

# Åsgard Subsea Compression Module Installation – Experiences

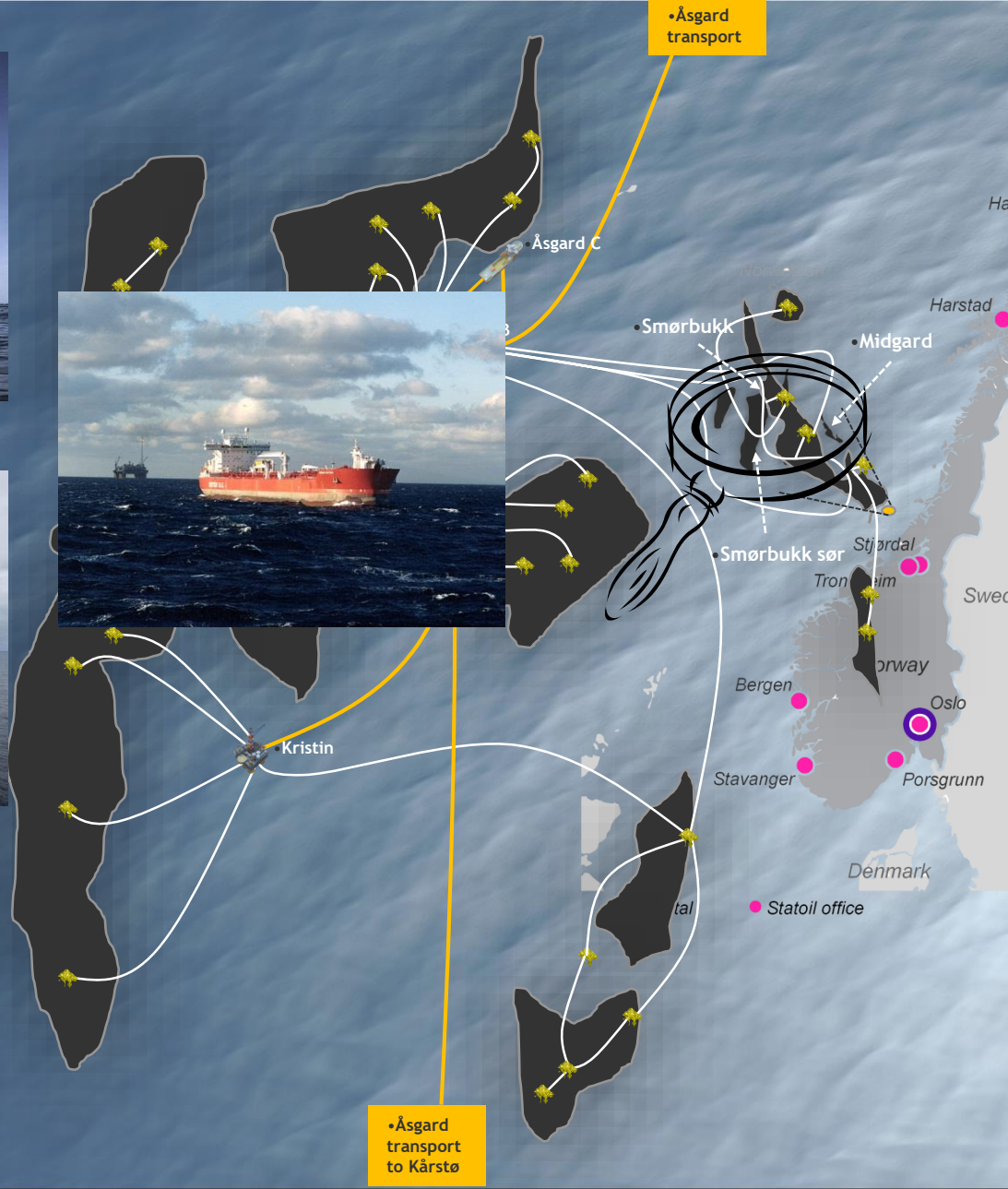


**FFU Seminar, Stavanger – 28<sup>th</sup> January 2016**

**Morten Person – Marine Operations Manager, ÅSC Statoil**

# The PROJECT

Åsgard Subsea Compression



norge

ExxonMobil

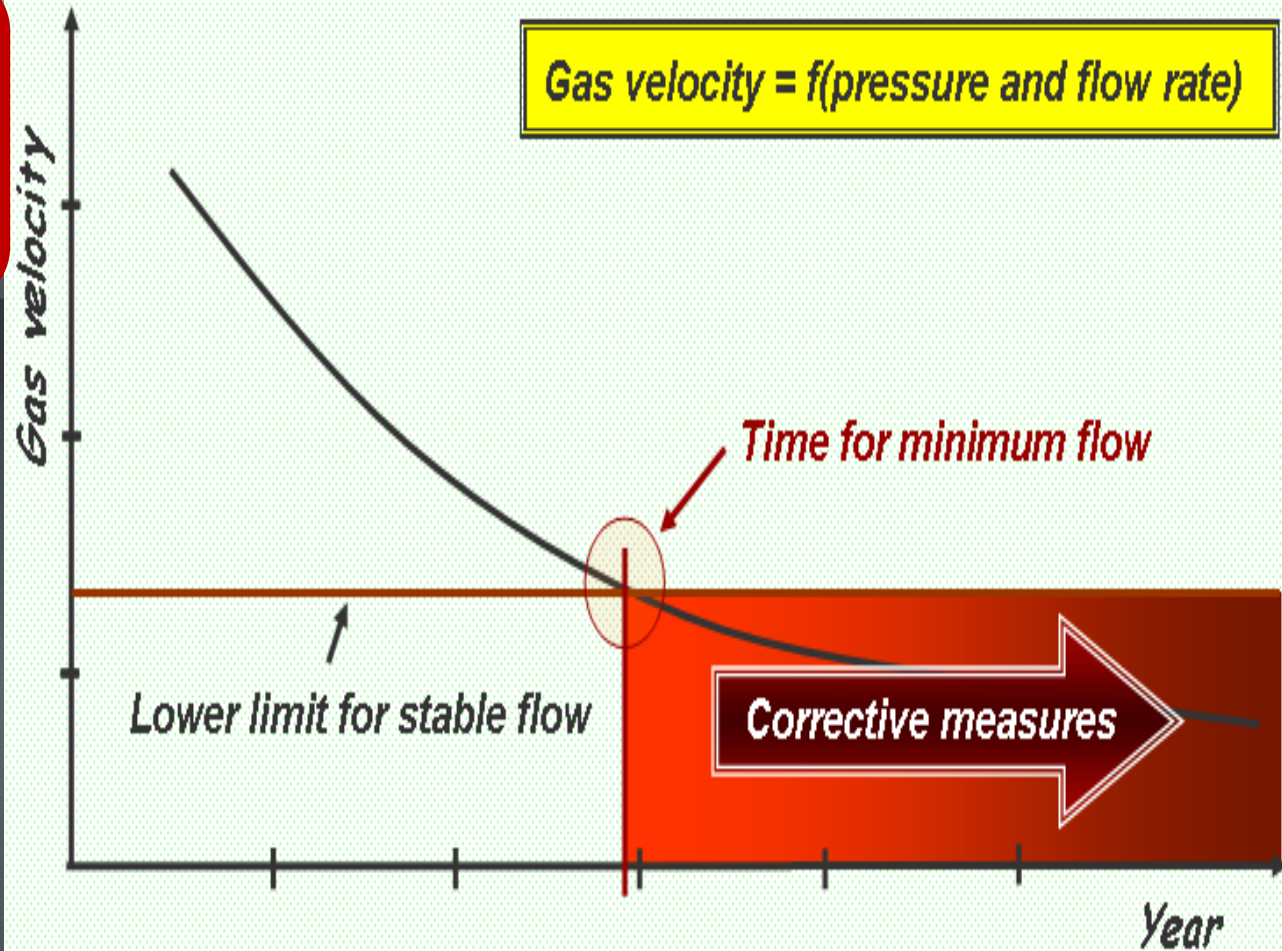


TOTAL

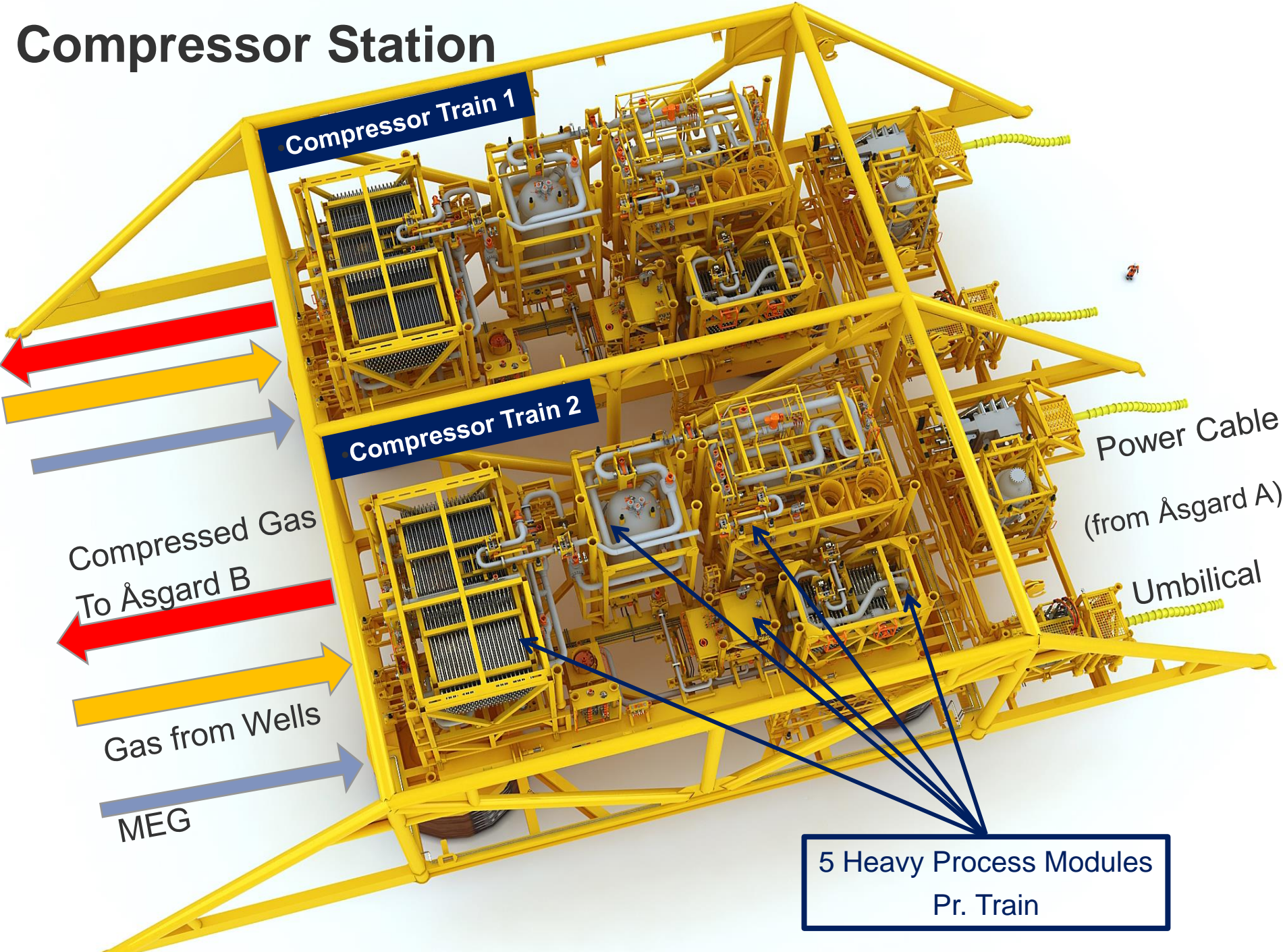


# Value creation

Increased recovery from Midgard and Mikkjel estimated to 306 Mboe



# Compressor Station



Compressor Train 1

Compressor Train 2

Compressed Gas  
To Åsgard B

Gas from Wells

MEG

Power Cable  
(from Åsgard A)

Umbilical

5 Heavy Process Modules  
Pr. Train

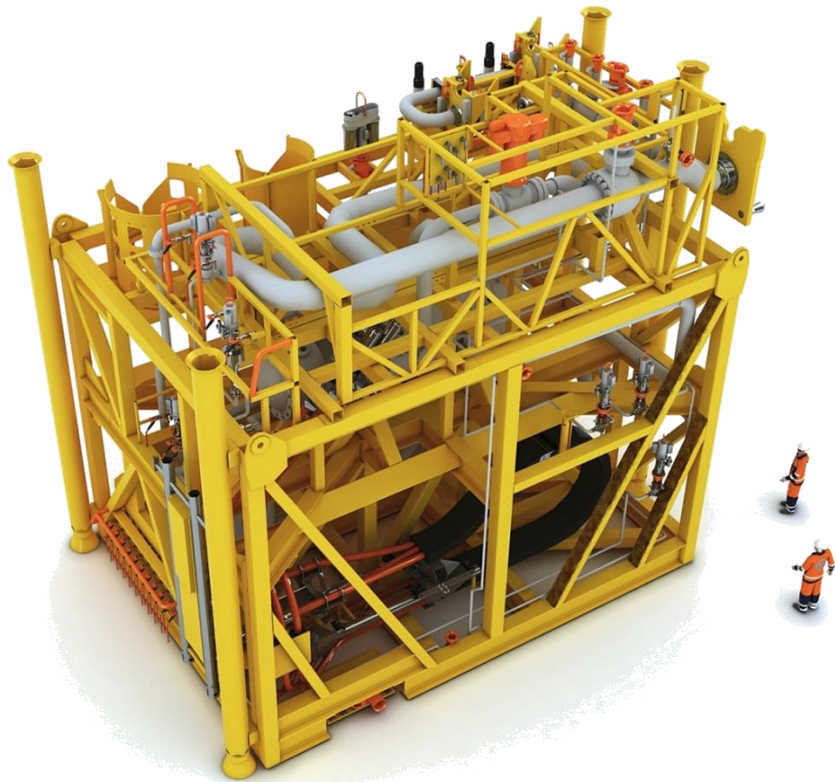


# Module Installation

Requirements, Assets,  
Tools & Experiences

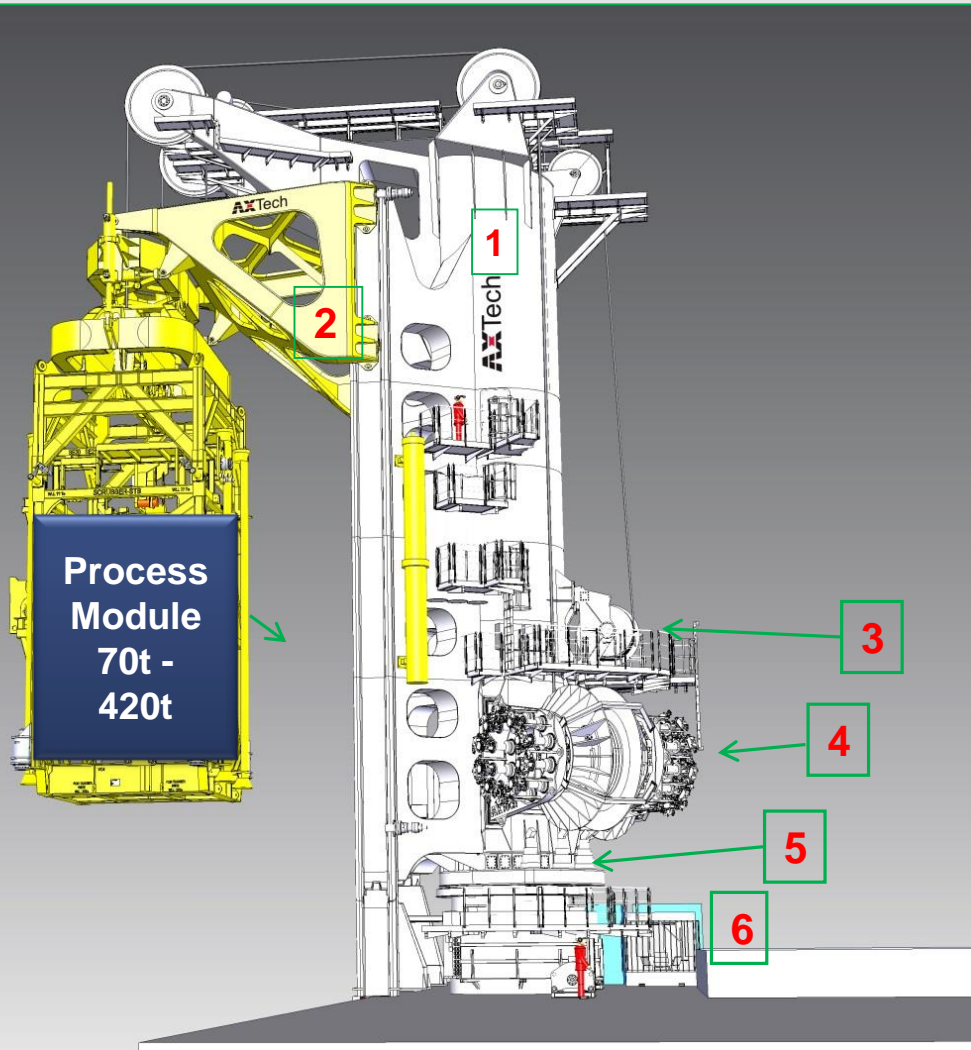
# Availability Requirements (Business Case)

- Availability is MTBF (Mean Time Before Failure) & Repair Time
- For Åsgard, **availability is set to ~96%** uptime of subsea plant
- Means; REPAIR TIME = 5 days response time + 10 days replacement / year
- Means; **COMPRESSOR MODULE REPAIR IN Hs = 4.5m**





# SHS = Special Handling System (Hs 4.5m)



**1** Superstructure incl. Guiderails and fixed boom.

Overall height approx. 31m

**2** Sliding frame w/ Running Tools.

**3** Sliding Frame (CGF) Winch (116t)

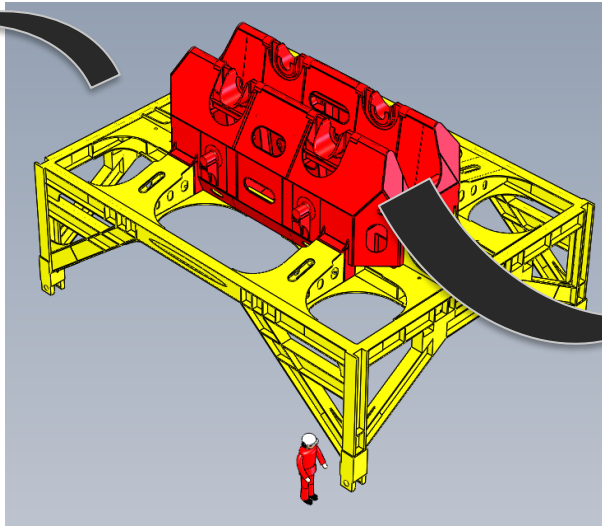
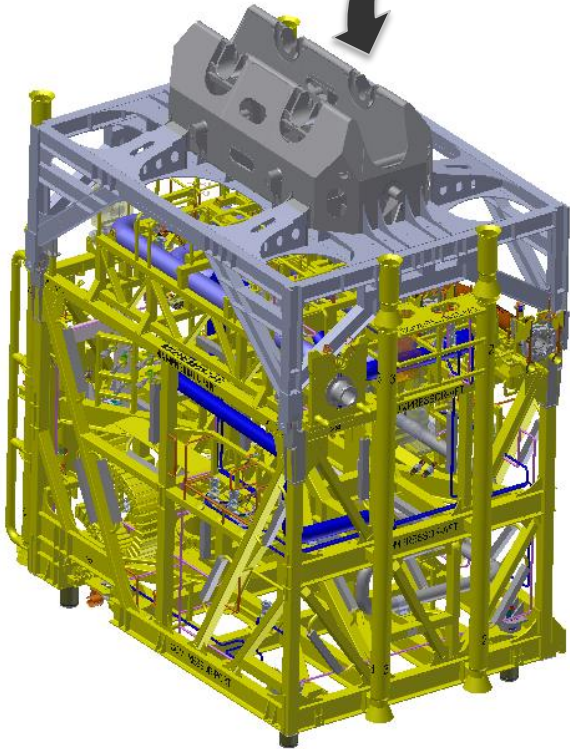
**4** 2 x Main Lift Winches (270t)

**5** Slewing arrangement

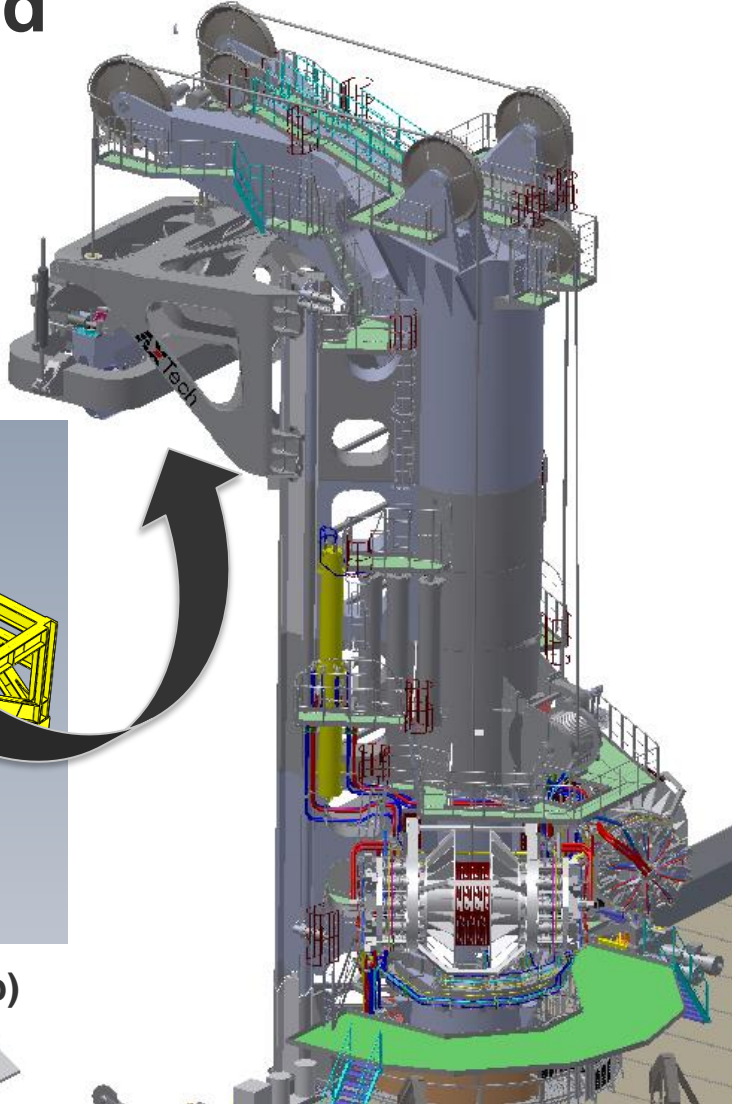
**6** Drag Chain.

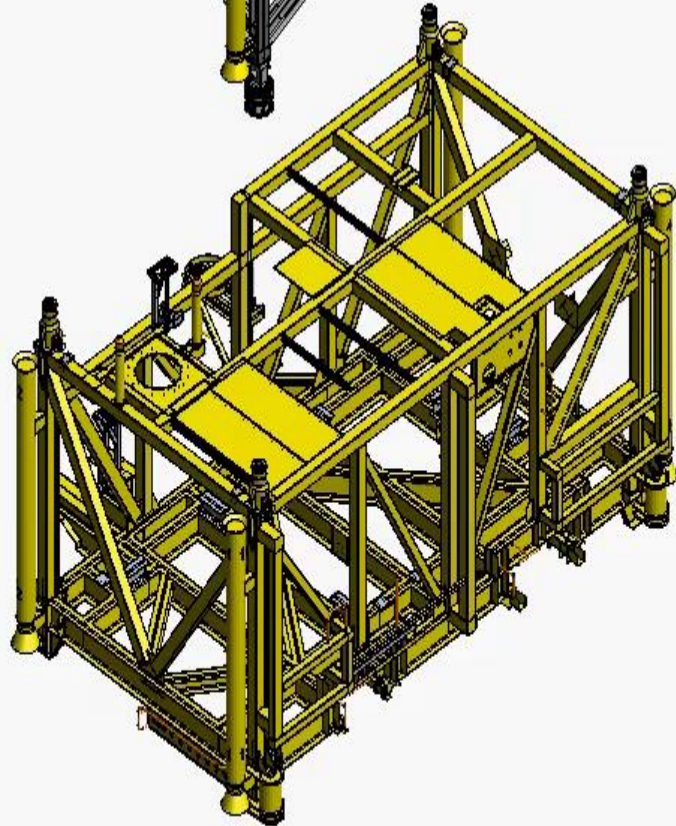
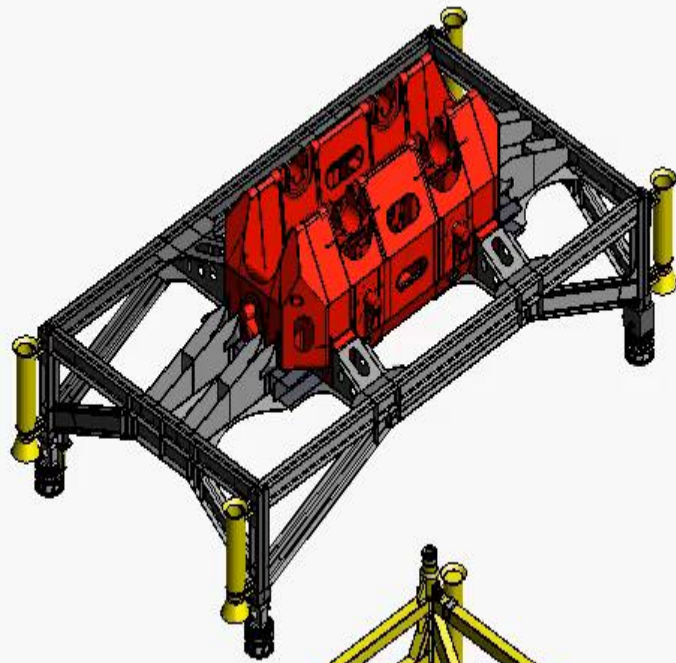
Note; Winch Capacities quoted are operational capacities offshore in Hs 4.5m waves

# Adaptor frame with docking head



Adaptor frame (AKER/Technip)



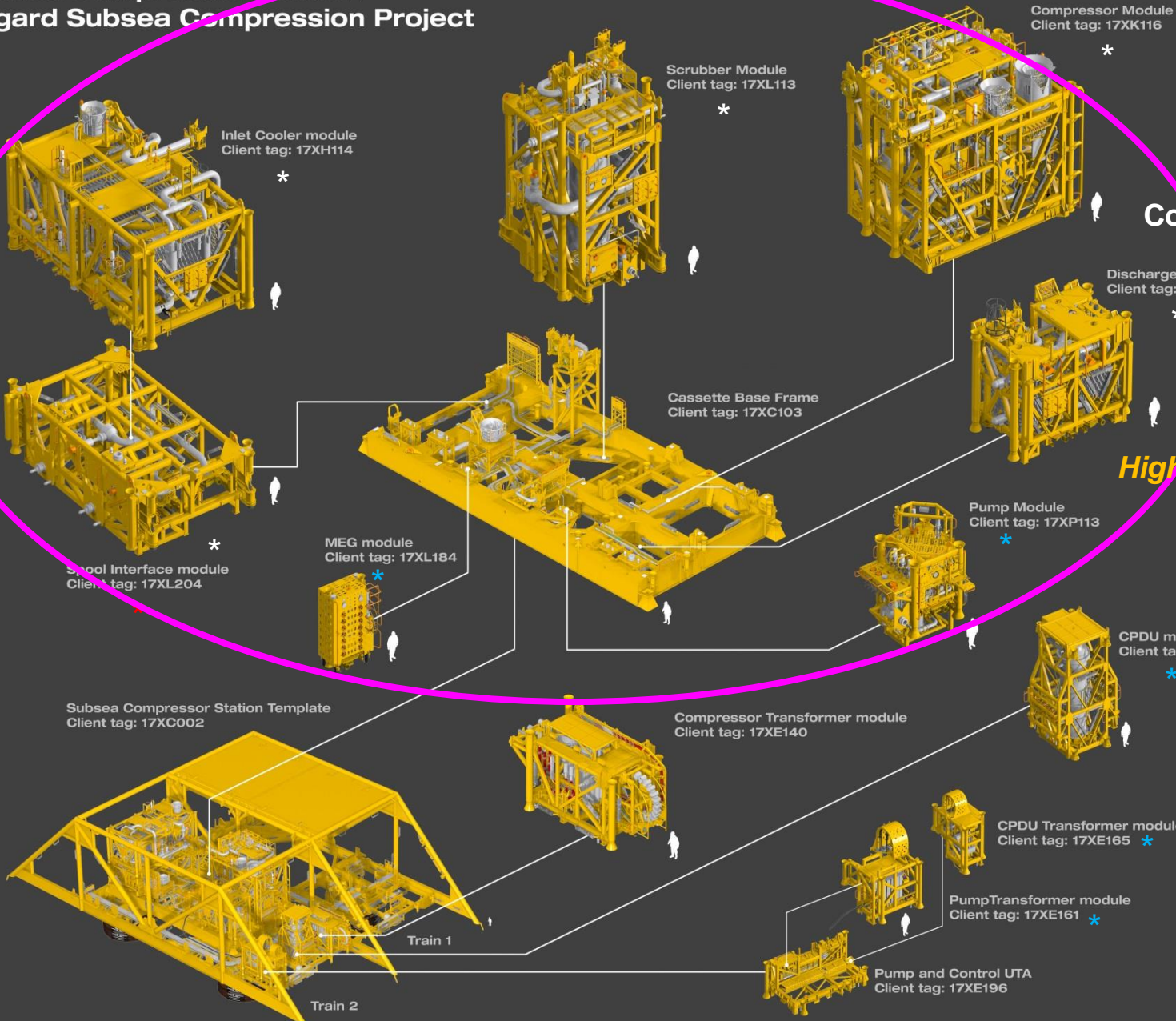


# SHS Adapter frames & Seafastening Skids



# Subsea Compression Station Åsgard Subsea Compression Project

## Process Modules



### Tie-In pr Train

- 10 VMC
- 12 HCS

### Controlled Landing

### High Voltage pr Train

- 2x 36 kV
- 2x 12 kV
- 3x 5.8 kV

### Misc pr Train

- 6x FOFL
- 95x EFL
- 1x BF

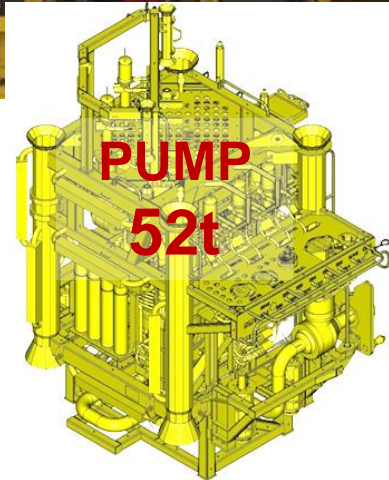
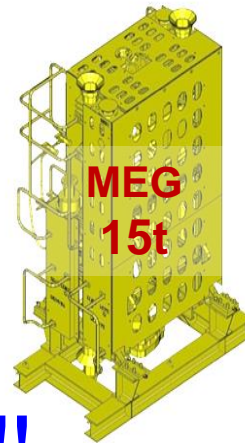
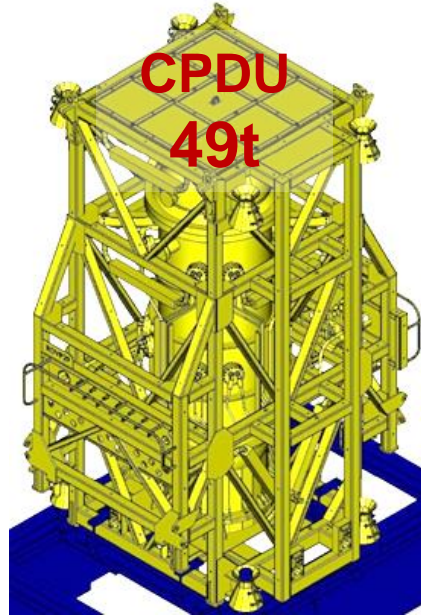


Statoil

\* Installed using the SPACIAL handling system \* Installed using the MODULE handling system

AkerSolutions™

# MHS Modules - Dim < 6x6x11m & W < 70t



Also to be deployed in Hs 4.5m!!

# North Sea Giant – Module Installation Modus



# Go Pros

ICM – Good Weather

Test Module – Bad Weather



## ***SHS Operation; 6 hours***

Prepare Cassette Base Frame

Deploy Module (Head Sea)

- Release Seafasten
- Slew 165° and over board
- Water filling 50 msw
- Lower to 240 msw

Install Module (SCSt heading)

- ~~Establish Guide Wires~~
- Move in 50m and rotate
- Align and enter Guide Posts
- Lower on Water Dampers
- Release Balltec Lift Locks
- Recover Lifting Frame

## ***Hook-Up; 24-48 Hours***

Controlled Landing

VMC Connection (1 or 2)

HCS Connection (2 – 4)

FO Connection (2)

EL Connection (2 – 24)

EI. Actuators

HV Connections

## ***RFO; 48-72 Hours***

Seawater Displacement

Leak Testing

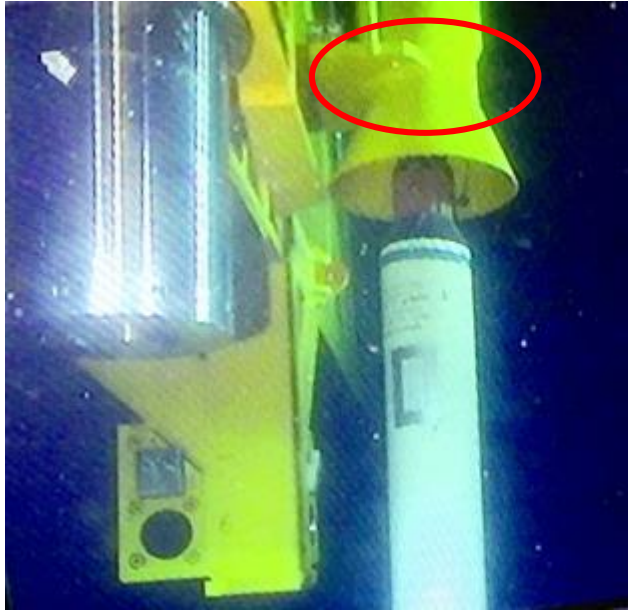
Draining

Calibrate Controls

Barriers

Final System Status

# Module Guiding and Controlled Landing



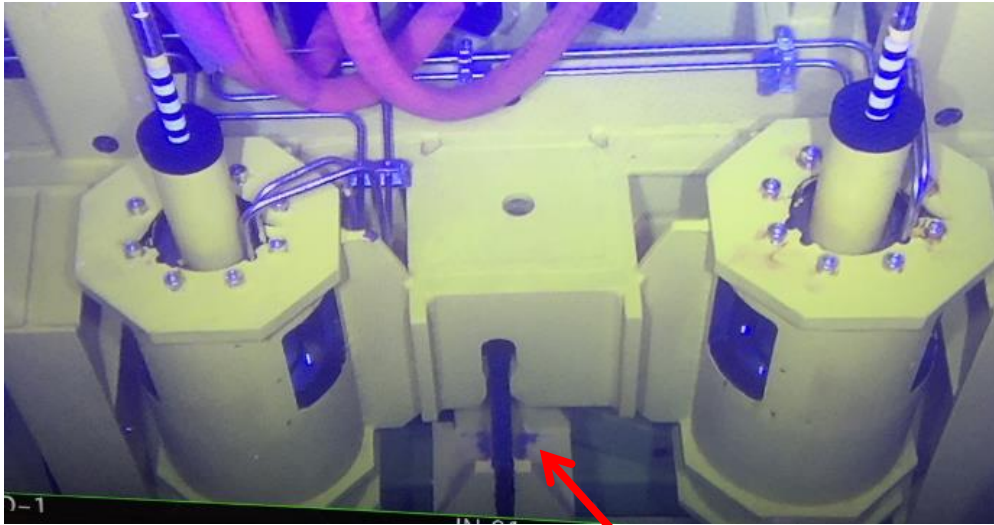
- 1 Guide Wires  
(if  $H_s > 2.5\text{m}$  & Beam Sea)
- 2 Guide Posts
- 3 Guide Funnel Restriction
- 4 Module lands on dampers



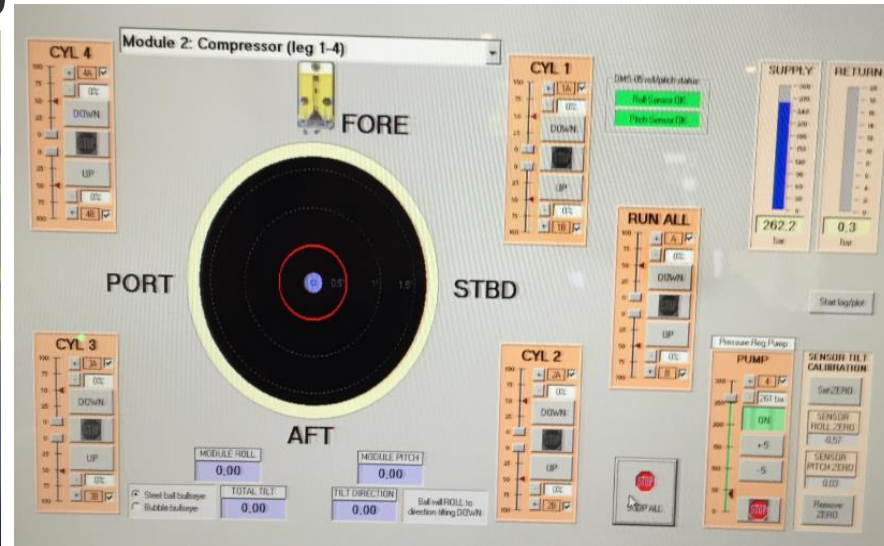
5 Passive Damping – 10cm  
(Lifting Frame Disconnected)

6 Controlled Landing – 45cm  
(Lifting Frame Recovered)

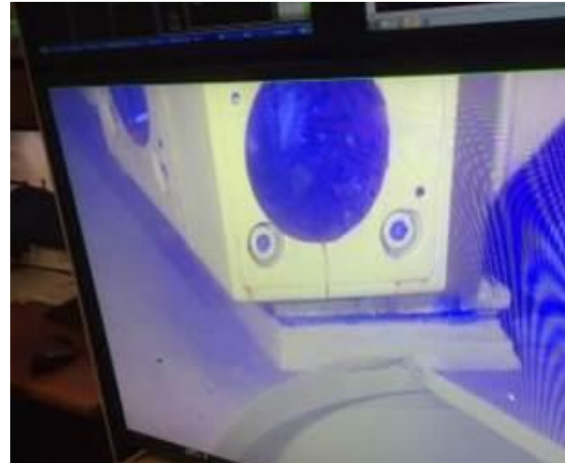
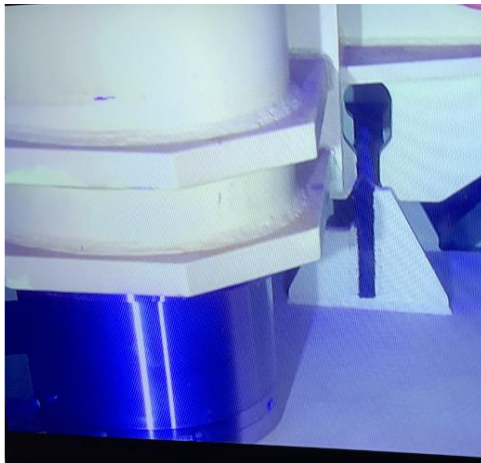
# Module Controlled Landing



2 Landing Cylinders & «Knife» on Pump Module



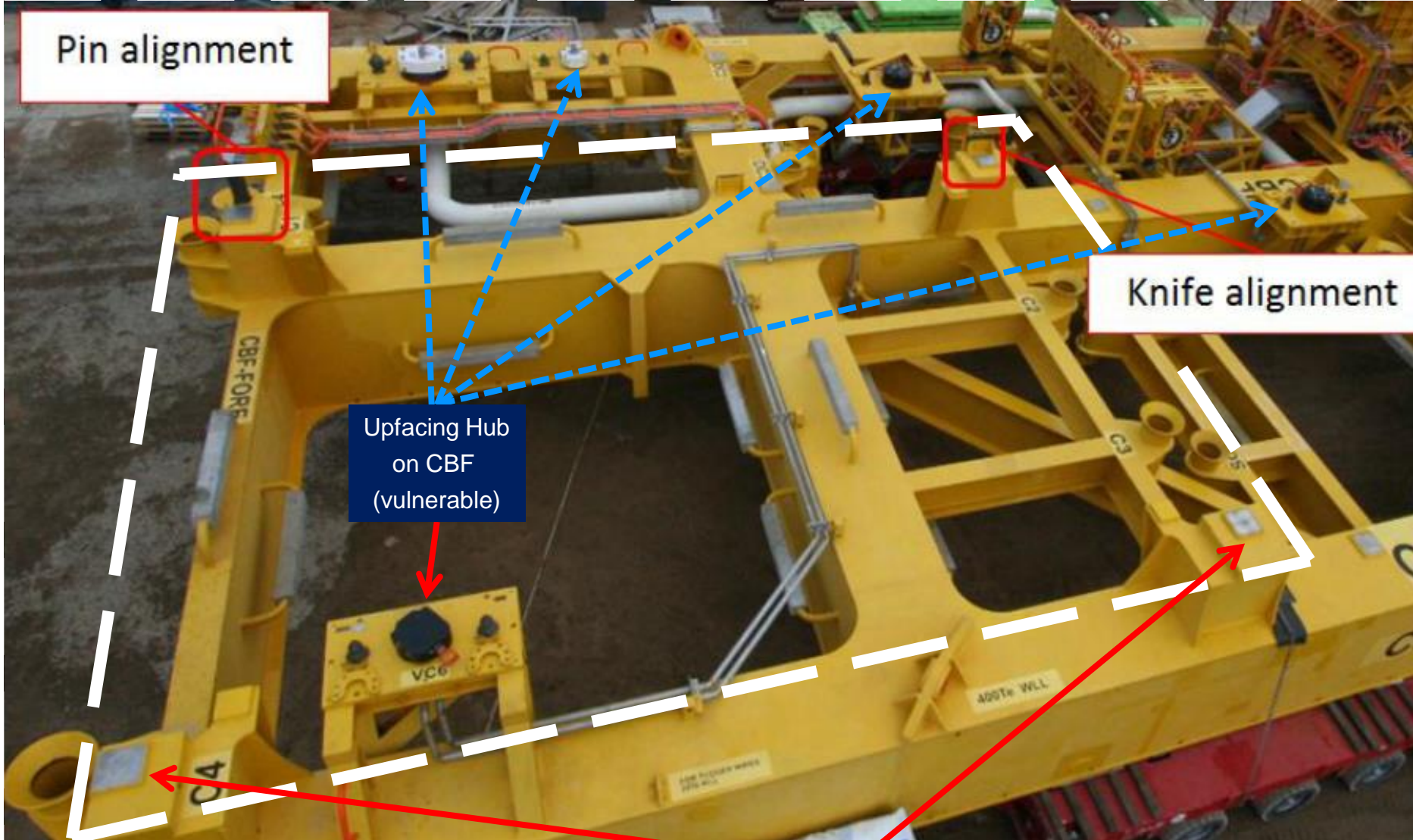
Operating panel in ROV Control Room



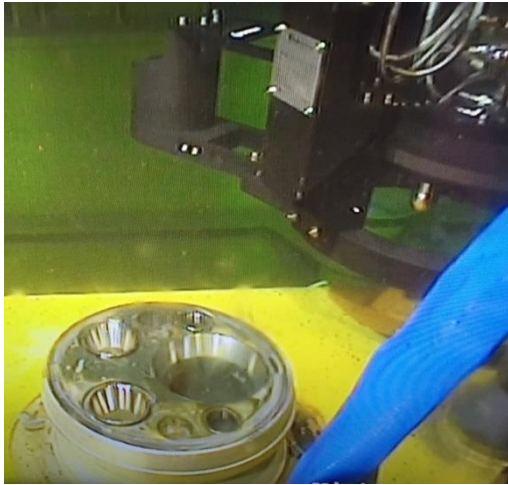
«Pin» & «Knife» fine alignment - during final lowering (~50cm)

Last operation; VMC Lowering & Conenction

# Module Controlled Landing – Protecting Upfacing Hubs



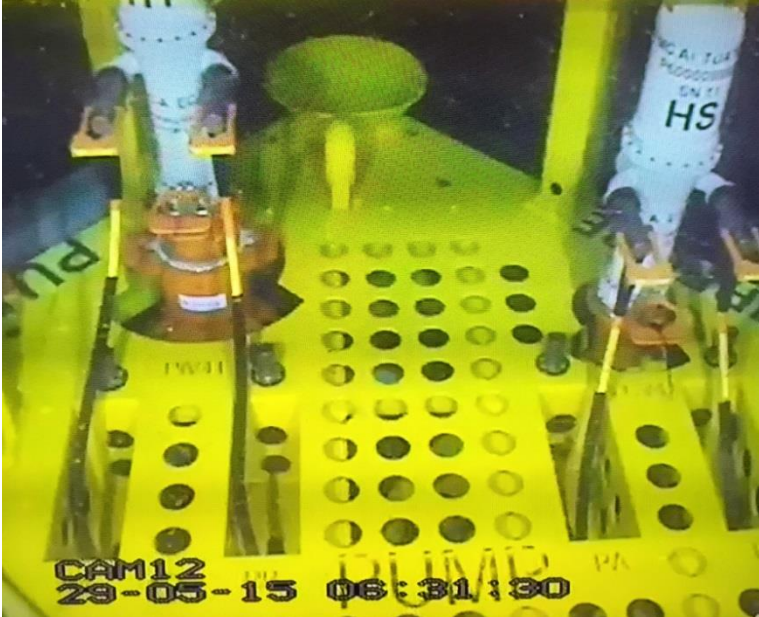
# Connection of Process pipes (6" – 16")



- Cleaning & insert Seal
- Break Out Tools (VMC)
- No Back Seal Tests
- Standard Clamp Connection



# Hook-Up of Controls



# Simulation

Training of Operators  
and

Prepare for Operations

by using State of the Art tools

# Traditional System Integration Test ??

- Stack Up (Fitness, clash checking & interchangeability)
- Controls testing (communication, function, redundancy, closed loop, C&E)
- Testing of ROV Operations
  - Dummy ROV, i.e. «Space Envelope»
  - Mock-Up ROVs, i.e. Full functionality wrt Manipulators & Cameras
  - Shallow Water Testing (SWT) in Test Pit / Dock

**SWT NOT  
POSSIBLE ON  
ÅSGARD DUE  
TO SHEAR  
SIZE & COST  
&  
COMPLEX  
SCOPE**





# ÅSC's solution for TRAINING of Marine Operations

# SIMULATION

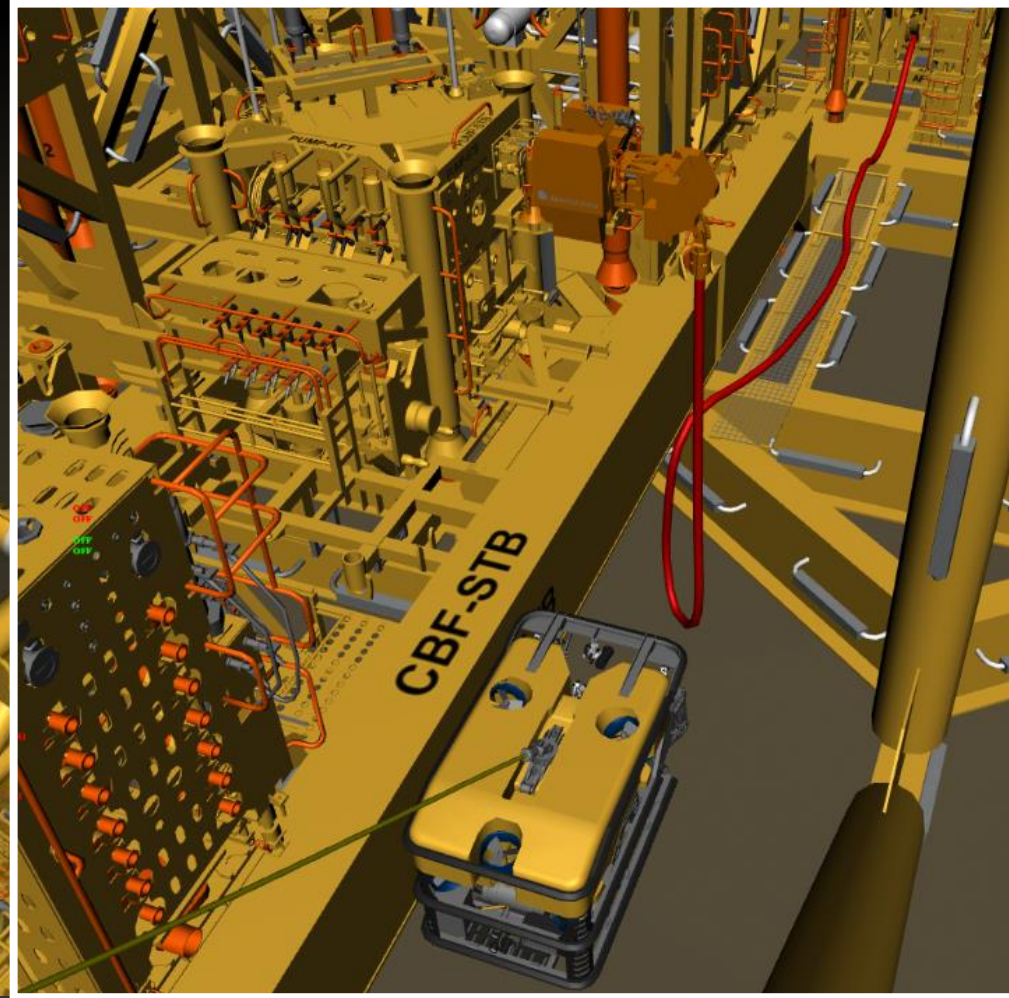
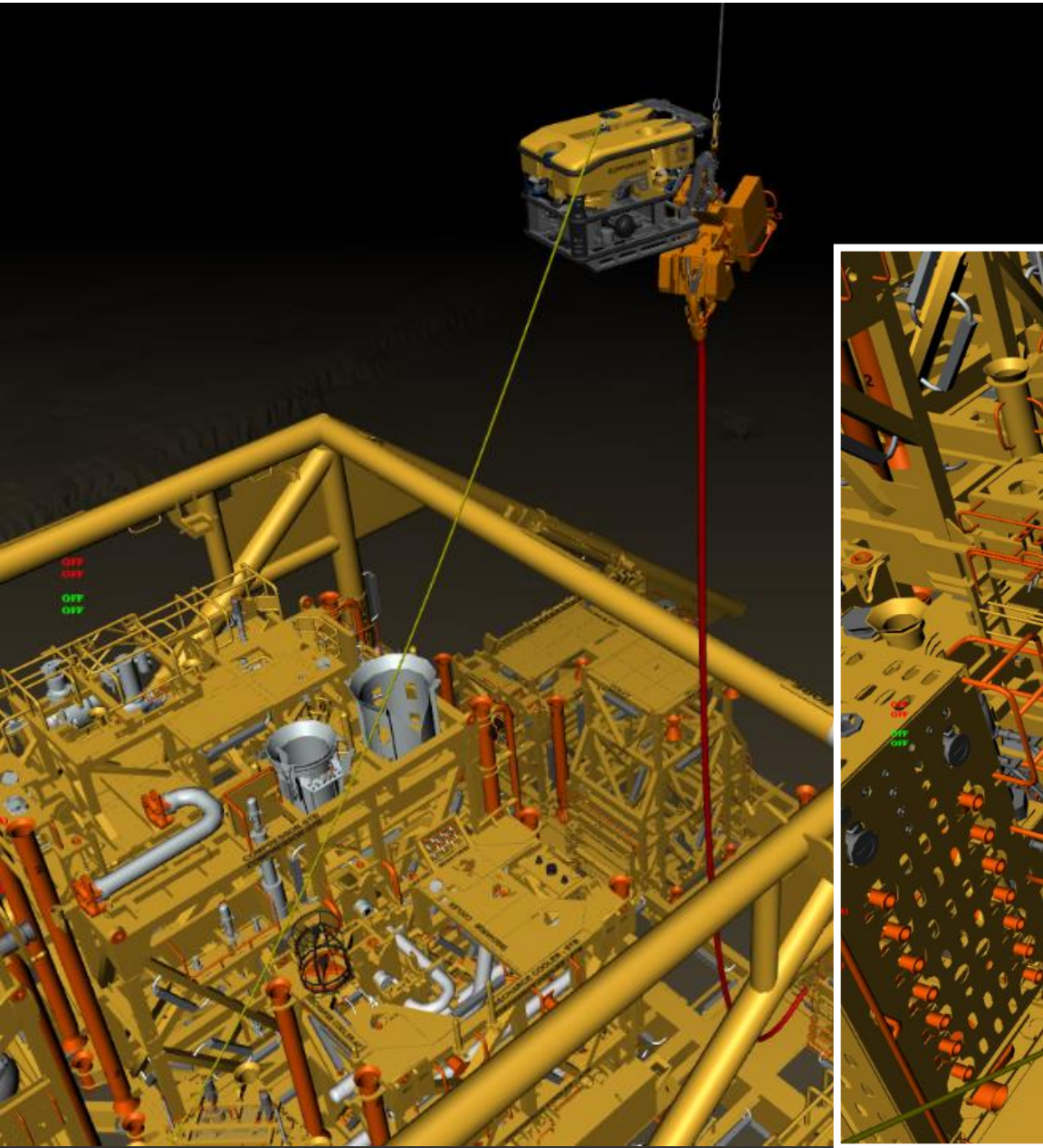
- Offshore Simulation Centre** - **Simulation tools**
- College of Ålesund (HiÅ)** - **Training Resources**

**Train 3 crews in 4 days, appr. 75 persons**

- Deploy / Land / Recover Modules in Simulator (6 Stations)**
- Human Training in class room; Perception / Situational Awareness / Learning theories / Communication / Team Development / Debrief**
- Dedicated ROV Tasks; HV Bridge / HV Pig Tail / Controlled Landing**

# HV Pig Tail

(Pump Trafo to Pump – 5.8 kV)



# 3D NAV Screen – Online Viz Tool Offshore



# The «Puzzle»

Åsgard Subsea Compression -  
A major field development Project

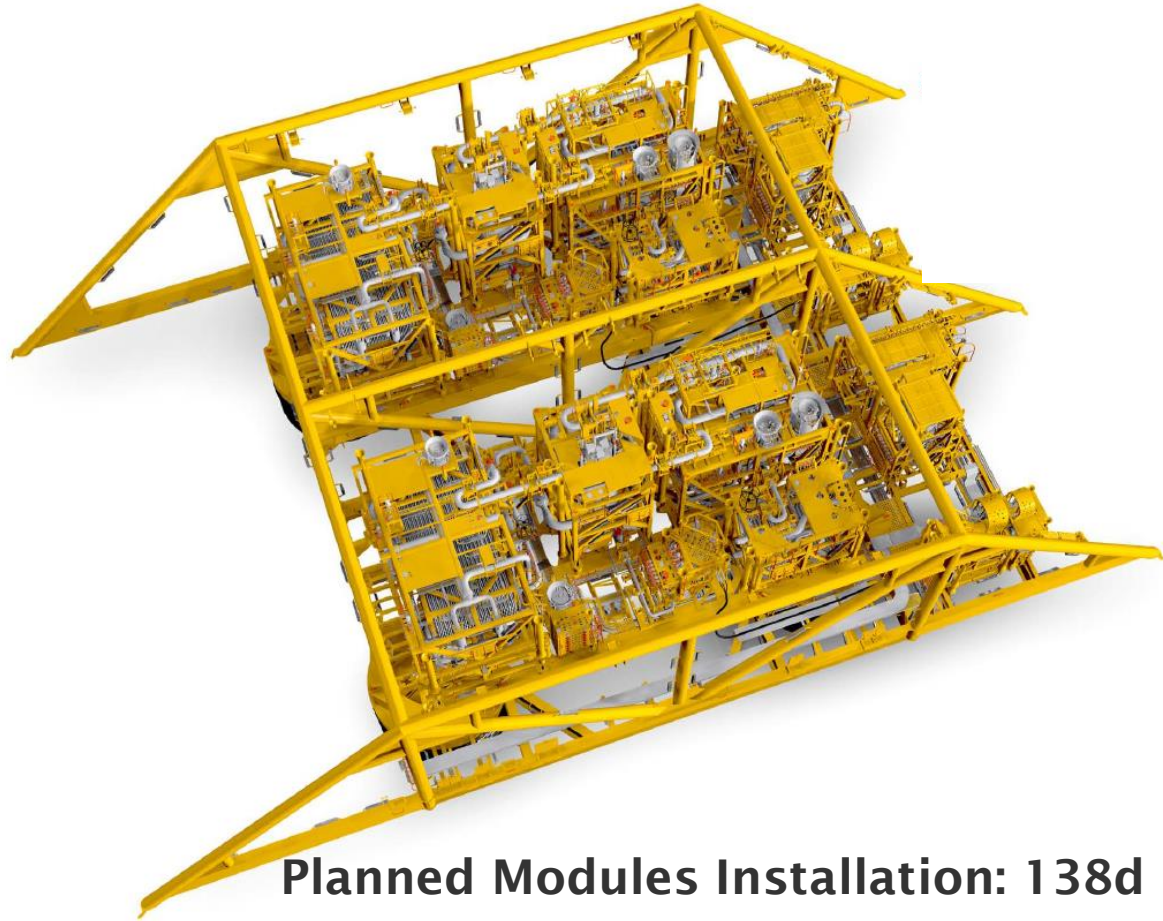
# ASC EXPERIENCES World's First Subsea Compression Station

***Both Trains Installed***

***All Hooked Up***

***Train 1 Running***

***Train 2 soon Running***



***Nothing Damaged***

***Nothing Lost***

***No Mis-haps***

Planned Modules Installation: 138d

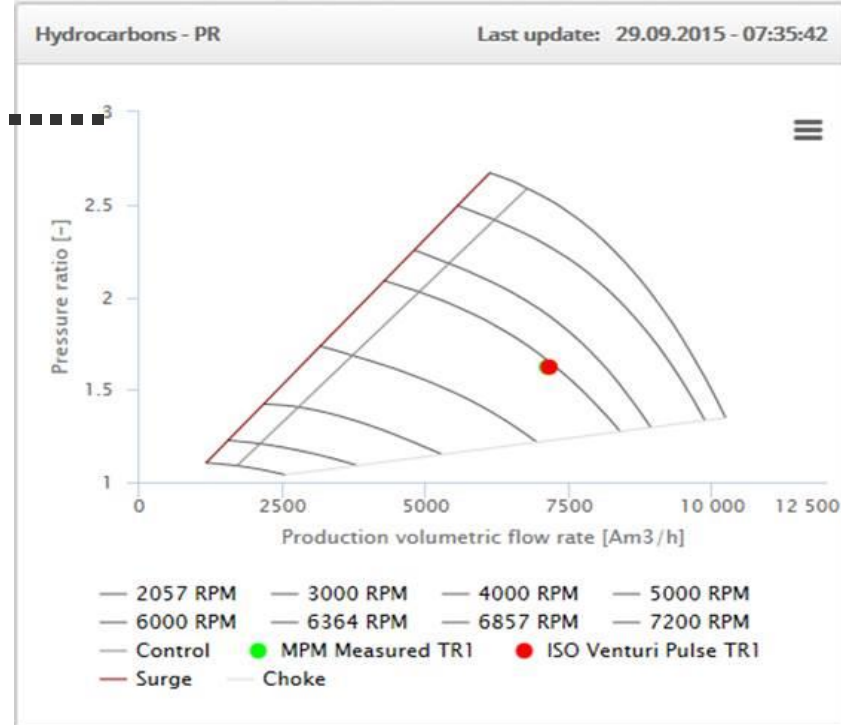
Actual Modules Installation: 80d

**SIMULATION at OSC PAID OFF BIG TIME**

# ASC PERFORMANCE, So far.....

## General – Train 1:

- Train 1 running from 16.09.15
- Smooth, trouble free operation
- Various trips due to platform issues
- 4 – 7 Wells being fed into plant
- All Midgard / Mikkel wells



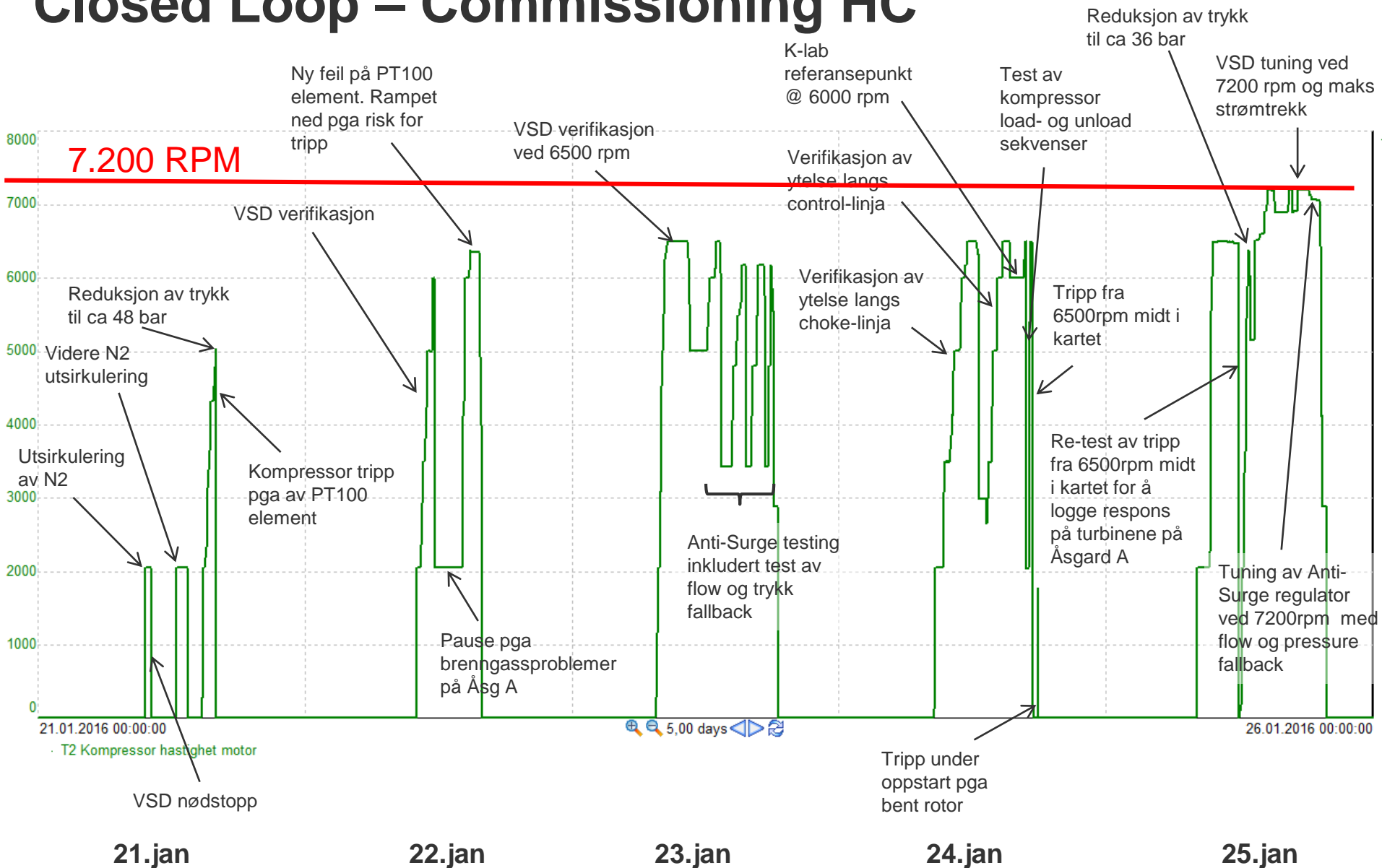
## Compressor:

- dP 20 - 50 bar
- Power 11 MW (max)
- Speed 4-6.000 RPM
- 10 - 15 MSm<sup>3</sup>/d

## Train 2:

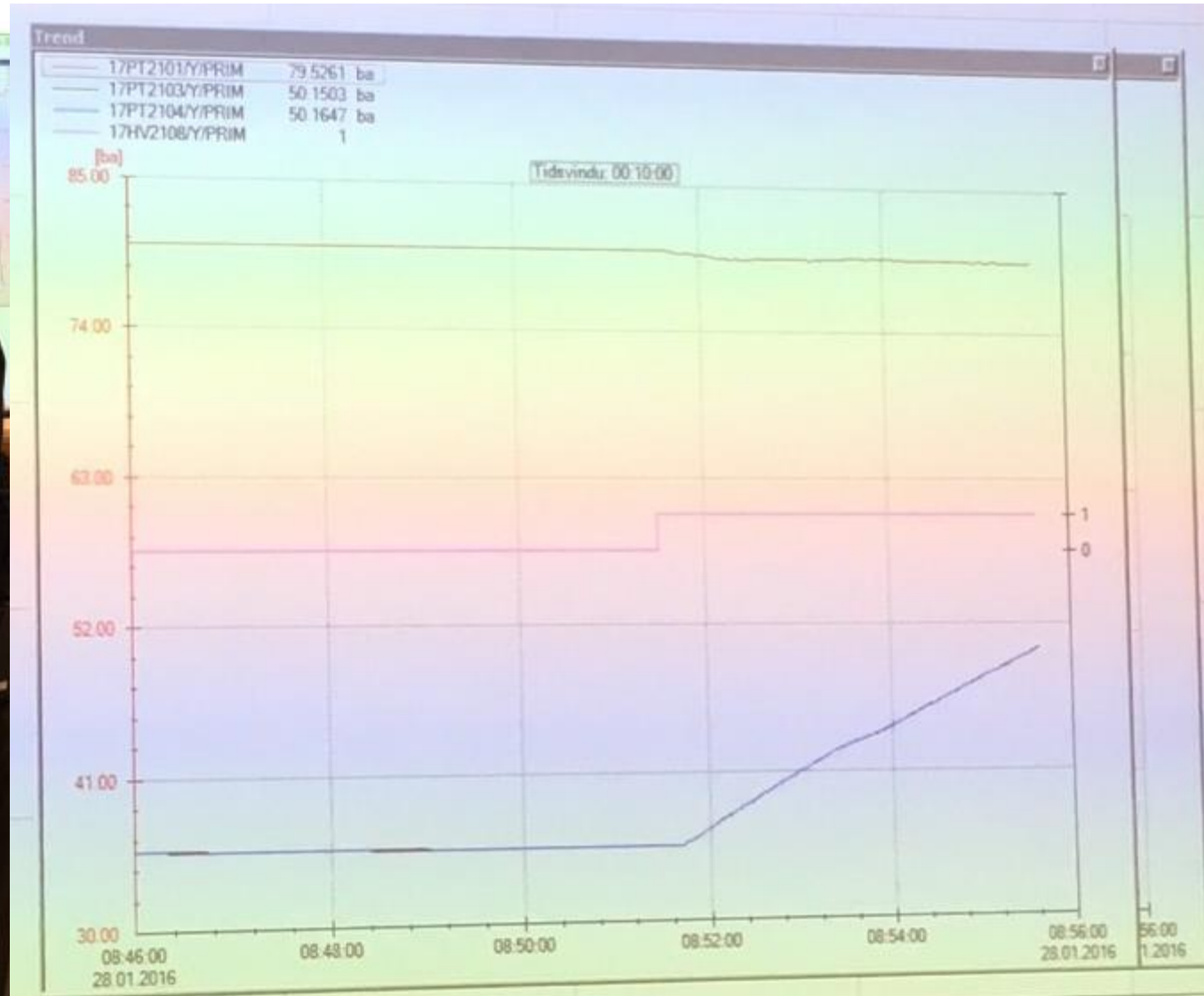
- Cold Commissioning completed
- Hot Commissioning completed
- Closed Loop completed
- Start-Up process IN PROGRESS!

# Closed Loop – Commissioning HC



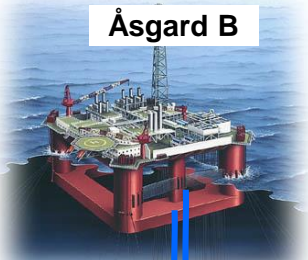
Trykksetting med HC skjedde 19.jan

# «WAR ROOM» Stjørdal - 28th January 2016





# ÅSC Marine Operations ...a long time ago...(2012)

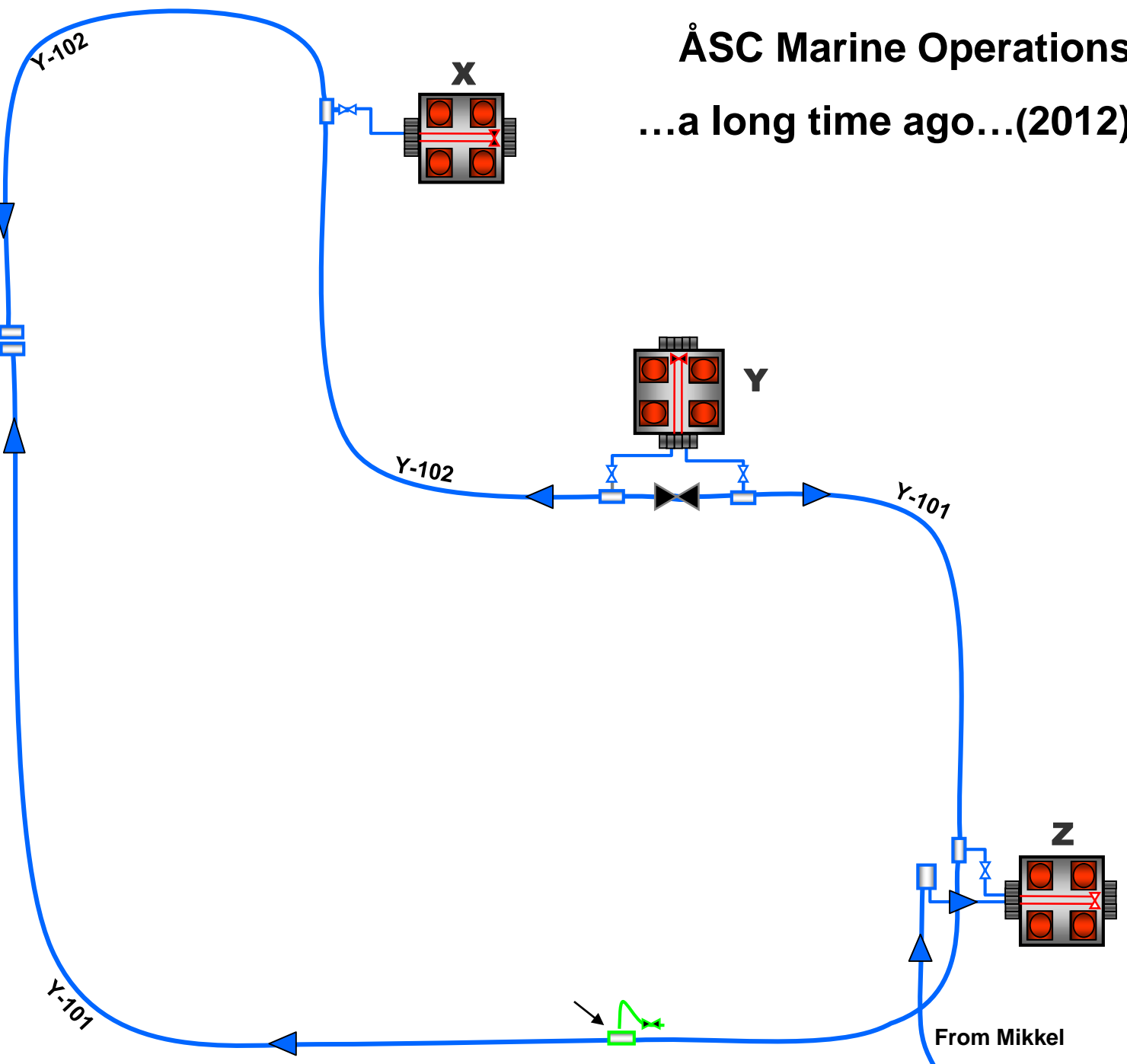


Åsgard B

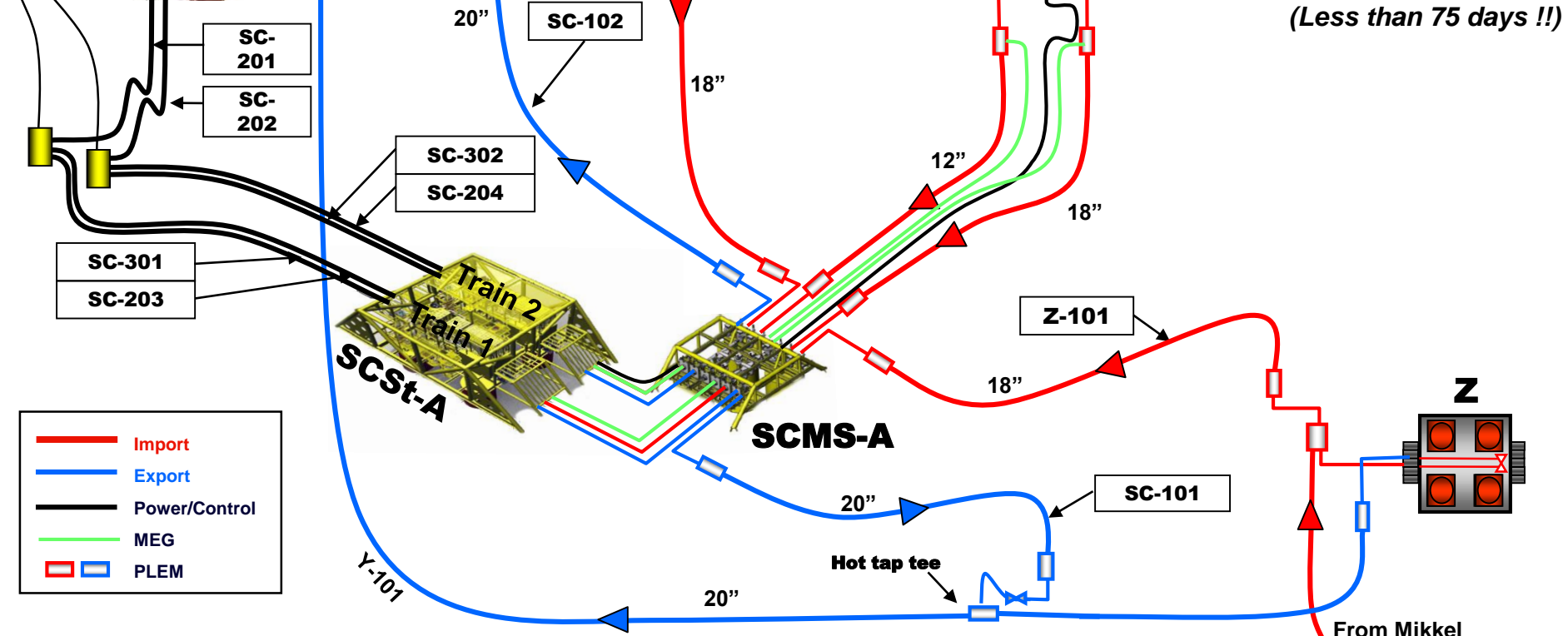
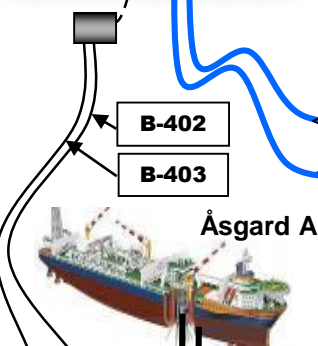
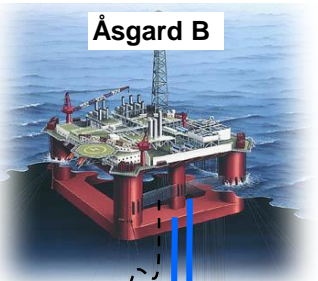


Åsgard A

	IMPORT to SCS/SCMS
	EXPORT to Åsgard B
	POWER/ UMBILICAL
	MEG
	PLEM/PLET
	CABLE SPLICE BOX
	NOT STARTED
	NOT INSTALLED



# Åsgard Subsea Compression - Final Field Layout



1.600 Vessel Days in 4 seasons

Hot Tap Tee (Un-prepared)

SCSt / SCMS / ÅsgA Module Installation

4x 40km Power Cables & Umbilicals

8 Pipelines and 12 PLEMs

18 spools and 139 Tie-Ins

2 x Cassette Base Frames (420t)

RFO and Decommissioning

2x 11 Modules with NSG & SHS

(Less than 75 days !!)

	Import
	Export
	Power/Control
	MEG
	PLEM

# *Thank you!*



*Morten Person*

*ASC Marine Operations Manager*

*moper@statoil.com, tel: +47 90 63 77 11*

*www.statoil.com*

# Back Up

Slides to support

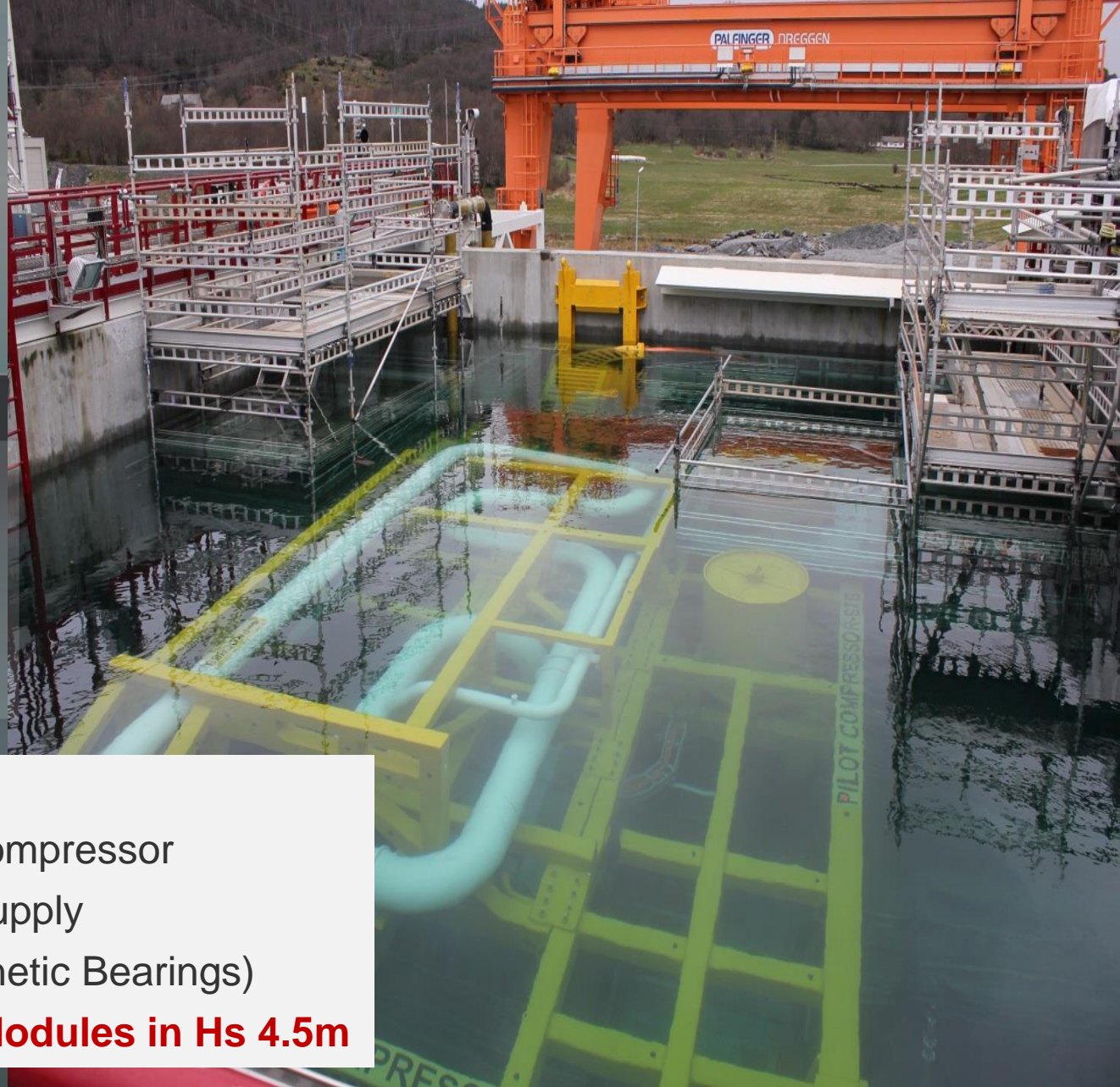
Answer to Questions

# Technology step

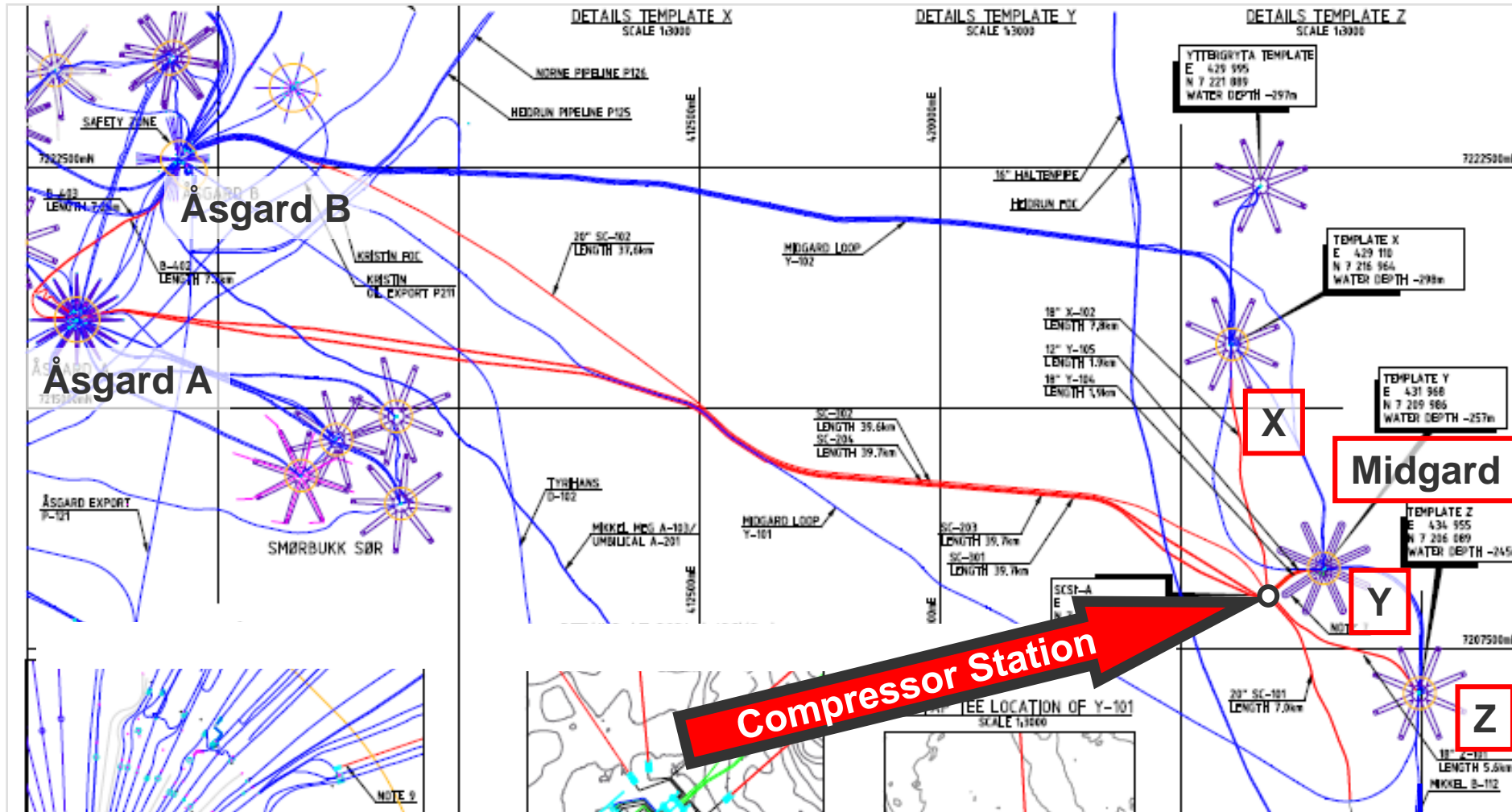
Substantial recovery and lifetime increase for other technology users (gas fields)

Main TQPs (out of 40);

- Electrical Motor for Compressor
- High Voltage power supply
- Control System (Magnetic Bearings)
- **Installation of 300t Modules in Hs 4.5m**



# Åsgard Field, overall field layout

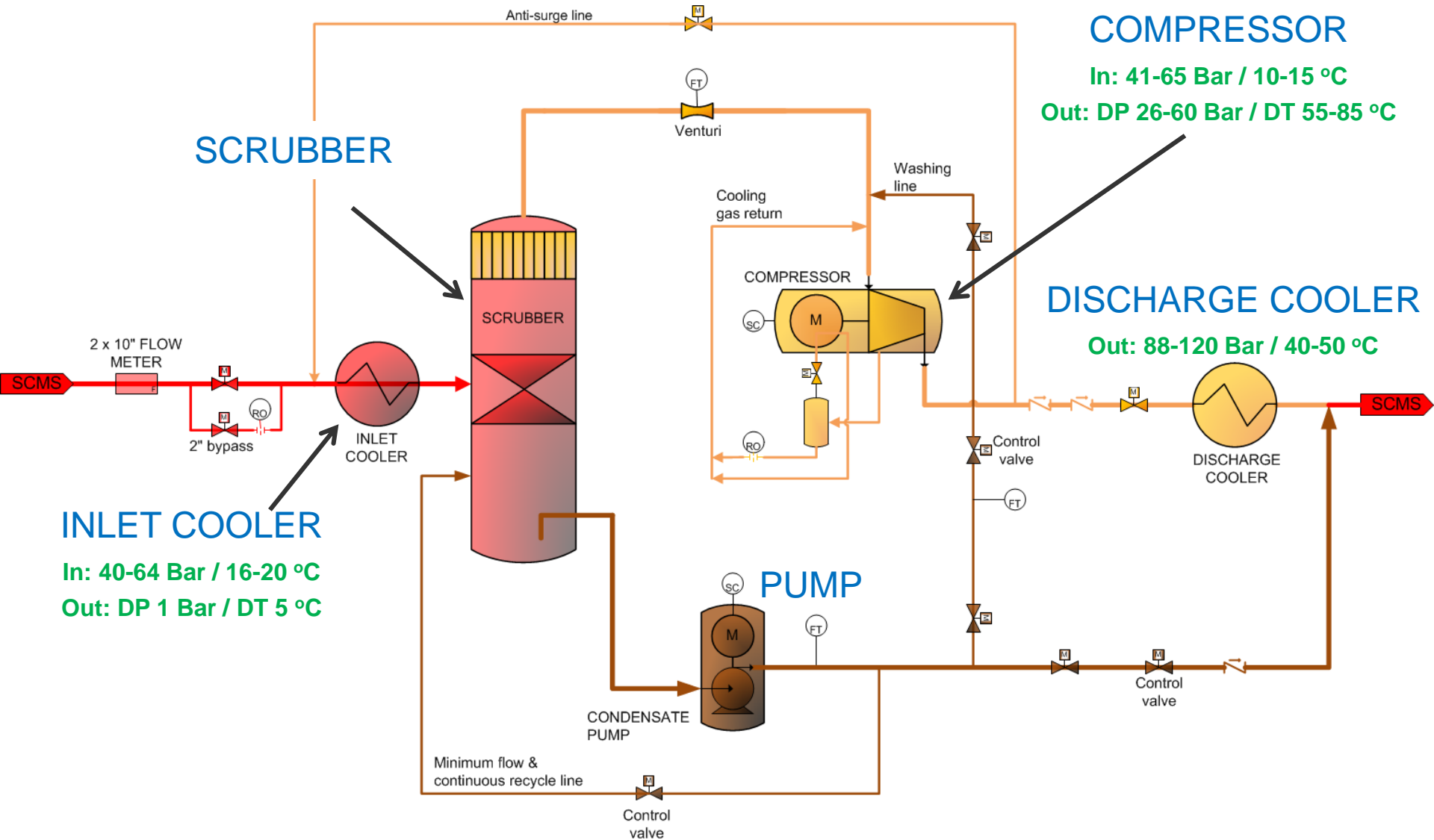


Åsgard, in Norse mythology, is one of the nine worlds and the homeland of the Aesir, the race of warrior gods. Located on the highest level of the Norse universe.

Midgard is Middle Earth.

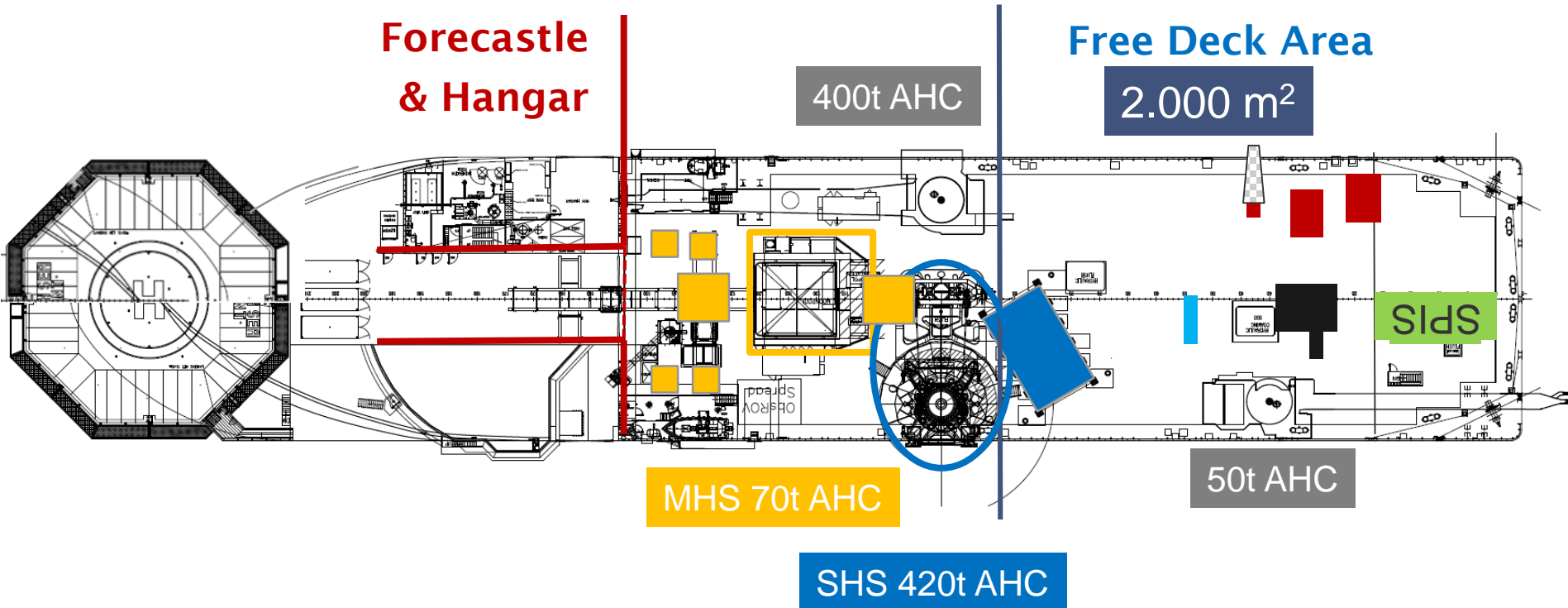
Mikkell

# Process Flow Diagram - ÅSC (pr. Train)



# North Sea Giant – A very versatile, robust and efficient subsea Construction Vessel

NSG in SHS & MHS & SPIS operation modus:

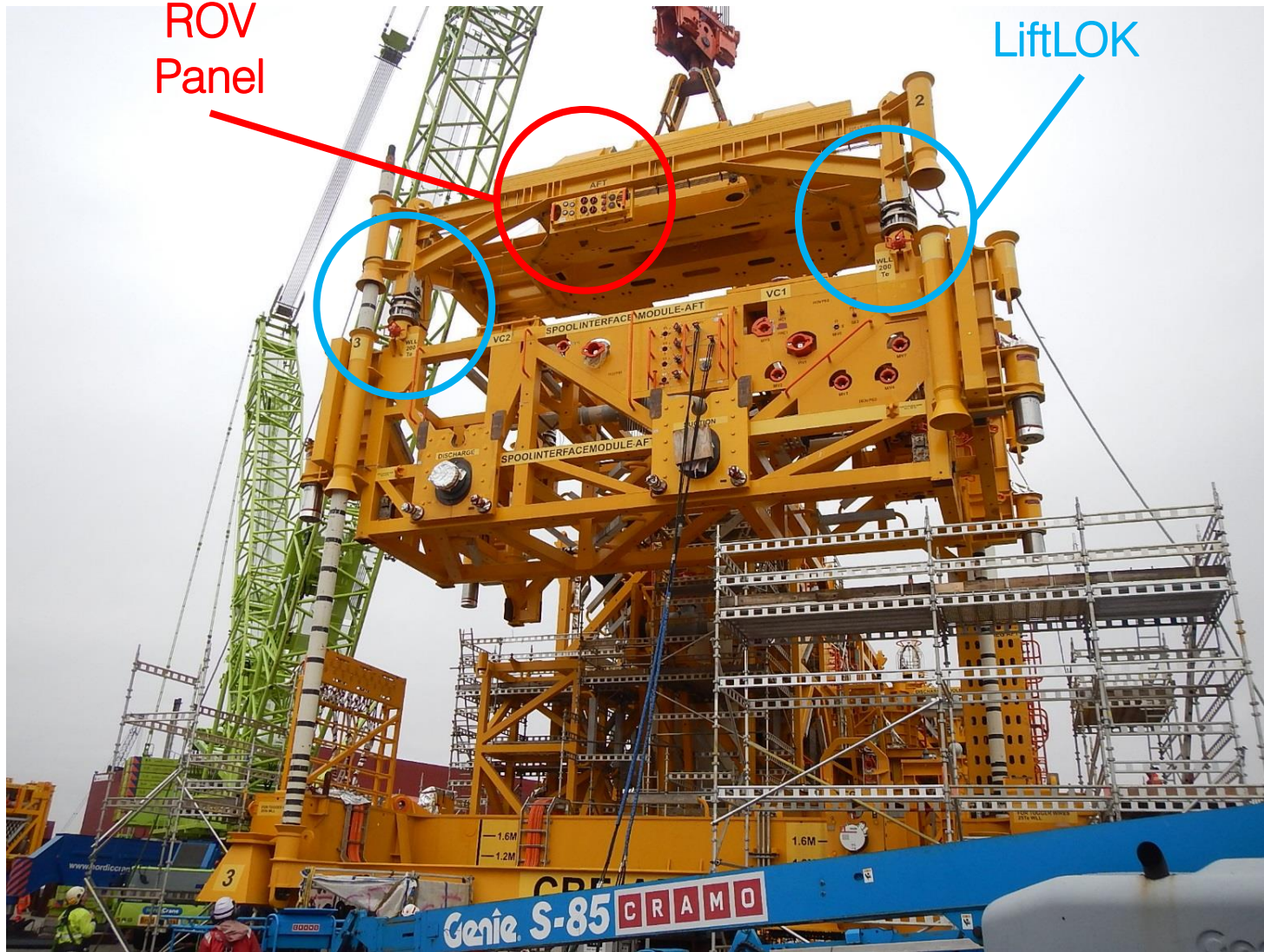
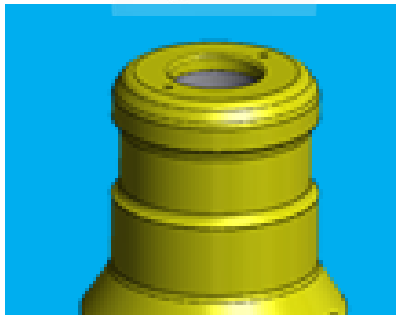






*Compressor Module #2 deployed 8th September 2015 in Hs 2.5m*

# SHS Adapter frames & LiftLOK Connections



# SHS Adapter frames & Liftlok Connections



# Lifting Frame & Liftlok dis-connection



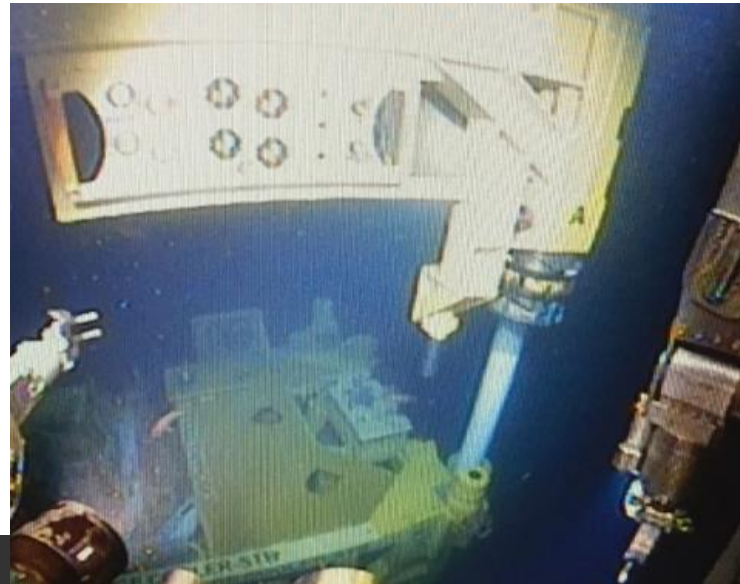
1 Liftlok engaged (self-locked) yellow ring



2 ROV panel for release of lifting frame



3 Liftloks being released, orange ring



4 Lifting Frame disconnected

# Module Controlled Landing

## WHY ??

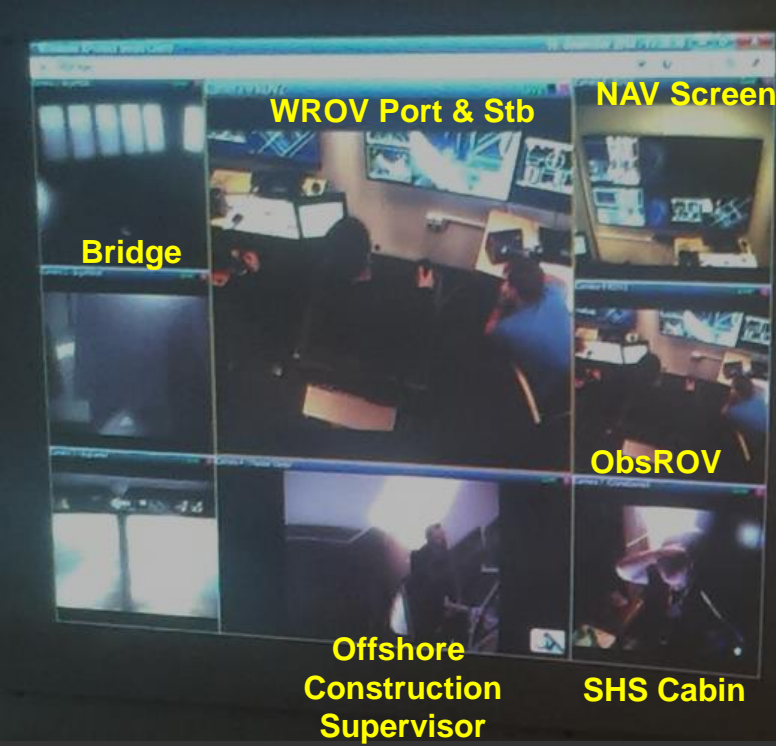
Unlikely, but still possible to damage upfacing hubs on Cassette Base Frame while landing modules

Due to large module, large (stiff) piping



# TRAINING in SIMULATOR

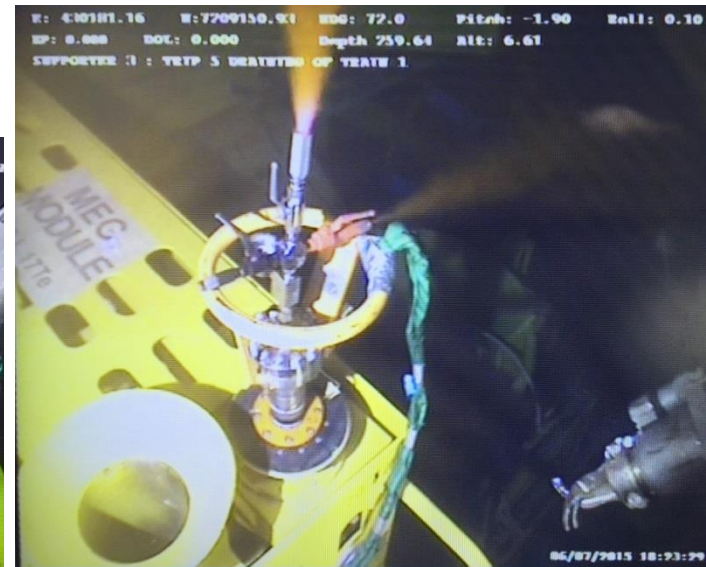
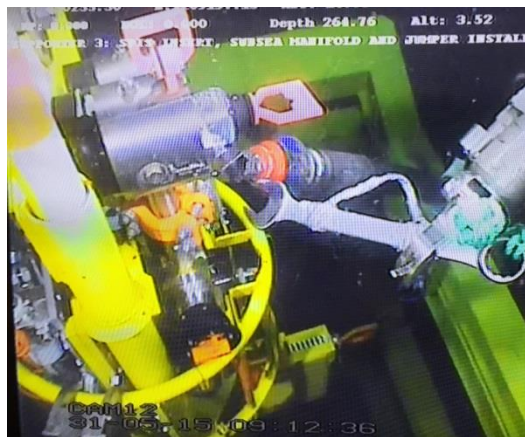
ROV Crew A «off shift» - monitors Crew B  
Clear Com so everybody hears everything  
Instructor Station = Virtual World in Gin Clear viz



# RFO - often an under estimated activity



- Long Durations / Vessel Day impact
  - Leaks and clogged valves
- Large variations in Tools and Torques
- Low Hs to deploy ROV unfriendly hoses



# **PREPARATIONS for OPERATIONS**

***MODULE DEPLOYMENT BY SHS***

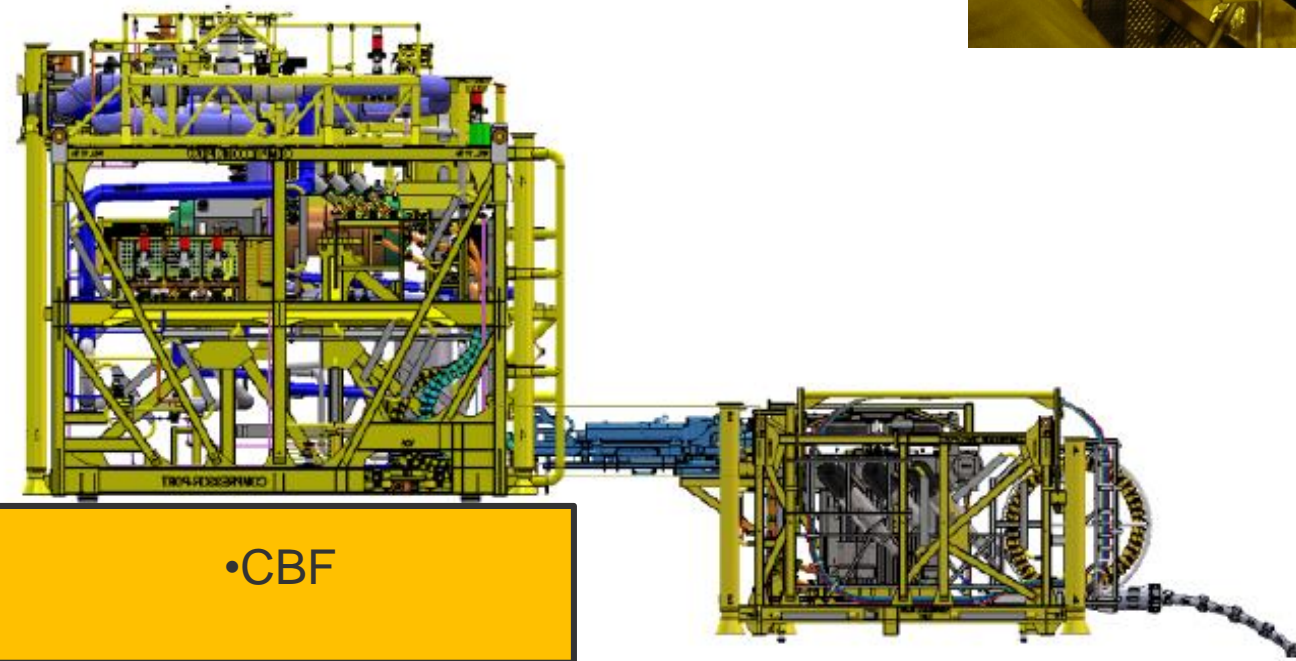
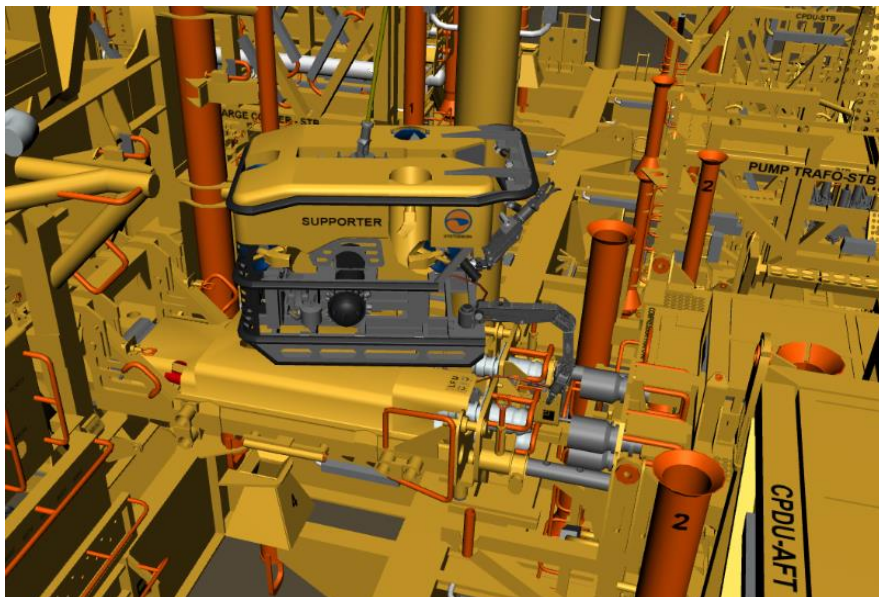
***HOOK-UP OF MODULES SUBSEA***

***TRAINING OF OPERATORS***

***VERIFICATION OF PROCEDURES***



# HV Bridge (Compressor to Compressor Trafo – 36 kV)



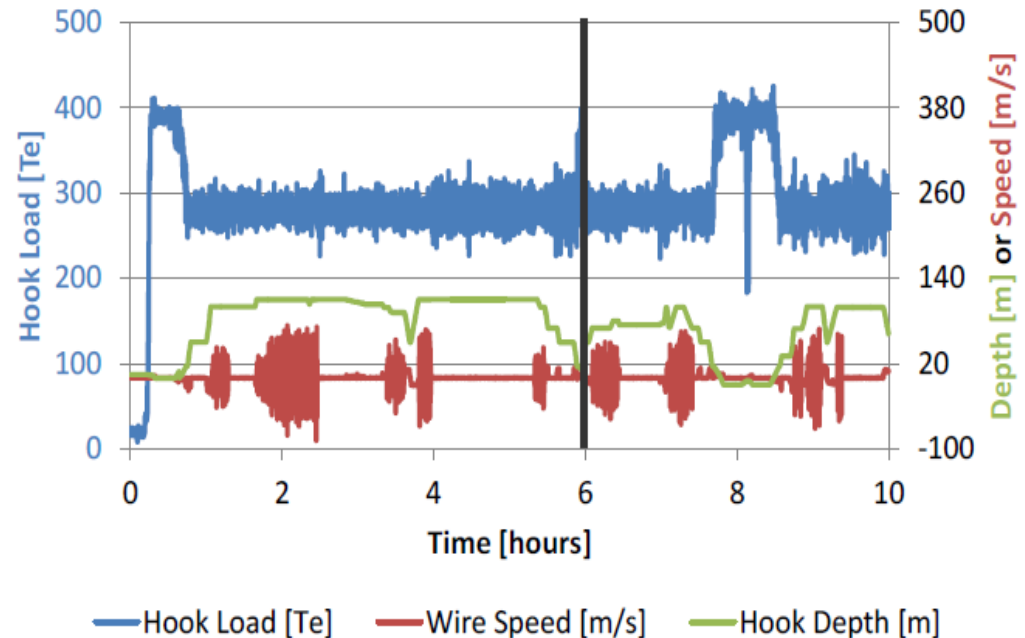
# Bad weather test

## Outside Sandnessjøen

- Hs around 4.0 – 4.5m
- Tp 11 – 12s
- Off best heading to induce roll
  - Exact heading & wave spreading unknown
- Test module 390 te configuration
- Extreme dynamic loads
  - Max 411 te
  - Min 226 te

Offshore logs from 1<sup>st</sup> Nov 2015

### Test Module under Rough Weather



## ■ Extreme loads from analysis

- Max ~ 500 te
- Min ~ 180 te

