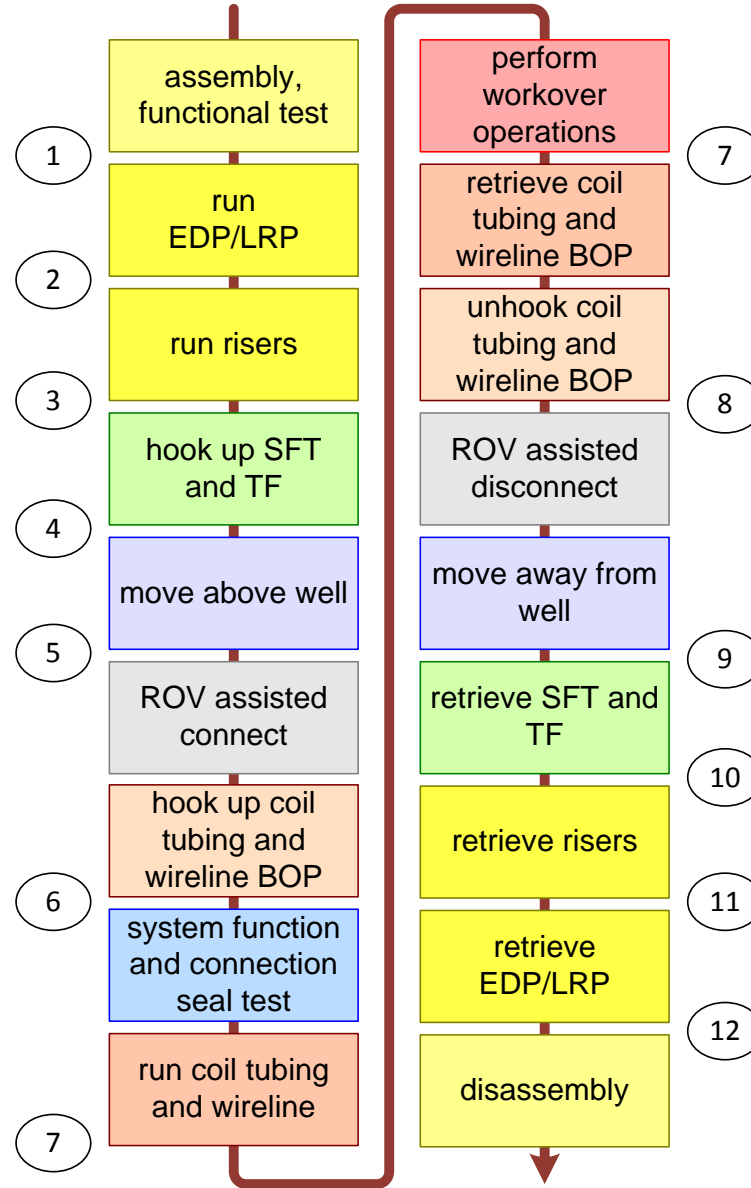
The weather forecast shows a depression close to Iceland that moves slowly in Norway's direction. If they can start deployment of the riser on September 7, then they probably finish the workover before the storm associated with the depression is too severe.

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.

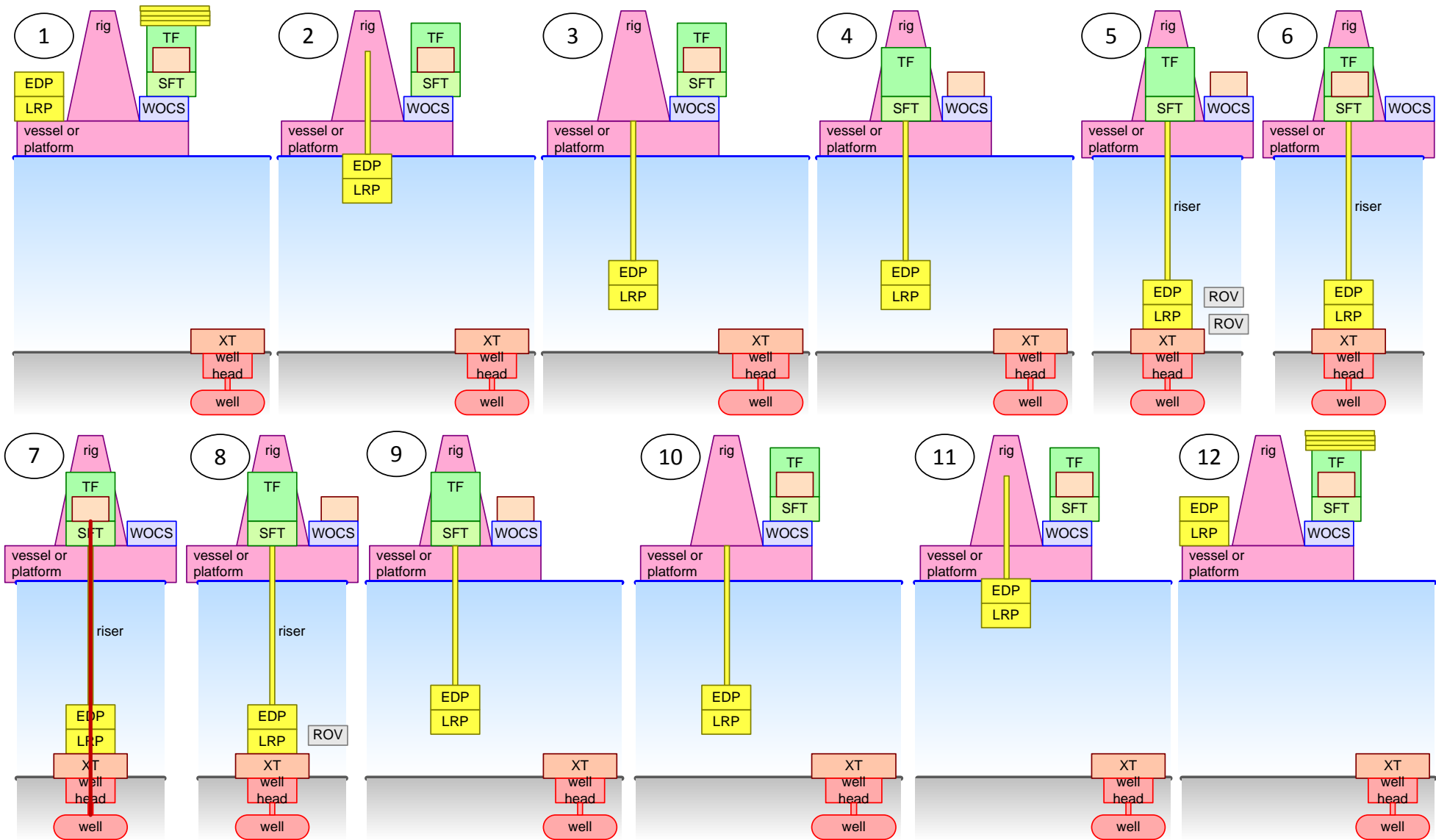
Annotated Physical Diagram of WorkOver System



Typical Workover Operation



Typical Workover Operation as Cartoon

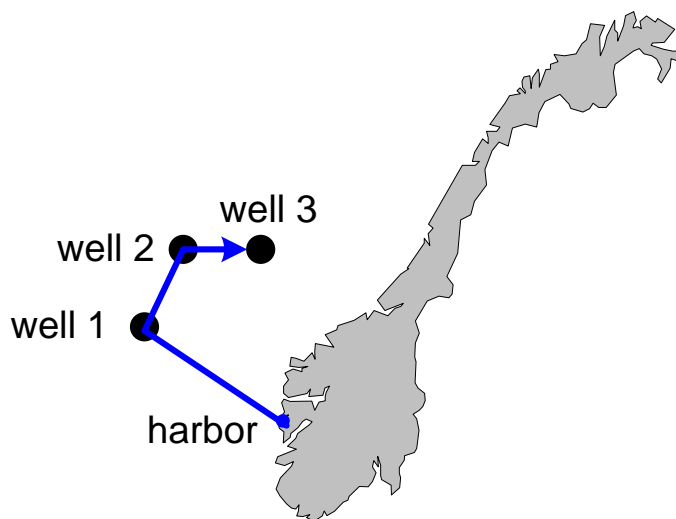


Typical Workover Operation on Timeline

assumptions:
 running and retrieving risers: 50m/hr
 running and retrieving coiled tubing/wireline: 100m/hr
 depth: 300m



Typical Workover Operation Context



zero order model

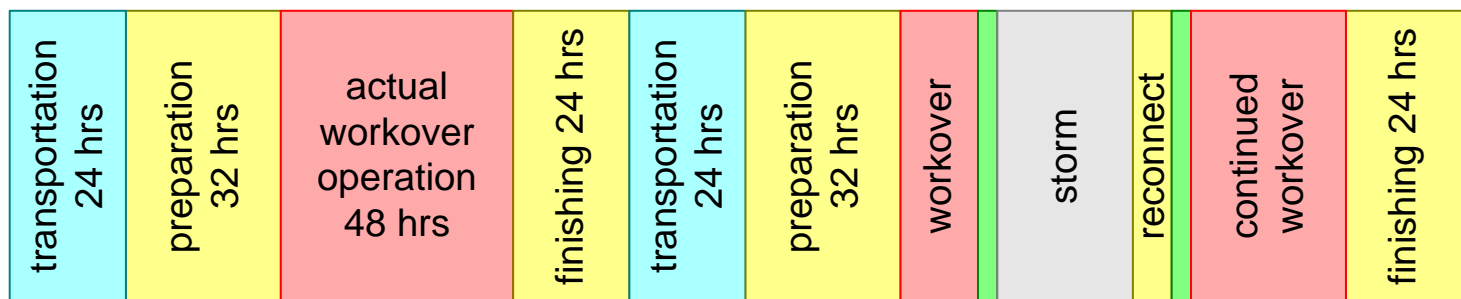
$$t_{workover} = t_{transportation} + t_{preparation} + t_{workover} + t_{finishing}$$

first order model

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

← workover well 1 →

← workover well 2 →



← disruption →



5

10

days →

0-order Cost Model Workover Operation

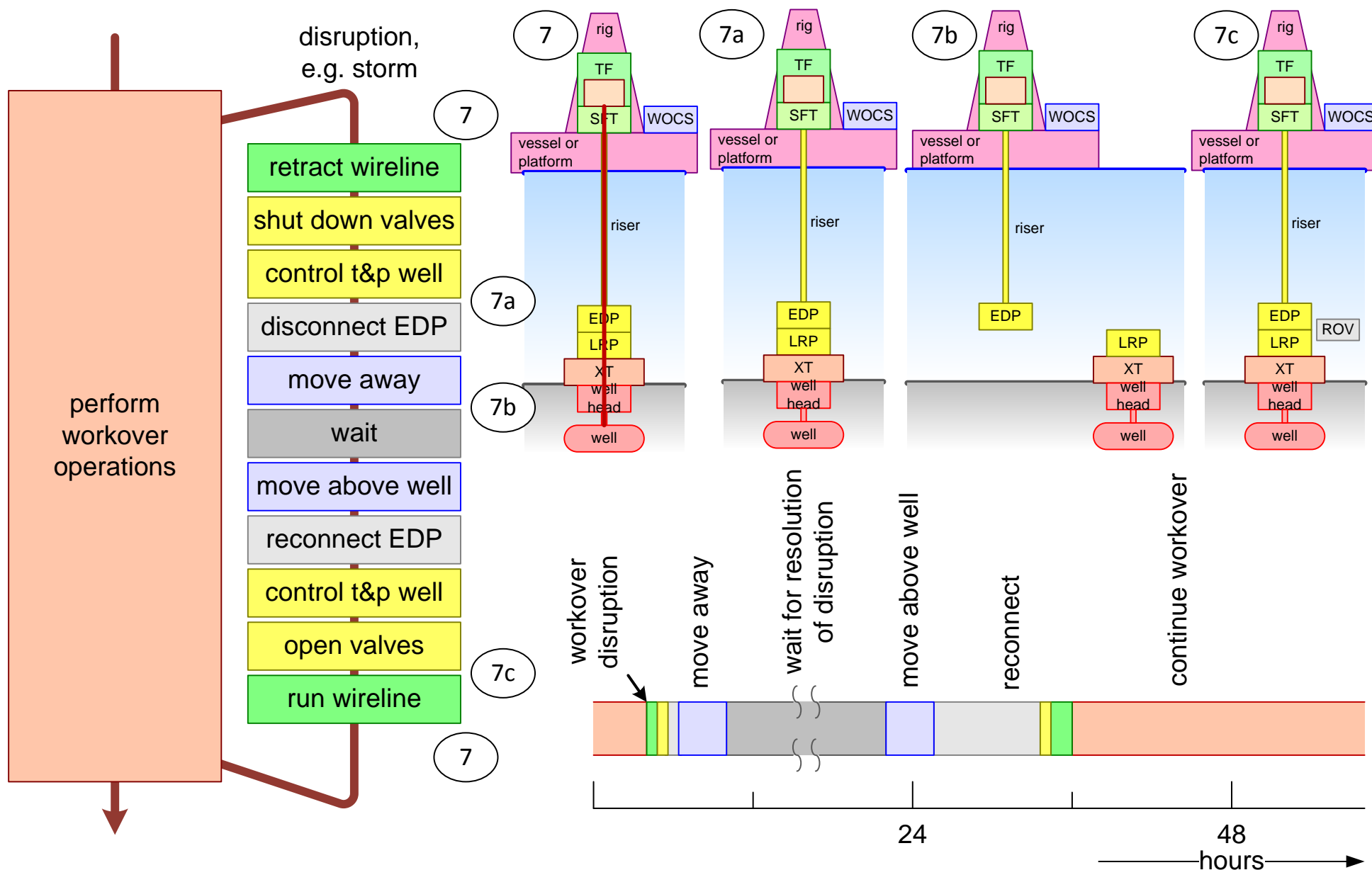
| <i>workover cost per day</i> | <i>assumed cost (MNoK)</i> | <i>workover duration</i> | <i>estimated duration (hours)</i> | |
|------------------------------|----------------------------|--------------------------|-------------------------------------|------------------------|
| platform, rig | 2 | transportation | 24 | <i>production loss</i> |
| equipment | 0.2 | preparation | 36 | 6 |
| crew | 0.1 | workover | 48 | 48 |
| total | 2.3 MNoK/day | finishing | 27 | 8 |
| | | total | 135 (5.6 days) 62 (2.6 days) | |

| <i>deferred operation per day</i> | <i>assumed cost (MNoK)</i> |
|-----------------------------------|----------------------------|
| production delay | 0.1 |
| ongoing cost operation | 0.2 |
| total | 0.3 MNoK/day |

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

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

Disruption Workover Operation



1st order Cost Model Workover Operation

| <i>workover cost per day</i> | <i>assumed cost (MNoK)</i> | <i>workover duration</i> | <i>estimated duration (hours)</i> <i>production loss</i> |
|-----------------------------------|----------------------------|---|---|
| platform, rig | 2 | workover 0-order average disruption duration overhead <i>disruption frequency</i> 1 st order disruption correction | 135 (5.6 days) 62 (2.6 days) |
| equipment | 0.2 | | 72 |
| crew | 0.1 | | 11 |
| total | 2.3 MNoK/day | | 0.3 |
| <i>deferred operation per day</i> | <i>assumed cost (MNoK)</i> | | |
| production delay | 0.1 | | 83*0.3= |
| ongoing cost operation | 0.2 | | 27 27 |
| total | 0.3 MNoK/day | <i>total</i> | 162 (6.7 days) 89 (3.7 days) |

$$1^{\text{st}} \text{ order COST} = \text{COST}_{\text{workover/day}} * t_{\text{workover}} + \text{COST}_{\text{deferred op./day}} * t_{\text{deferred op.}}$$

$$\sim = 2.3 * 6.7 + 0.3 * 3.7 \sim = 16.5 \text{ MNoK / workover}$$

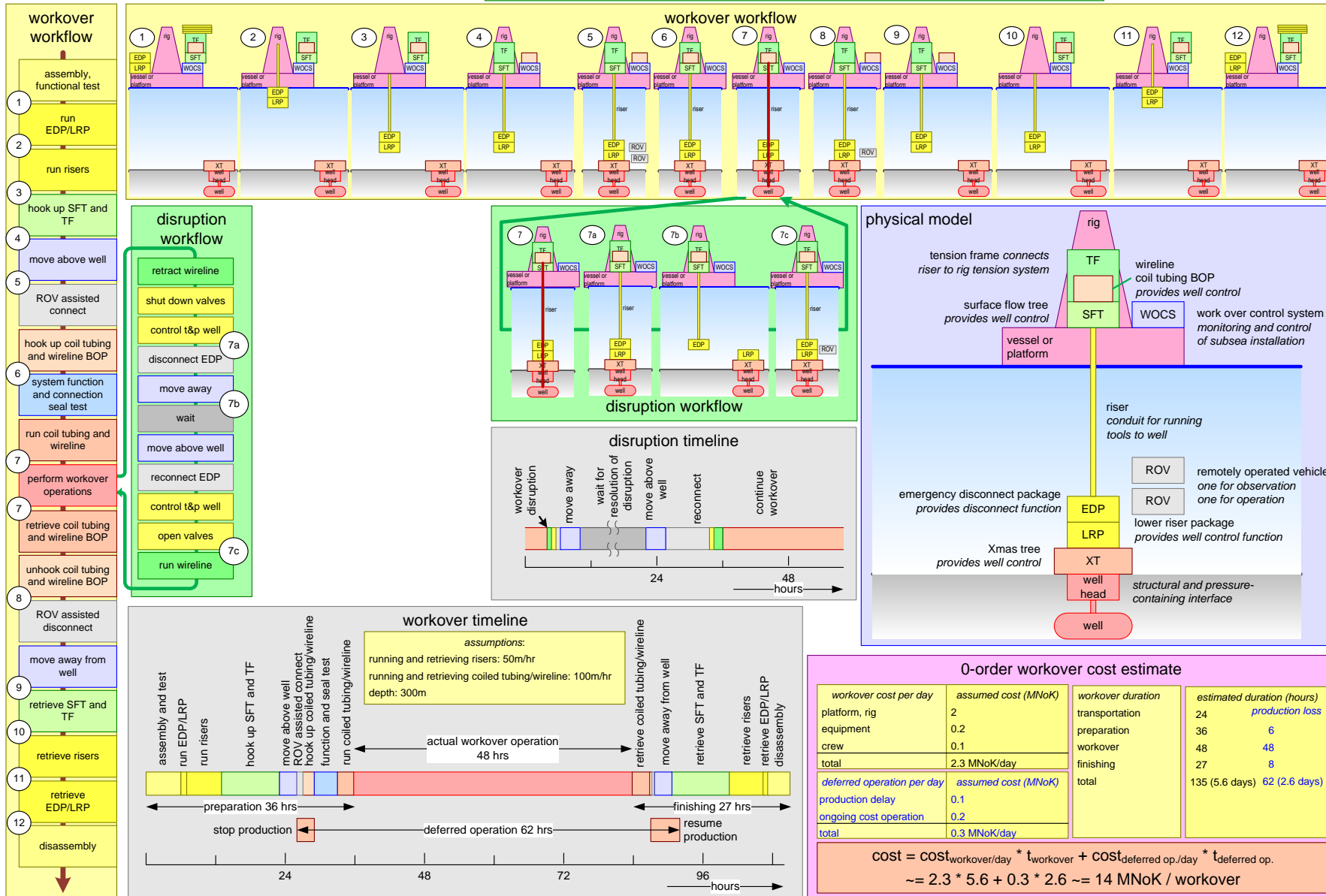
$$0\text{-order cost} \sim = 14 \text{ MNoK ; disruption cost} \sim = 2.5 \text{ MNoK}$$

A3 Architecture Overview

Workover operation; architecture overview

This A3 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. ^aAker Solutions, ^fFMC Technologies

version 2.2 Gerrit Muller



Levels of A3s

