Webinars

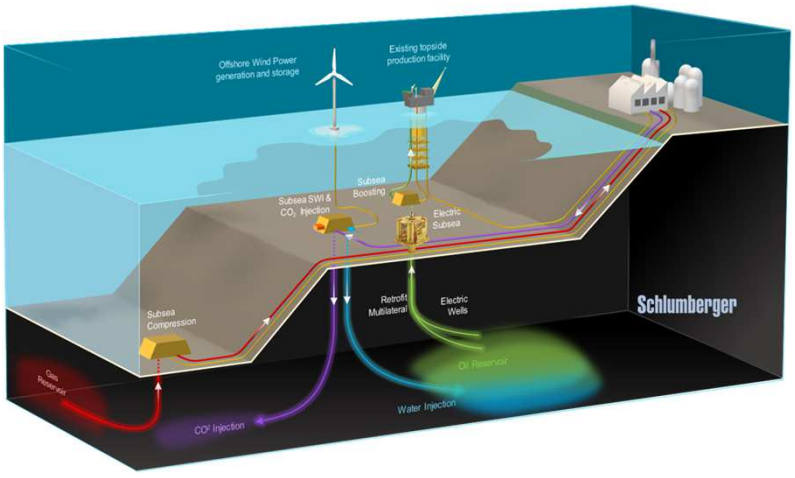
Enabling Low-Carbon Production with Electrification and Subsea Processing

Schlumberger – Stephane Hiron

Equinor – Ole Økland

Moderator: Schlumberger – Mads Hjelmeland

Production Systems Electrification



All-Electric Wells
Maximize production of valuable fluids in a minimum number of wells

All-Electric Subsea
Smaller, cleaner, cheaper, smarter, extendable

Subsea boosting & separation
Lift oil, reinject water & undesired gas, CCS enabler

All-Electric Platforms
Direct Electric feed from low carbon source

Digital Enablement
Full process insight, Advanced diagnostics, Automation

Reduced cost

Improved reliability, enhanced operability

Digitally enabled, automation ready

Improved sustainability, reduced footprint

Production Systems

Schlumberger

Vigdis Booster Station
Installation, Start-up and Operation

Presentation on
SPE Webinar
2nd November 2021

VBS project team

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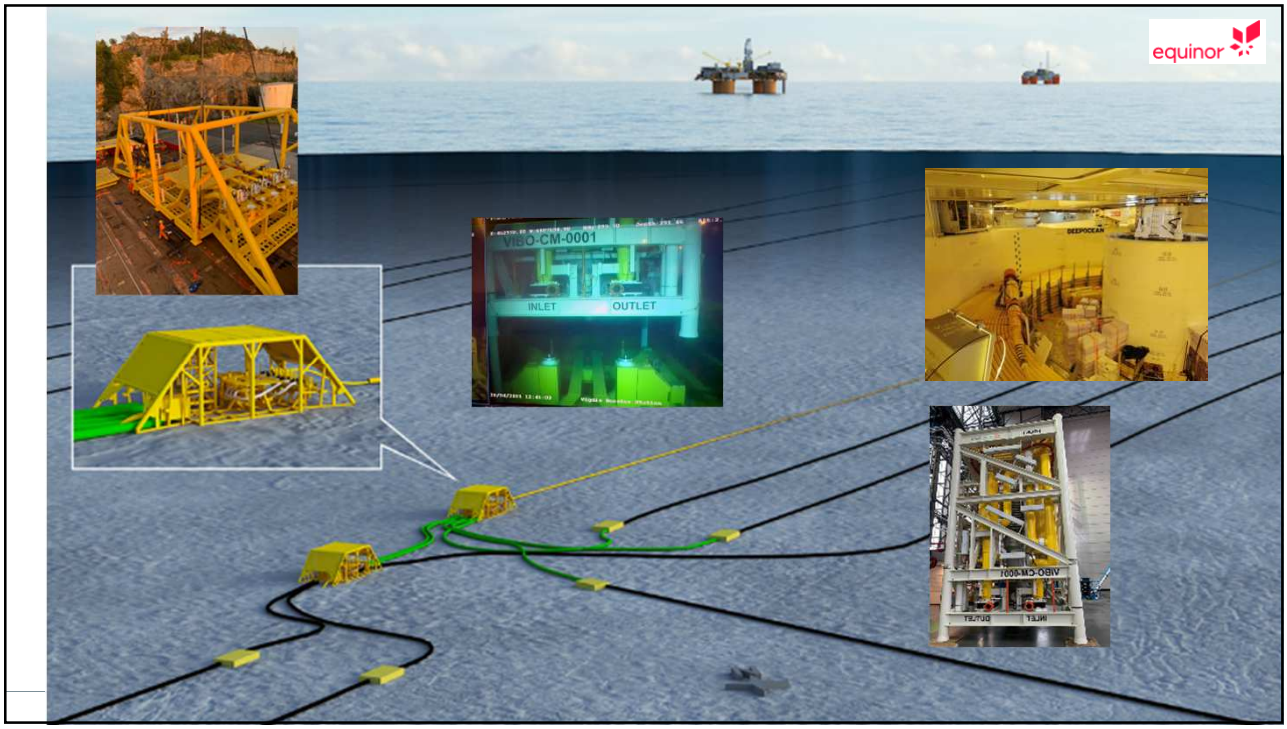
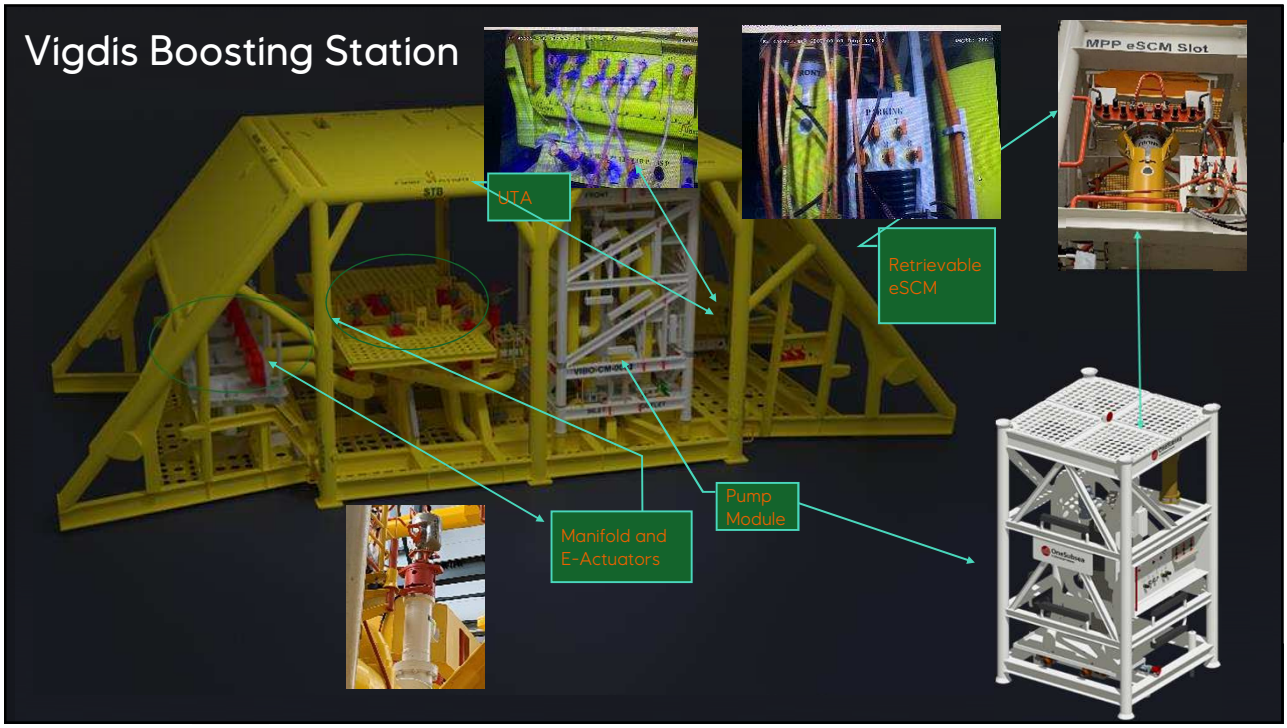


Agenda - Vigdis Booster Station (VBS)

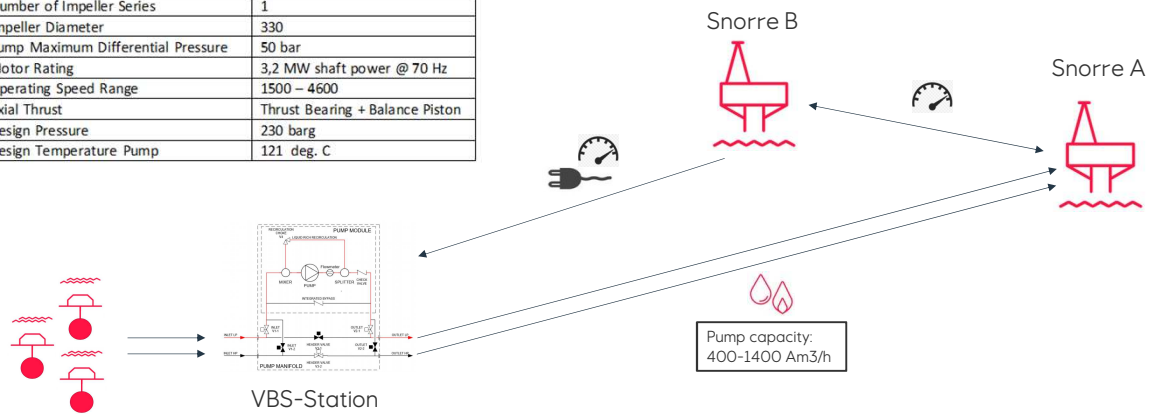
- Project overview and Business case
- General information
- Topside equipment at Snorre B
- Installation phase 1 (2020)
- Installation phase 2 (2020)
- Installation phase 3 (2021)
- Commissioning & start-up (April-Mai 2021)
- Early phase (Mai-June 2021)
- *The Future is "All electric"*

Vigdis Boosting Station



General information

Parameter	Value/Selection Vigdis
Type	Multiphase Hx330 Helico Axial
Number of Pumps	2
Number of Stages	8
Number of Impeller Series	1
Impeller Diameter	330
Pump Maximum Differential Pressure	50 bar
Motor Rating	3,2 MW shaft power @ 70 Hz
Operating Speed Range	1500 – 4600
Axial Thrust	Thrust Bearing + Balance Piston
Design Pressure	230 barg
Design Temperature Pump	121 deg. C



Topside equipment at SNB

- Control cabinets
- Variable Speed Drive
- Transformer

Snorre B




Topside equipment

- HPU
- TUTU
- Umbilical (High Voltage, Low Voltage, Fiber Optic, barrier fluid)

Snorre B




Installation phase 1 - 2020

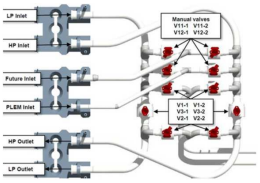
- Station Installation
  - VBS on Mudmats installed August 2020 on a rock carpet next to Vigdis template B, no issue. Good planning is key to success.
- Umbilical Installation
  - 17 km integrated power and controls umbilical installed from SNB to VBS Aug/sept 2020. SUTA landed in VBS but not connected.

Installation phase 2 - 2020

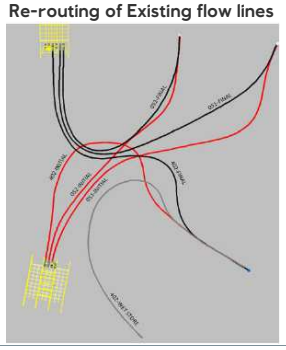
- Tie-in of station to production

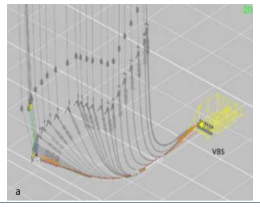
1. Wet store 2 off new 100m long Flexible flowlines
2. Disconnect 3 off old Flextailes from Template B (connected 1996)
3. Connect 3 off old Flextails to new Booster station (re-routed from Template B)
4. Replace 3 off Clamp connector at Template B
5. Re-rout and connect 2 off new Flexible flowlines between Template B and VBS
6. Release 1 off Pressure cap at VBS
7. Install 1 off Pressure cap on inboard hub at Template B

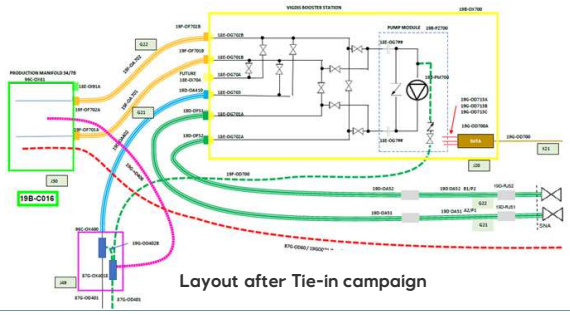
VBS Manifold Large bore piping



Re-routing of Existing flow lines



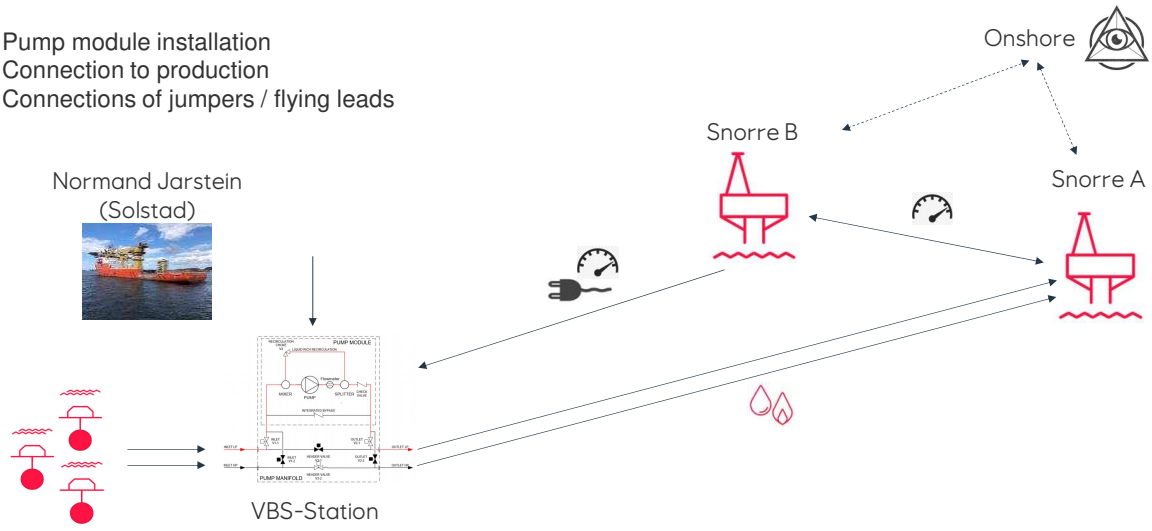




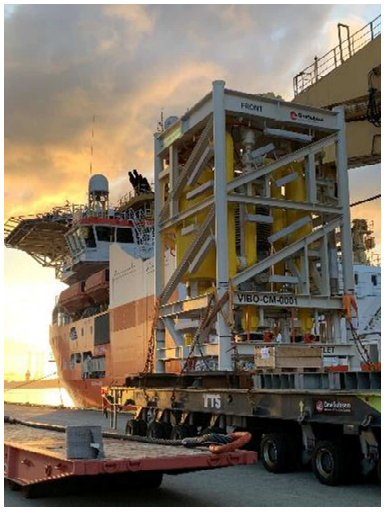
Layout after Tie-in campaign

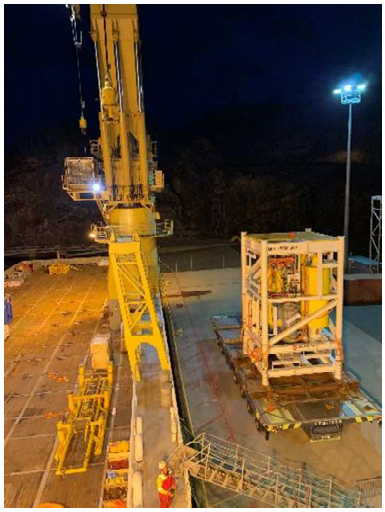
Installation phase 3 - 2021

- Pump module installation
- Connection to production
- Connections of jumpers / flying leads

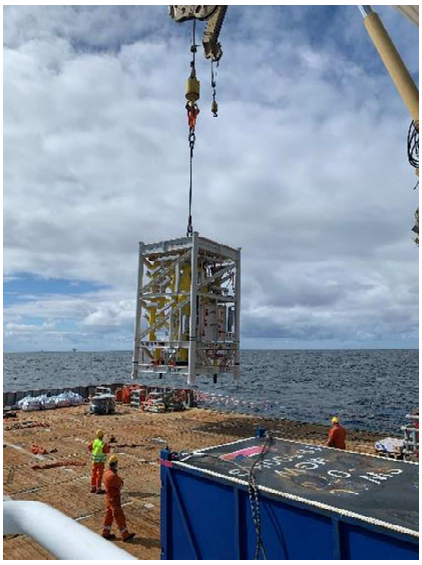


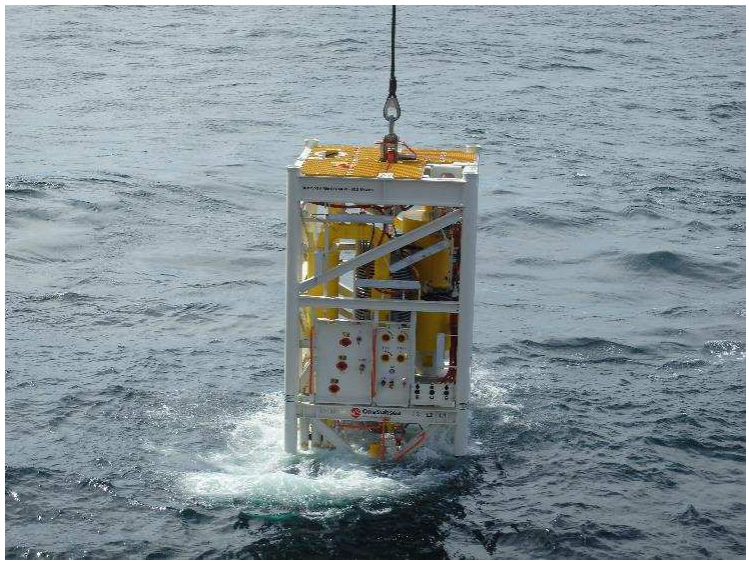
Mobilisation on Normand Jarstein (Solstad)





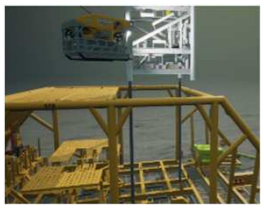
Pump deployment

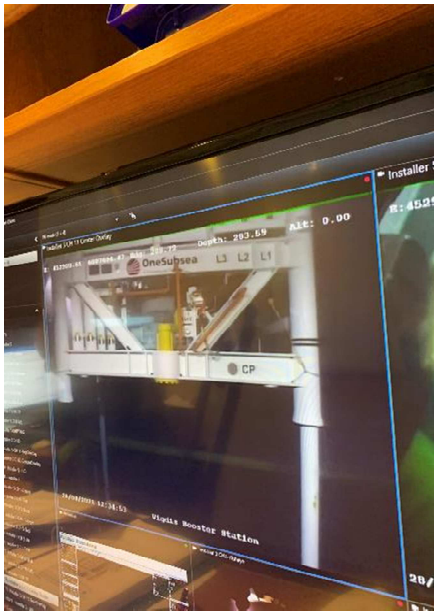


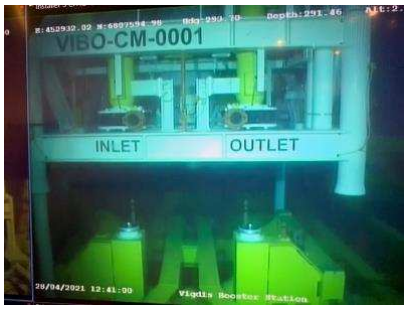


Connection

- Insert & land the Module
- Close Destec clamps
- Perform Back Seal test

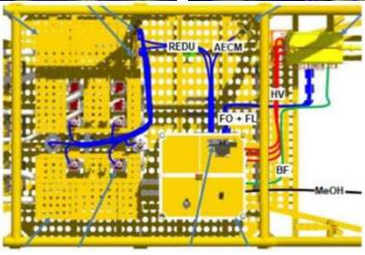


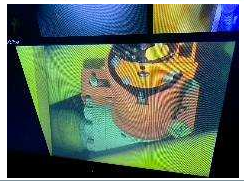




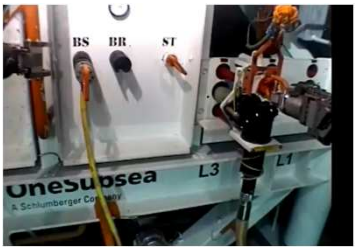
Electrical, optical and hydraulic connections

- Electrical & optical
  - Connect OFLs and EFLs between eSCM and SUTA
  - Opening BF Valve V-1-3
  - Connect HV Flying leads
  - Connect remaining signal flying leads (eSCM to eSCM)
  - Connect MeOH jumper to PM
  - SEM A&B Power up: Control System Commissioning
- Functional test
  - MPP Functional test: BF Commissioning
  - Valve testing of Choke Valve XV704 (V4) and MeOH valve XV771 (V71): Control System Commissioning





Electrical, optical and hydraulic connections



Pump operation and power test, day 2&3

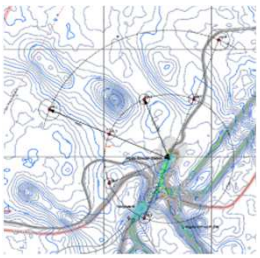
- Pump Operational test
  - Up to max speed 4600 RPM
  - 24 hours load test
- Close collaboration with Petec: supervise transients upstream & downstream

Operational/power test

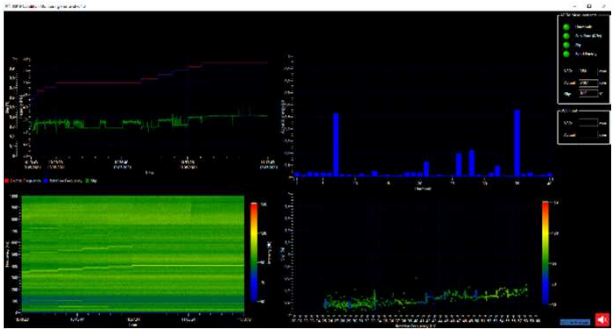
Adjustments to load test

Naxys & DeepOcean & Platform

- Acoustic Leak Detection (ALD) at VBS
- Acoustic and Electrical Condition Monitoring
- Pump conditioning monitoring and audio
- Noise measurement at VBS (5-8 positions)

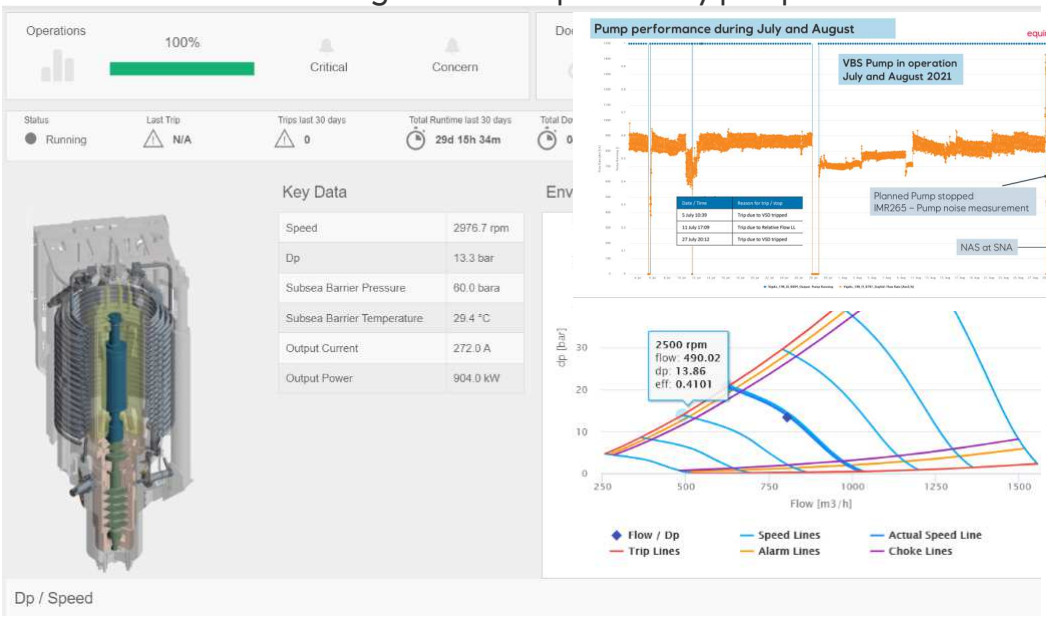


Noise measurement: pump starts and stops



Speed increase from 3400 RPM to 3500 RPM

Operations FRIEND – Showing flow envelope and key pump data



All Electric Subsea System

- Subsea Pump stations prior to VBS have been electro-hydraulic control system. Equinor specified all-electric solution for Vigdis
- The conceptual solution contained un-qualified solution.
  - Subsea battery
  - New designed power supply
- **Project decision→ Change to fail-As-Is philosophy (no need for battery or new components.)**

- Large-bore Manifold valves
  - HighPower High Torque Actuator
  - Wittenstein
- Small-bore control valves.
  - Low PowerLow Torque Actuator, OSS
- Gear between Valve and Actuator
  - API 17D ROV class 7/class 4 interface
  - Verktøy Industri

Pump Module Control Valves

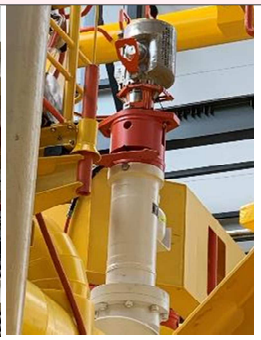
- There are 2 electrically actuated valves with corresponding LP/LT eActuator (24 V DC)
- There are 4 ROV operated small bore valves
- There are 3 NRV Valves
- There are 4 ROV panel valves only used during pump installation for BF flushing and sampling

Pump Station Process Valves

- There are 6 electrically actuated valves with corresponding gear and eActuator (300-600 V DC)
- There are 4 ROV operated Valves
- All valves are delivered by Cameron (Ring-O)
- Alle valves are Ball Valves - quarter turn to open /close

All eActuators need to be calibrated after installation. Included in Valve testing and commissioning program

No.	EQN Tag No.	OSS Alias	Description	Size / Type	LP/LT eActuator SIE No.
1	19B-XV 704	V4	Choke Valve w/LPLT eActuator	5 1/8 inch Choke Valve Opening / Closing time: Approx 7 min.	VIBO-EA-0001 VIBO-EA-0009*
2	3/4"GAUX1-720	V20	Intervention Valve - ROV operated	3/4" Subsea slab gate valve - 9 turns to open	N/A
3	3/4"GAUX1-721	V21	Intervention Valve - ROV operated	3/4" Subsea slab gate valve - 9 turns to open	N/A
4	3/4"GAUX1-722	V22	Intervention Valve - ROV operated	3/4" Subsea slab gate valve - 9 turns to open	N/A
5	3/4"GAUX1-770	V70	MeOH Inj. Valve - ROV operated	3/4" Subsea slab gate valve - 9 turns to open	N/A
6	19B-XV 771	V71	MeOH Inj. Valve w/LPLT eActuator	3/4" Subsea slab gate valve - 9 turns to open. 1440 turns on eActuator Opening/Closing time: Approx 2.6 min	VIBO-EA-0002 VIBO-EA-0010*
7	1"CKUX1-772	V72	NRV MeOH injection line	1 inch NRV	
8	10"CKUX1-706	V6	NRV Downstream flow splitter	10 inch NRV	
9	10"CKUX1-713	V13	NRV Internal by-pass line	10 inch NRV	
10	N/A	V1-1	BF isolation valve for BF return coupler – ROV operated	3/8 inch turn to	
11	N/A	V1-2	BF isolation valve for pump integrated accumulators - ROV operated	3/8 inch turn to	
12	N/A	V1-3	BF isolation valve between ROV panel and pump - ROV operated	3/8 inch turn to	
13	N/A	V1-4	BF isolation valve for pressure manometer - ROV operated	3/8 inch turn to open	



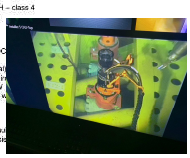
6.1.6 HP/HT eActuator for Process Valves
6 of 10 process valves are equiped with an eActuator. Ref table in 4.7.
These are named HP/HT eActuator and are supplied by electric power from the topside EPU.
Key data:

General data:
- Design Water Depth 3000m (10000 ft)
- Design life 25 years
- Redundancy No - single channel
- Mechanical Override No
- Retrievability Yes
- Fail "as is" on loss of power or communication
- Output Torque Maximum: 2700 Nm
- Breakout Torque: 1800 Nm
- Nominal: 1000 Nm @800W power
- Output speed Approx. 1 rpm @2700Nm consumption
- Approx. 2.6 rpm @ 1800Nm
- Approx. 4.0 rpm @ 880Nm

Mechanical Interface
- Valve Interface API RP 17H – class 4
- ROV interfaces D-handles

Electrical Interface
- Input voltage 300 - 800V DC
- Input current max. 5A
- Input Power 800W (nominal
- 1800 W (max @ 600V DC in
- Idle mode power max. 10W
- Connector Siemens 7-way w

Communication Interface
- Communication SIB L2 (fau
- Note: 500Ω termination resis



Vigdis Booster Station - Lesson learned on schedule and execution for next project:

- Subsea pump technology is deployable and has high reliability
- A subsea pump station is significant different from a conventional Subsea Production System
  - Subsea Pump system consist of large topside power equipment, power & Control cable and pump module
  - SAS integration requires high attention
  - All Electric control is the future!
  - Barrier Fluid system and production chemicals still needed.
  - Subsea pump systems have high reliability
- Standardization of Pump Module interface
- Project execution in 20 months:
  - Feed period: 6 months
  - Pre engineering: 3 months
  - Engineering and 30% design review : 3 months -→**Engineering freeze and start detail engineering**
  - Detail engineering : 3 months
  - Fabrication of large steel structures, pump forging: 4-6 months→ Delivery milestones follows 12 months after contract award
  - Horsøy site: System fabrication and preparing for System and operation testing: 4 months
  - System and operation testing: 1 month
  - Delivery to Equinor: July 2021 (on time). **20 months after Contract award**
- On critical line: Transformer + Power & Control Module (topside equipment)

equinor

Acknowledgements

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