Aasta Hansteen

Operational Experiences

FFU Seminar – 28th January 2016

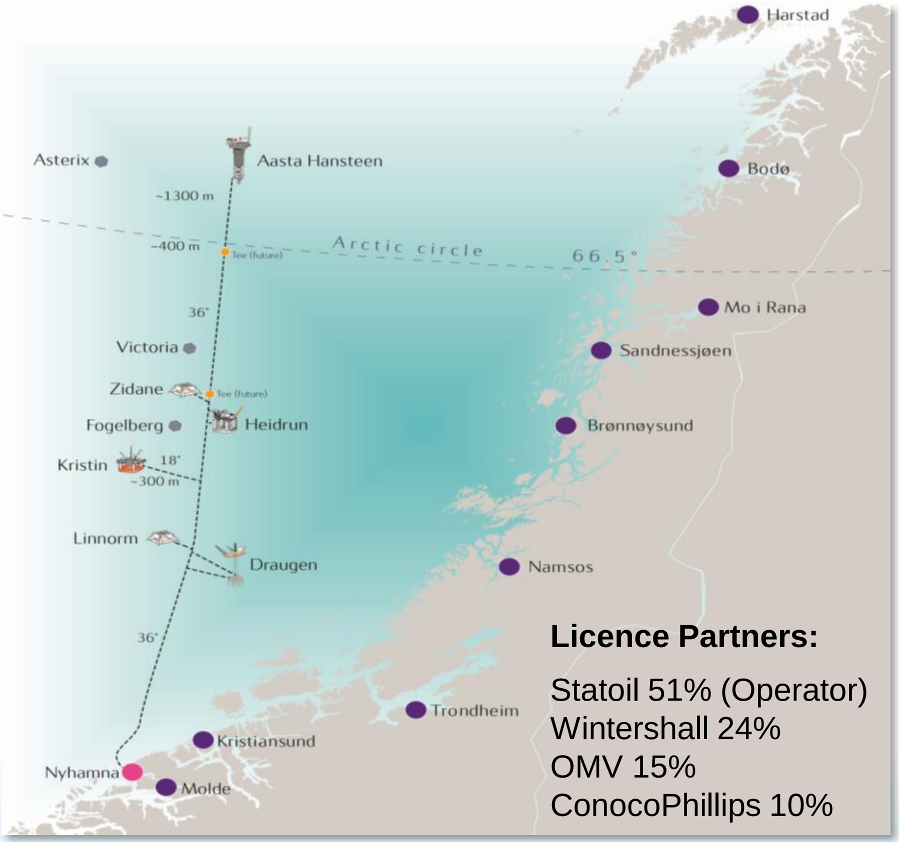
Tom-Erik Henriksen

Agenda

- **Introduction to Aasta Hansteen**
- Main Challenges & Risks
- Operational Experiences - 2015 Campaigns

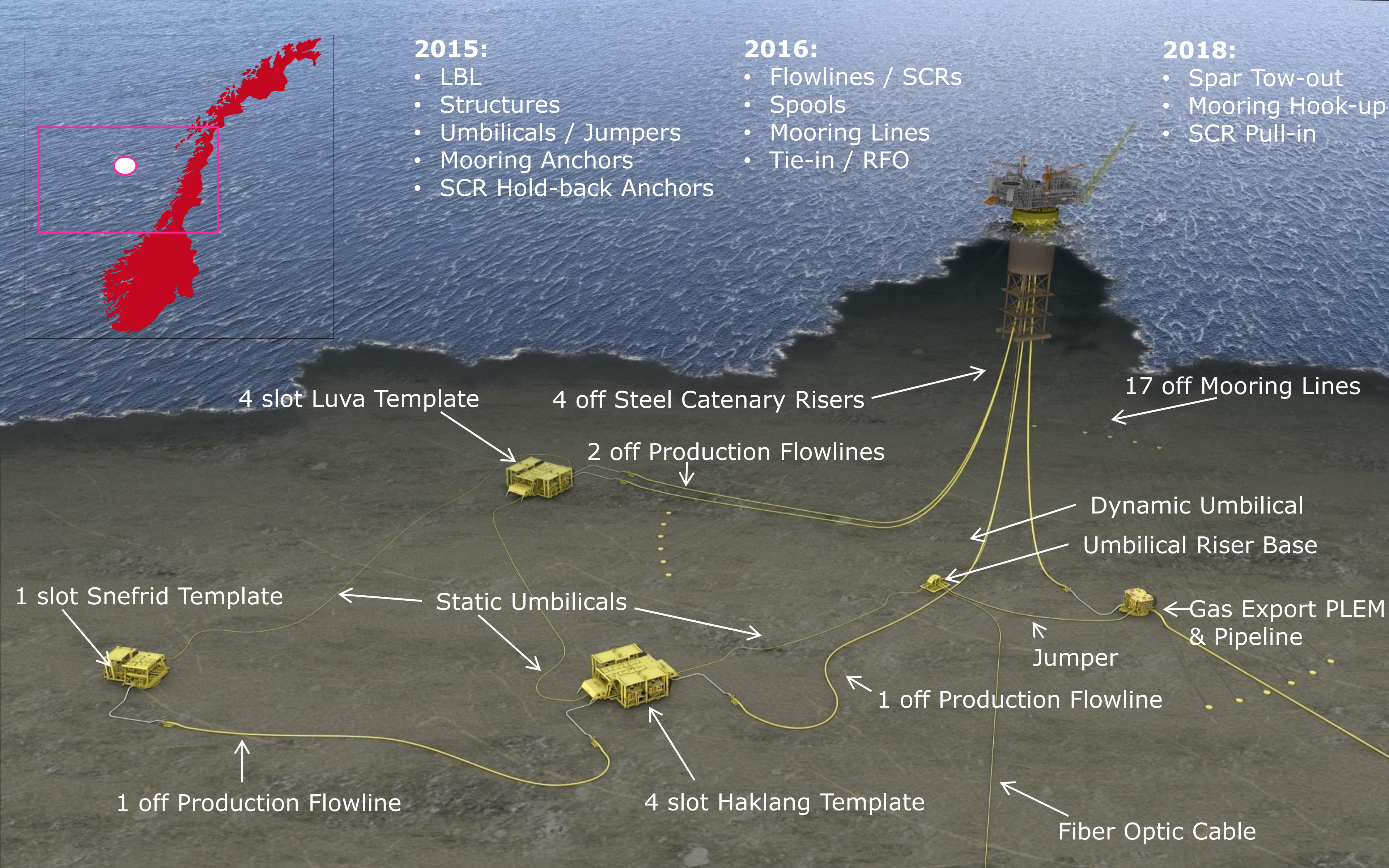
Aasta Hansteen – Pioneer in Norwegian Deep Water

- Dry gas field
- 1300 m water depth
- Reserves 47 billion Sm3
- Process capacity 23 million Sm3/day
- Seven production wells
- New 480 km gas pipeline to Nyhamna (Polarled)
- Production start up: 2018



Licence Partners:

Statoil 51% (Operator)
Wintershall 24%
OMV 15%
ConocoPhillips 10%



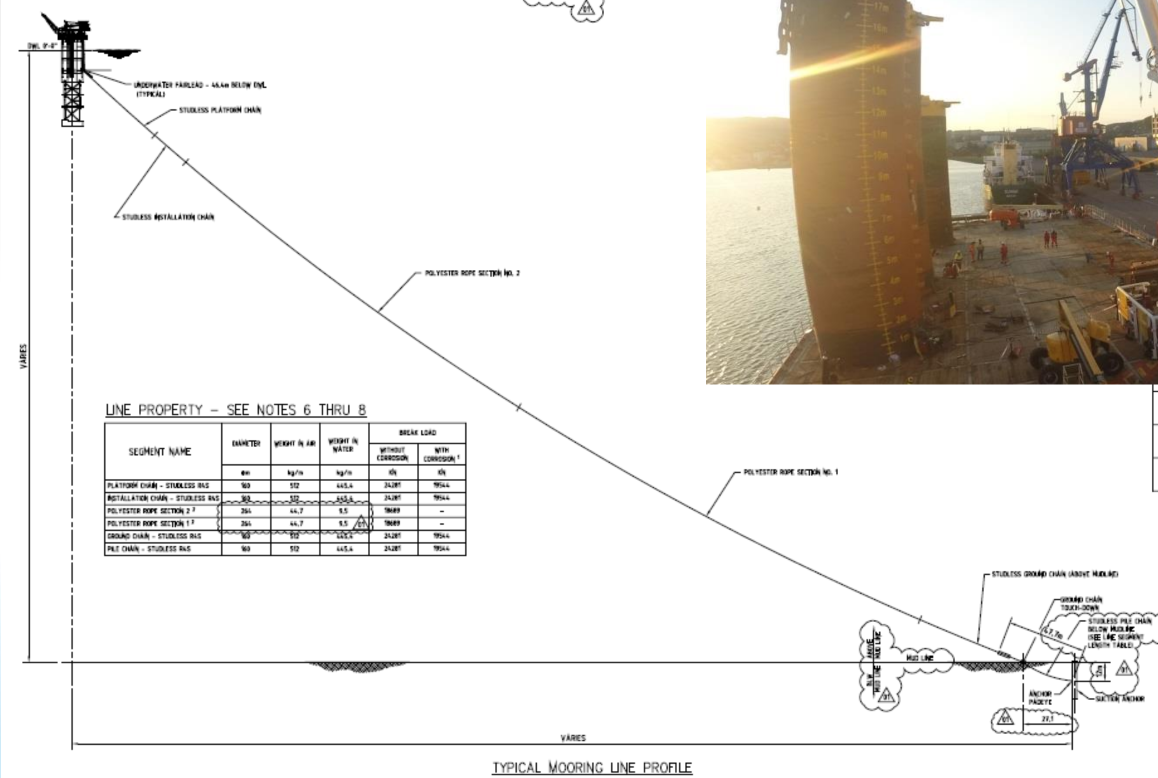
2015:
• LBL
• Structures
• Umbilicals / Jumpers
• Mooring Anchors
• SCR Hold-back Anchors
2016:
• Flowlines / SCRs
• Spools
• Mooring Lines
• Tie-in / RFO
2018:
• Spar Tow-out
• Mooring Hook-up
• SCR Pull-in
4 slot Luva Template
4 off Steel Catenary Risers
17 off Mooring Lines
2 off Production Flowlines
Dynamic Umbilical
Umbilical Riser Base
1 slot Snefrid Template
Static Umbilicals
Gas Export PLEM & Pipeline
Jumper
1 off Production Flowline
1 off Production Flowline
4 slot Haklang Template
Fiber Optic Cable

Mooring system

subsea 7

LINE SEGMENT LENGTH – SEE NOTES 1 THRU 5

GROUPS	MOORING LINE NO.	MOORING LINE AZIMUTH ANGLE ¹	PRE-TENSIONS FAIRLEAD	PLATFORM CHAIN LENGTH ABOVE FAIRLEADS	PLATFORM CHAIN LENGTH BELOW FAIRLEADS	INSTALLATION CHAIN LENGTH	POLYESTER ROPE LENGTH ¹ SEGMENT 2	POLYESTER ROPE LENGTH ¹ SEGMENT 1	GROUND CHAIN & PILE CHAIN LENGTH ABOVE MUDLINE	GROUND CHAIN & PILE CHAIN LENGTH BELOW MUDLINE
		DEG	MT	m	m	m	m	m	m	m
GROUP 1	1	287.5	312.2	203.0	91.4	30.0	1,201.1	1,201.1	107.2	29.1
	2	292.5	312.3	203.0	91.4	30.0	1,201.1	1,201.1	107.2	29.1
	3	297.5	312.5	203.0	91.4	30.0	1,201.1	1,201.1	107.2	29.1
	4	302.5	312.7	203.0	91.4	30.0	1,201.1	1,201.1	107.2	29.1
	5	307.5	312.8	203.0	91.4	30.0	1,201.1	1,201.1	107.2	29.1
	6	312.5	312.9	203.0	91.4	30.0	1,201.1	1,201.1	107.2	29.1
GROUP 2	7	50.0	364.3	203.0	91.4	30.0	1,204.0	1,204.0	107.2	29.1
	8	55.0	364.1	203.0	91.4	30.0	1,203.9	1,203.9	107.2	29.1
	9	60.0	363.9	203.0	91.4	30.0	1,203.9	1,203.9	107.2	29.1
	10	65.0	363.7	203.0	91.4	30.0	1,204.0	1,204.0	107.2	29.1
	11	70.0	363.5	203.0	91.4	30.0	1,204.0	1,204.0	107.2	29.1
GROUP 3	12	167.5	290.9	203.0	91.4	30.0	1,199.8	1,199.8	107.2	29.1
	13	172.5	291.0	203.0	91.4	30.0	1,199.7	1,199.7	107.2	29.1
	14	177.5	291.0	203.0	91.4	30.0	1,199.7	1,199.7	107.2	29.1
	15	182.5	291.0	203.0	91.4	30.0	1,199.7	1,199.7	107.2	29.1
	16	187.5	291.1	203.0	91.4	30.0	1,199.8	1,199.8	107.2	29.1
	17	192.5	291.1	203.0	91.4	30.0	1,199.8	1,199.8	107.2	29.1



LINE PROPERTY – SEE NOTES 6 THRU 8

SEGMENT NAME	DIAMETER	WEIGHT IN AIR	WEIGHT IN WATER	BREAK LOAD WITHOUT CORROSION	BREAK LOAD WITH CORROSION ¹
	mm	kg/m	kg/m	kN	kN
PLATFORM CHAIN – STUDLESS R4S	160	512	445.4	24281	19544
INSTALLATION CHAIN – STUDLESS R4S	160	512	445.4	24281	19544
POLYESTER ROPE SECTION 2 ²	264	44.7	9.5	18689	–
POLYESTER ROPE SECTION 1 ²	264	44.7	9.5	18689	–
GROUND CHAIN – STUDLESS R4S	160	512	445.4	24281	19544
PILE CHAIN – STUDLESS R4S	160	512	445.4	24281	19544

TYPICAL MOORING LINE PROFILE

POLYESTER ROPE SECTION 1 ²	264	44.7	9.5
GROUND CHAIN – STUDLESS R4S	160	512	445.4
PILE CHAIN – STUDLESS R4S	160	512	445.4

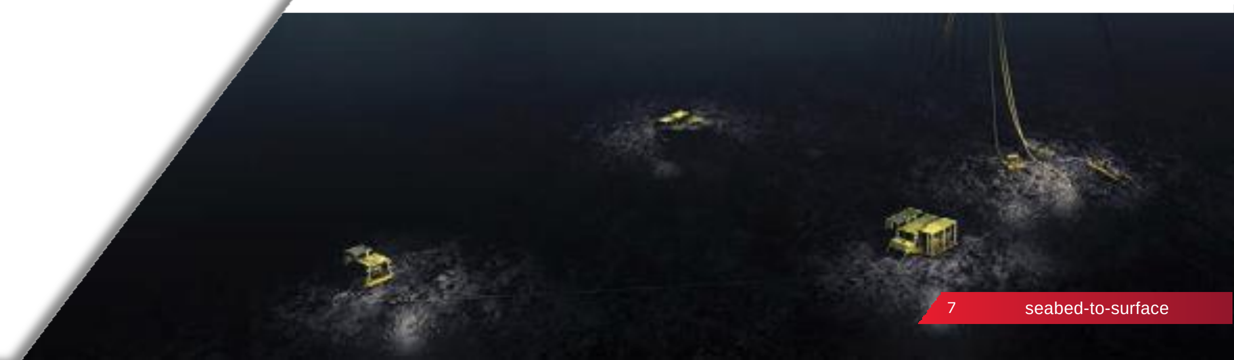
Vessels & Assets

2015

2016

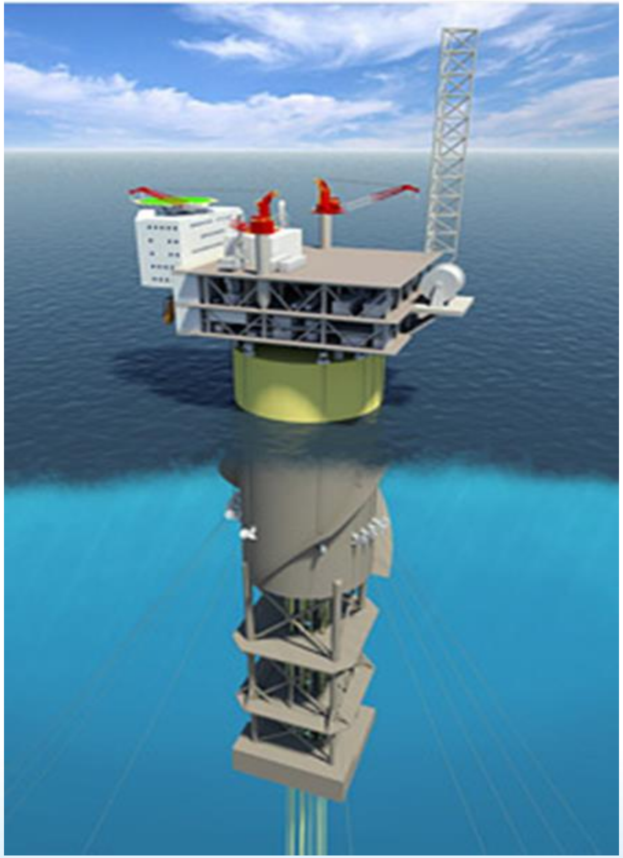
Agenda

- Introduction to Aasta Hansteen
- **Main Challenges & Risks**
- Operational Experiences - 2015 Campaigns

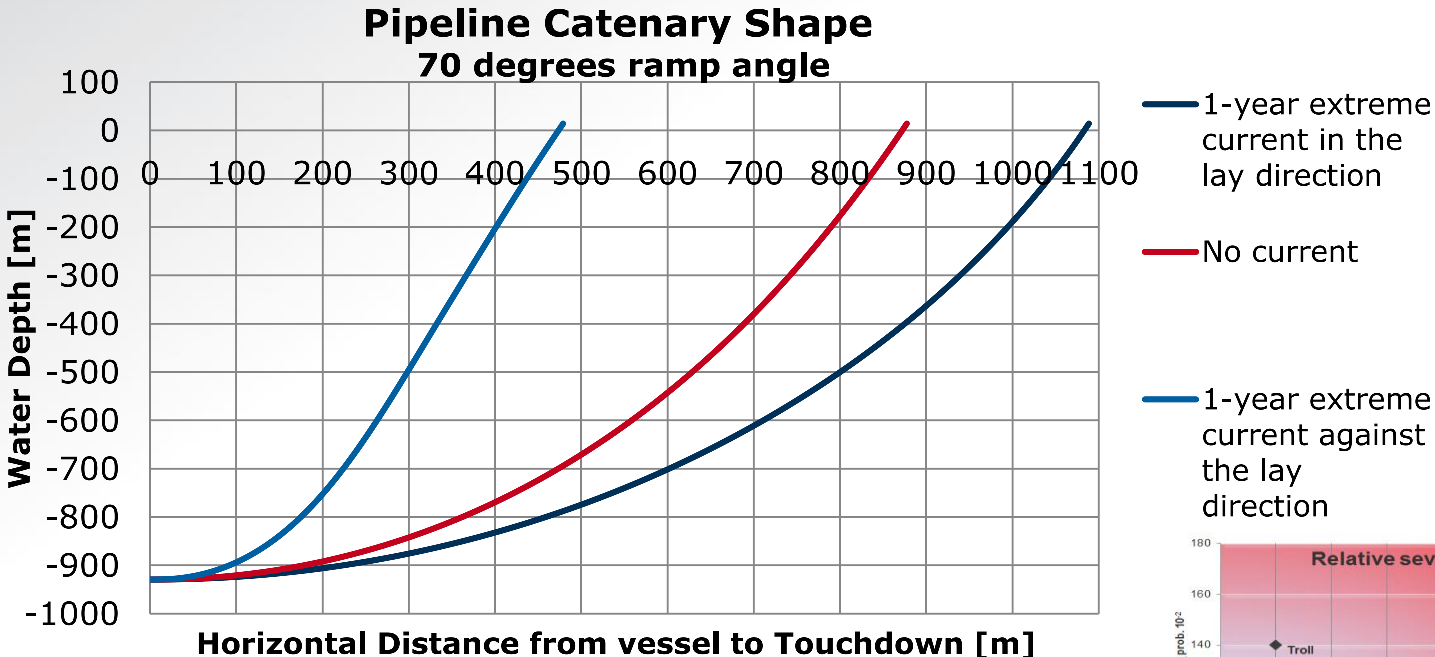


Challenges & Risks

- Challenges
  - Deepwater technologies are generally not designed for North Sea environmental conditions
  - Motion patterns of the SPAR
  - Fatigue of SCRs
  - Resonance
  - Seastate and current
- Risk
  - Use of local (inexperienced) subcontractors
  - Tow out of SPAR
  - Limited float between campaigns - SIMOPS
  - RFO Downline
  - Pipe buckling and walking
  - Pull-in of SCRs
  - Handling of mooring ropes / hook-up



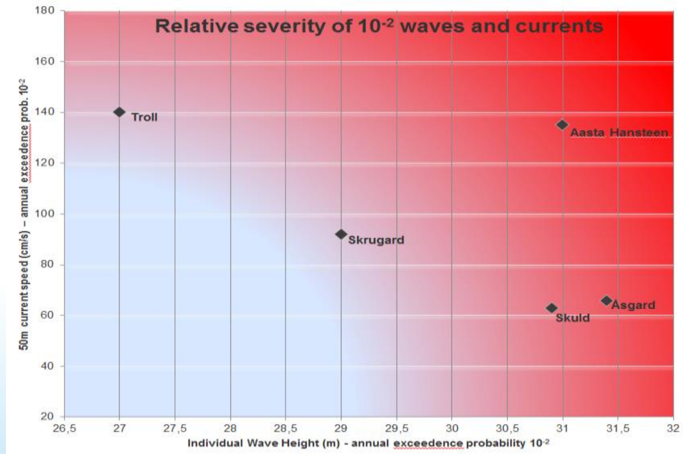
Water Depth, Weather & Current



1300m Water Depth

Resonance

Depth [m]	1st eigenperiod [s]
100	2.04
300	3.53
500	4.6
700	5.4
900	6.15
1100	6.8
1300	7.45



Local Infrastructure & Fabrication

- Personnel logistics and crew changes
  - Flights, accomodation, local transport
- Quayside and base facilities
- …and high media coverage
  - Harbour facilities Sandnessjøen
  - Harbour facilities Mo i Rana
- Fabrication & Mobilisation support
  - Delivered on large fabrication packages
  - Seafastening

Agenda

- Introduction to Aasta Hansteen
- Main Challenges & Risks
- **Operational Experiences - 2015 Campaigns**

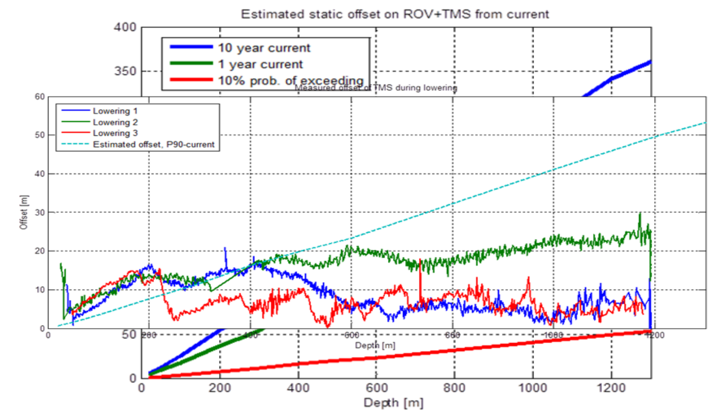
Marine Operations 2015

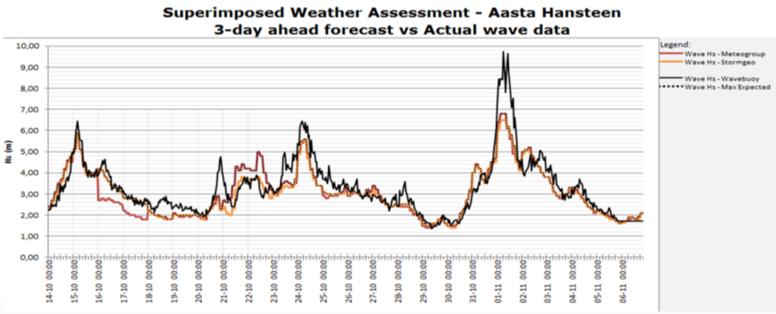
Planning for Marine Operations in 2015

- 2,5 years of planning and engineering
  - Plan, plan and plan has been essential
  - Thorough design reviews and risk assessments
  - Experience transfer from previous projects
- Short installation window due to harsh environment (May to August)
  - Robust solutions
  - Focus on effective installation
- Exceptions for installations outside window:
  - Subsea Positioning System (LBL)
  - Polarled PLEM and Tie-in operations

Weather and Current

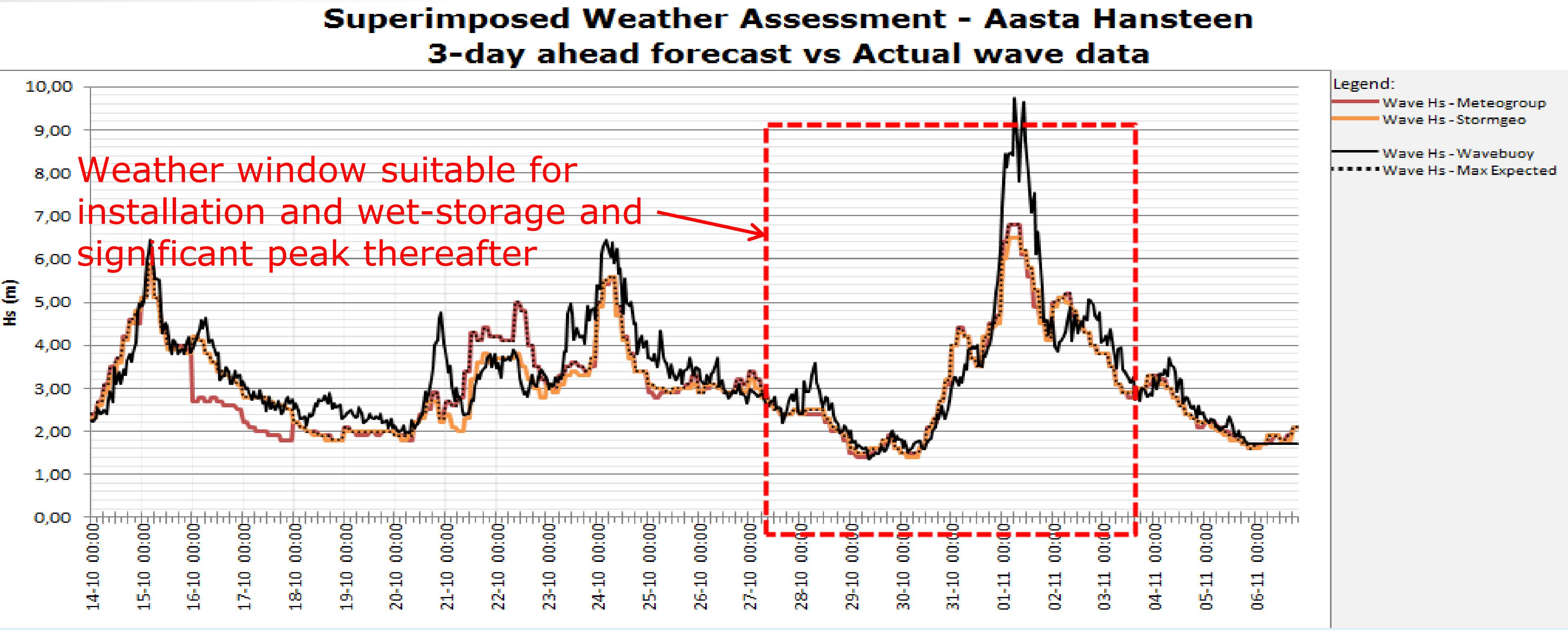
- Strong current
  - Included as important factor during design engineering
  - Light products drifted more than expected
  - Smaller impact on installation times
- Harsh weather conditions
  - Robust schedule and effficient operations
  - Very good summer season between 1st of May and 31st of August.
  - Operations outside window more challenging with sudden changes in seastate
  - Swell and wind direction important factors togehter with Hs
- Polar lows





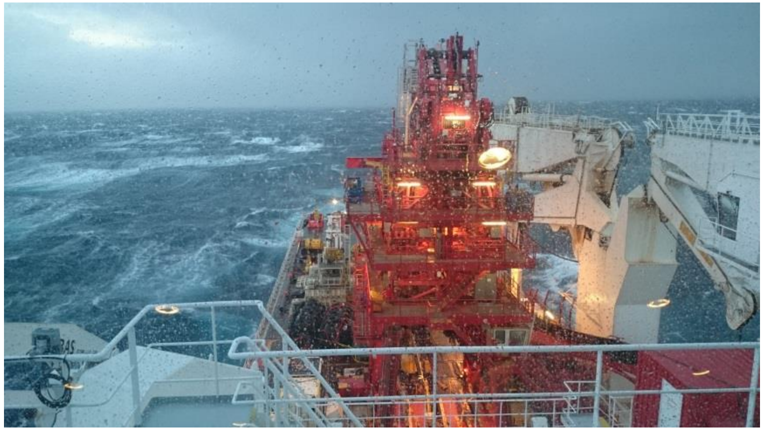
Superimposed Weather Assessment

- Skandi Acergy
- October-November 2015 campaign
- Installation and direct tie-in of 300Te Polarled PLEM



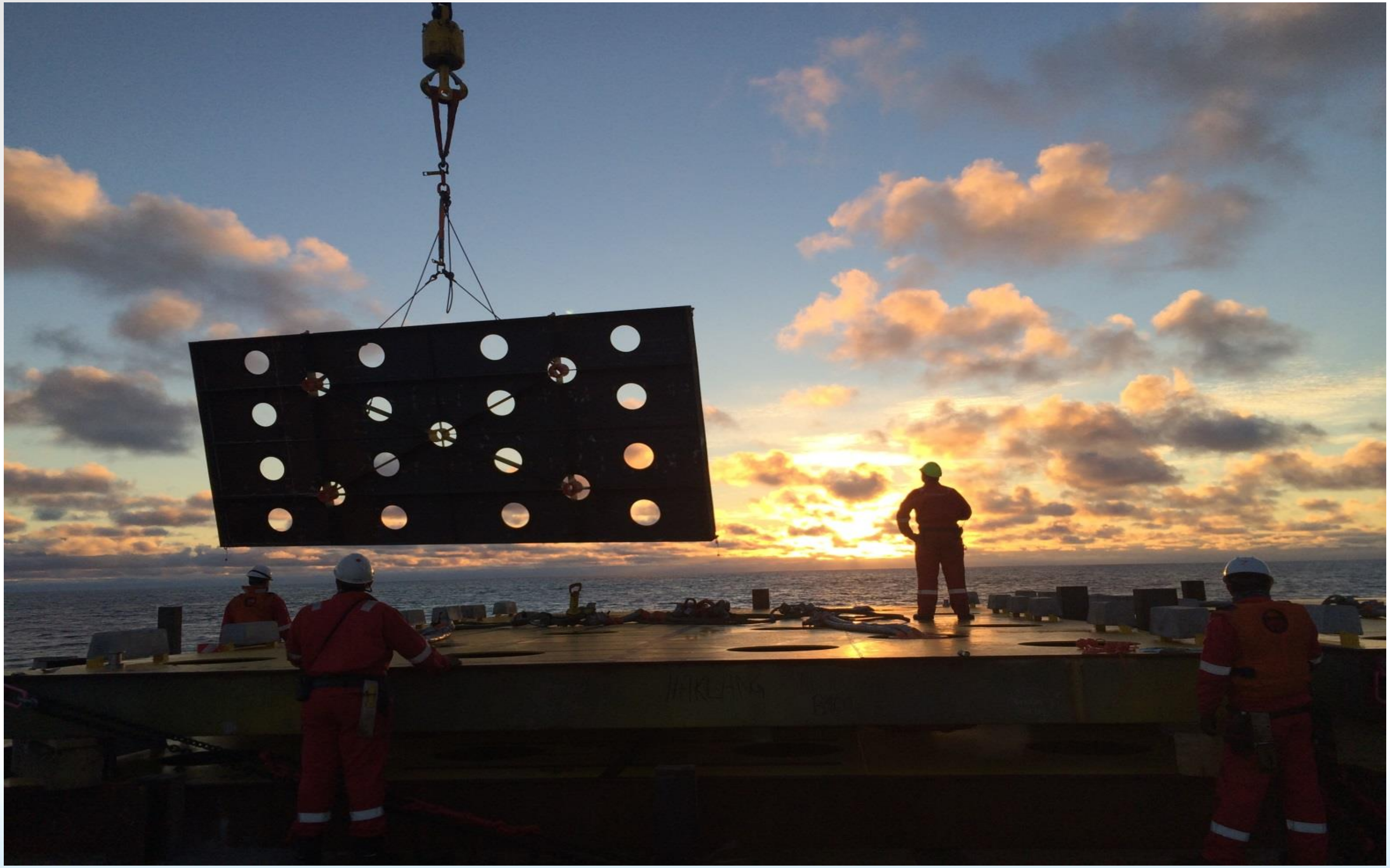
What we expected…

subsea 7



What we got…

subsea 7



Current

- A method was developped to check current through the full water column without bringing additional equipment on every campaign
- Excursion data from ROV/TMS were used for current heading and strength checks
- Approach is dependant on system properties (weight, wire stiffness, shape of ROV system) and available MetOcean data to compare excursions to.

Current

Method:

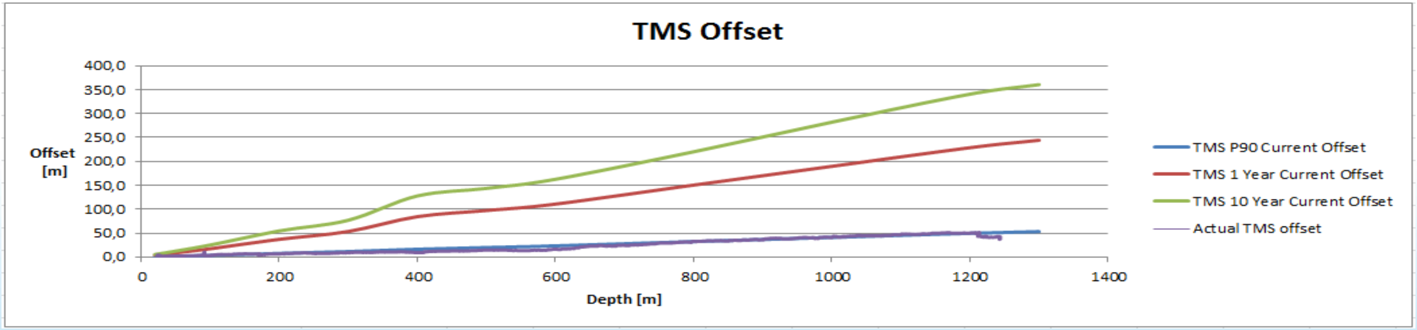
- Analyse impact of current on applicable ROV/TMS system
- Develop spreadsheet with comparison to MetOcean values: 90% probability, 1 year current, 10 year current
- Offshore: deploy ROV with HiPAP transponder on TMS
- Record offset from launch and bearing
- Insert into spreadsheet and calculate offset for deployments
- Evaluate current direction

INPUT			
Item	Suction Spar anchor	Update Data	
Current	P90		
Statistical Offset at surface	68		
Current Offset at surface	105		
Water depth	1300		
Angular deviation from DNV Table 10	3		
STRUCTURE OFFSET			
Depth of structure	Statistical offset	Current offset	Total offset
0	68	105	174
100	68	97	165
200	68	89	157
300	68	81	149
400	68	73	141
500	68	65	133
600	63	57	120
700	54	49	103
800	45	41	86
900	36	32	68
1000	27	24	51
1100	18	16	34
1150	13	12	26
1200	9	8	17
1250	4	4	9
1300	0	0	0

Nort

Vessel Possition

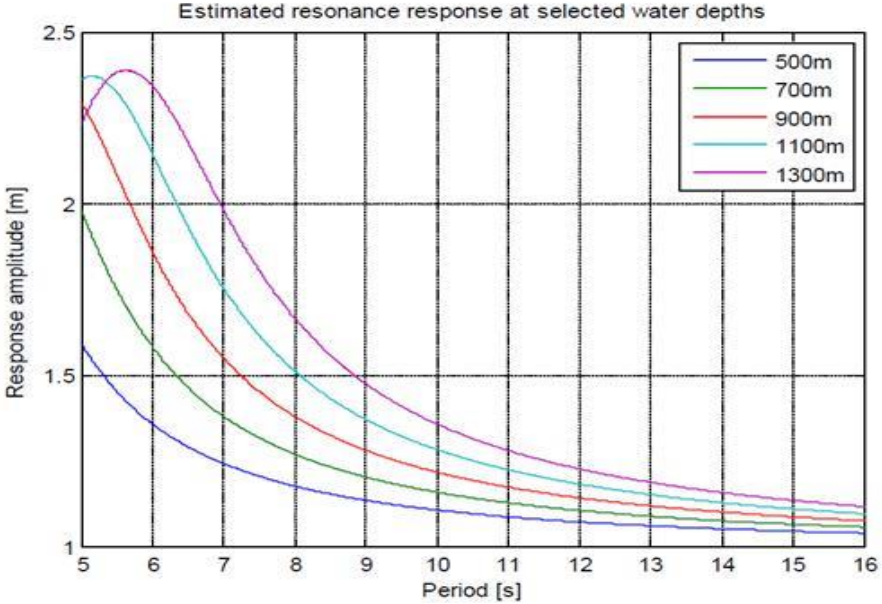
TMS Possition



Crane wire 'resonance'

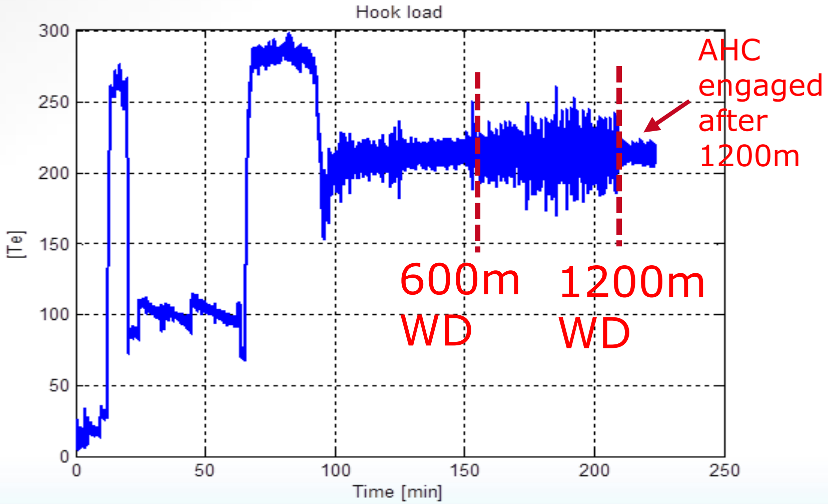
- Analysis: Resonance peaks may coincide with wave periods at larger depths 700m to 1250m

- Practise: Guideline for Crane operators and Shift Supervisors on how to identify 'resonance' and what to do:
  - Live crane load plot to track peaks and trends
  - A range of methods to tackle potential resonance: change in crane pay-out speed, engagement of AHC, vessel heading change, etc

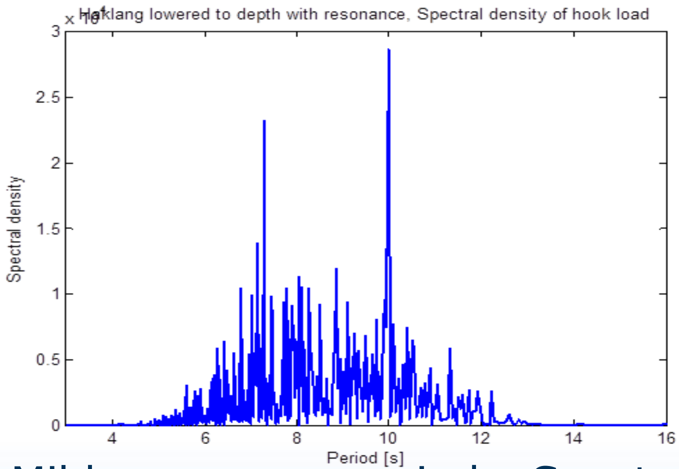


Crane wire 'resonance'

- Empirical evidence from deployments: existence of <u>mild</u> resonance can be argued, typically for lifts >200Te in water
- Increase in dynamics from 600m-700m water depth as per theoretical analysis and expectations
- Spectral analyses completed, however it does not strictly confirm that most of dynamics appear at primary swell Tp



Haklang manifold deployment
247Te in air, 210Te in water



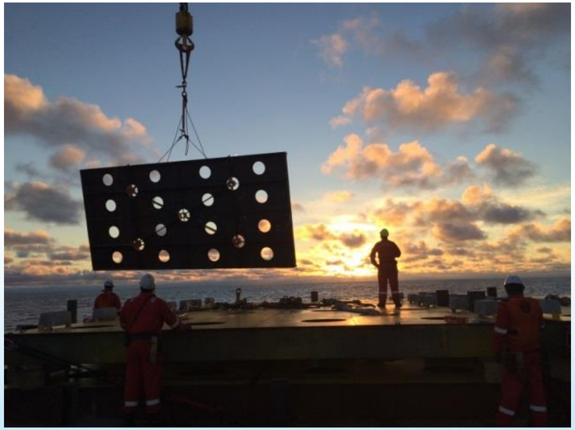
Mild resonance period… Spectral density of the hook load shows most energy in 7s and 10s periods.
Note: primary wave Tp =7.9s

Water Depth - Pre Launch Checklists

- Important with good checklists
  - Extended testing/audit of vessel systems
  - Equipment updates – crane software/wire length
  - Ensure right tooling and set-up
  - Leak test on deck to ensure no loose fittings etc.

- Launch and Recovery of ROV's
  - Typical time - 45min

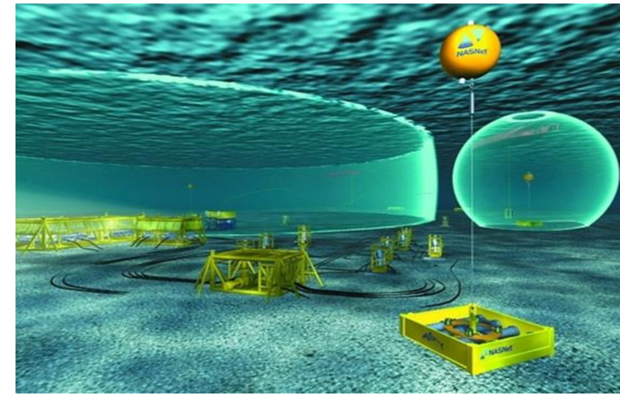
- Deployment and Recovery of structures
  - Typical crane wire speed through water column (if no resonance): 0.5m/sec
  - Typical deployment/recovery time: 30min to 40min

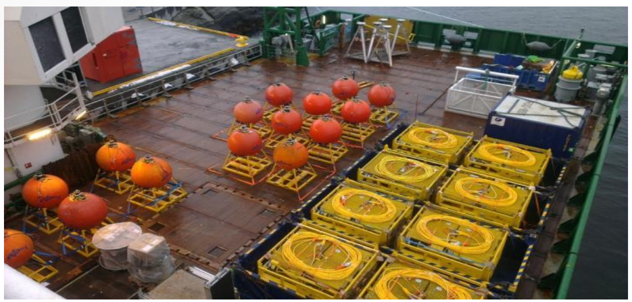


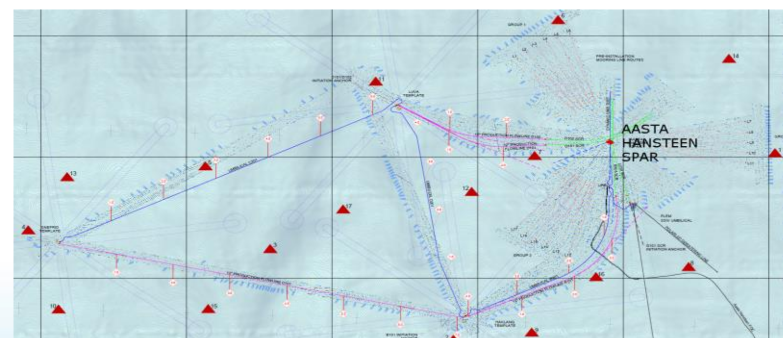
Water Depth - Survey – Nasnet LBL Array

subsea 7

- Survey accuracy at 1300 meters
  - Use of Nasnet LBL system for more accurate positining
  - Installed from MHS onboard Havila Subsea







Umbilicals & Jumpers – Lessons Learned

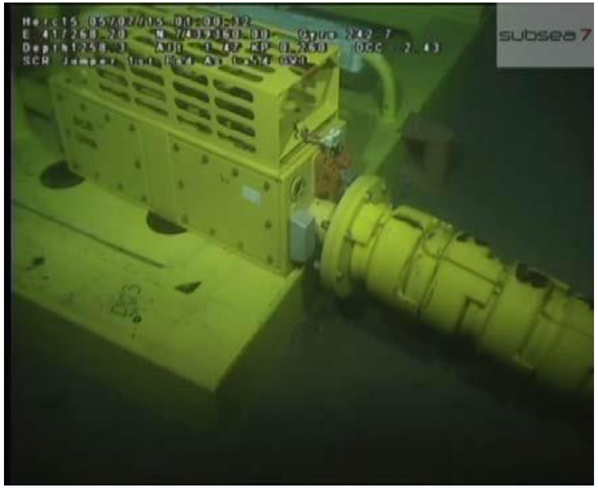
- Strong current.
- DNV approved tool to assess safe overboarding offset. Reducing offset from ROV current offset, reducing standard distance.

Umbilicals & Jumpers – Lessons Learned

- Lay speed reduced.
- Should consider to use main crane instead of whipline even though weight is less than 20Te to decrease offset.
- Possibility that umbilical have an S shape through the water column due to current in different directions à not sure where umbilical is located. See pic below.
- Subsea transfer can be challenging. Transfer rigging should be a lot longer than static distance if possible.

Umbilicals & Jumpers – Lessons Learned

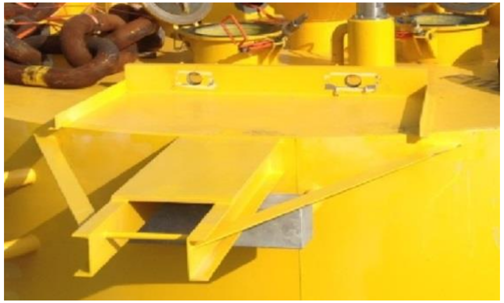
- Shepherds hooks made for ROV to assist during lay (strong current vs light product).



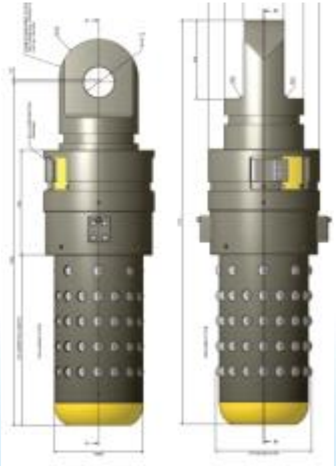
Suction Anchors – Onshore Preparations – Mo i Rana

Suction Anchors – ROV Interfaces

- ROV docking for positioning and orientation

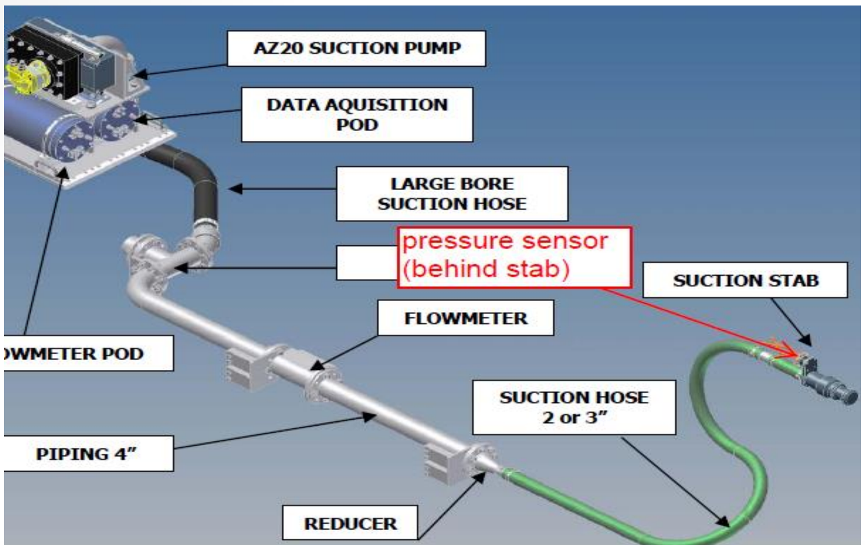


- Ballgrab solution for single point lifting

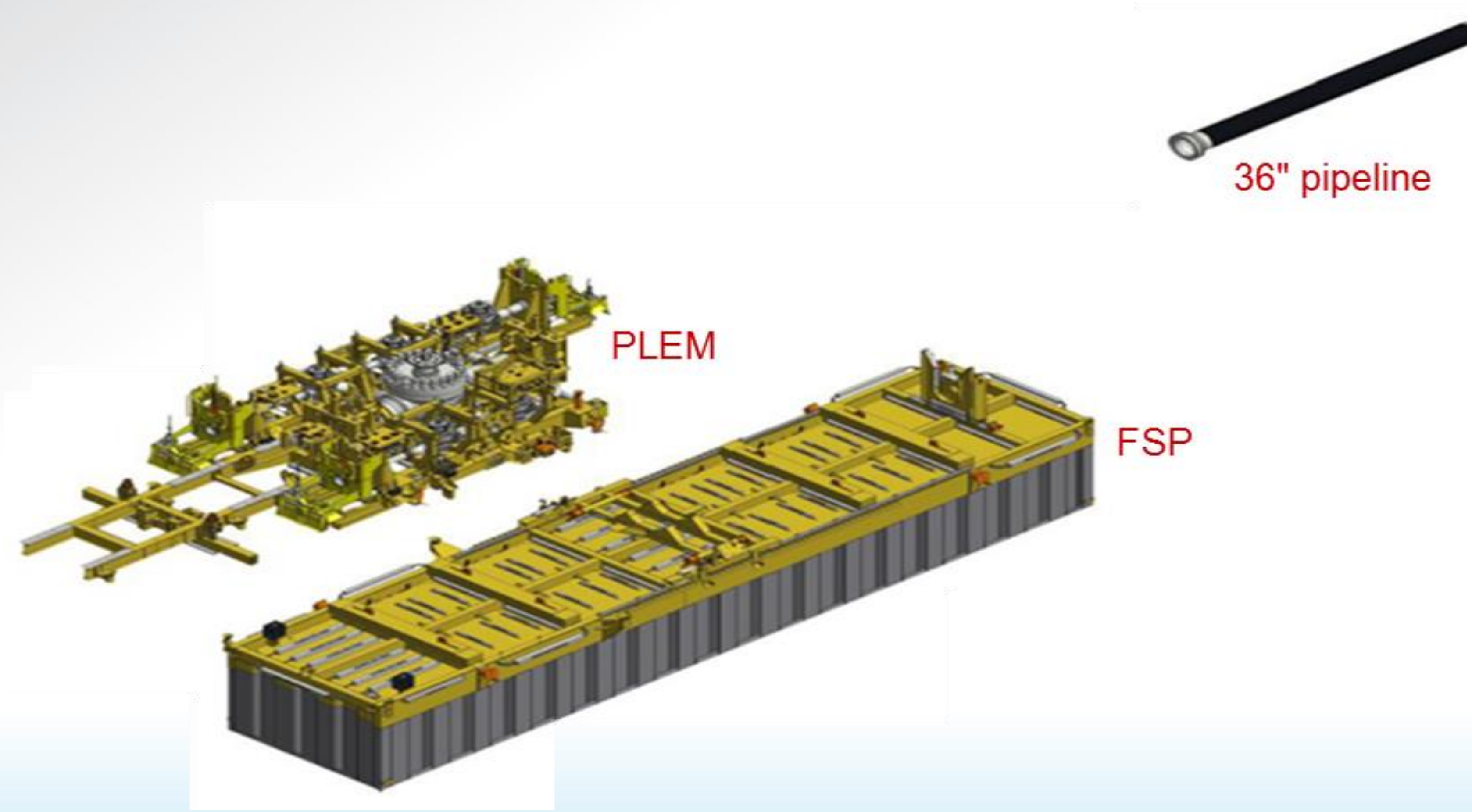


Suction Anchors – ROV Interfaces

- Stab and pump solution for suction penetration of anchors
- Straight and good penetration



POLARLED PLEM - Direct Tie-in



POLARLED PLEM - Direct Tie-in

- Pipe elevation
- P

POLARLED PLEM Installation / Tie-in

- Newly developed tooling packages for direct tie-in of 36’’ pipeline
- Big and heavy tooling
- 3 different hydraulic oil types
- Different stab types on almost all tooling

Torque Tool - 6Te

Complex ROV hydraulic setup

subsea 7

Stabs tool side					Hoses				Stabs ROV side		
Tool	Oil type	Pressure (bar)	Flow (l/min)	Volume (liters)	Stab	Connection	Hose	Connection	Stab	Hose name	Location
PLEM stroking	Shell Tellus S2V15	210	19,3 (Stroking) 6,13 (Pitch)	15 5.6	Ø43 TP Stab 5k Interv uCV BSP 3/8" ID8,5mm	3 x BSP 3/8" M - JIC-6 M	3 x JIC-6 FM-FM (8m)	3 x JIC-6 M - BSP 3/8" M	Ø43 TP Stab 5k Interv uCV BSP 3/8" ID8,5mm	H1 (spare)	Kongsberg Jumper (Crane deployment if needed)
APS	Shell Tellus S2V15	210	3,7	12.2	Ø43 QP Stab 4k uCV D8mm	4 x BSP 3/8" M - JIC-6 M	4 x JIC-6 FM-FM (4m)	4 x JIC-6 M - BSP 3/8" M	Ø43 QP Stab 4k uCV D8mm and Ø43 DP Stab 5k Interv uCV BSP 1/2" ID11mm	H2	Subsea basket Y Jumper
Laydown Head Trolley	Shell Tellus S2V15	210	2,94	8,6	Ø43 QP Stab 4k uCV D8mm	4 x BSP 3/8" M - JIC-6 M	4 x JIC-6 FM-FM (4m)	4 x JIC-6 M - BSP 3/8" M	Ø43 QP Stab 4k uCV D8mm and Ø43 TP Stab 5k Interv uCV BSP 3/8" ID8,5mm	H2 (Spare)	Subsea basket Y jumper
PLR Stroking	Shell Tellus S2V15	210	3,7	15,8							
Laydown Head	Oceanic HW443	120	N/A	1.7	STD 13628-8 Dual Stab	2x 3/8" AE M - JIC-6 M	2 x JIC-6 FM-FM (4m)	2 x JIC-6 M - BSP 1/2" M	Ø43 DP Stab 5k Interv uCV BSP 1/2" ID11mm	H3	Subsea basket
Axial Shift Tool	Exxon Mobile EAL 32	35	N/A	11.5	STD 13628-8 Dual Stab	2x 3/8" AE M - JIC-6 M	2 x JIC-6 FM-FM (4m)	2 x JIC-6 M - BSP 1/2" M	Ø43 DP Stab 5k Interv uCV BSP 1/2" ID11mm	H3 (spare)	ROV7
Single Cleaning Tool	Exxon Mobile EAL 32	50	50	3							
Dual Tool	Exxon Mobile EAL 32	50	50	8	STD 13628-8 Quad and Single	4 x ½" BSP M - JIC-6 M 1x 3/8" AE M - JIC-6 M	4 x JIC-6 FM-FM (4m) 1 x JIC-6 FM-FM (4m)	4 x JIC-6 M - BSP 3/8" M 1 x JIC-6 M - BSP 1/2" M	Ø43 QP Stab 5k uCV D8mm , Ø43 DP Stab 5k Interv uCV BSP 1/2" ID11mm	H4	Subsea Basket
BST Optima					STD 13628-8 Quad and Single	4 x ½" BSP M - JIC-6 M 1x 3/8" AE M - JIC-6 M	4 x JIC-6 FM-FM (4m) 1 x JIC-6 FM-FM (4m)	4 x JIC-6 M - BSP 3/8" M 1 x JIC-6 M - BSP 1/2" M	N/A Hardwired	H4 (Spare)	N/A Hardwired ROV 6
Twin Torque Tool	Panolin Gearsynch 220 Exxon Mobile EAL 32	230	50		1 Inch and 9/16 Inch (FES)	2x 1"-11.5 NPT M - JIC-6 M 9/16" autoclave M - JIC-6 M	2 x JIC-6 FM-FM (4m) 1 x JIC-6 FM-FM (4m)	2 x JIC-6 M - BSP 3/8" M 1 x JIC-6 M - BSP 3/8" M	Ø43 TP Stab 5k Interv uCV BSP 3/8" ID8,5mm	H5	FOGT Basket
					1 Inch and 9/16 Inch (FES)	2x 1"-11.5 NPT M - JIC-6 M 9/16" autoclave M - JIC-6 M	2 x JIC-6 FM-FM (4m) 1 x JIC-6 FM-FM (4m)	2 x JIC-6 M - BSP 3/8" M 1 x JIC-6 M - BSP 3/8" M	N/A N/A	H5 (Spare)	N/A
Class 4 Torque Tool	Exxon Mobile EAL 32 Shell Tellus 22 Shell Tellus S2V15	110		N/A	Hardwired	2 x JIC-6 M- JIC 8 M 1 x JIC-6 M- JIC 4 M 1 x JIC-6 M- 1/4 Swagelok	4 x JIC-6 FM-FM (5m)	4 x JIC-6 M - BSP 3/8" M	Hardwired	H6	ART ops
2 Class ... que Tools	Exxon Mobile EAL 32 Shell Tellus 22 Shell Tellus S2V15	110	max 75	N/A	Hardwired Hardwired	2 x JIC-6 M- JIC 8 M 1 x JIC-6 M- JIC 4 M 2 x JIC-6 M- JIC 8 M 1 x JIC-6 M- JIC 4 M	3 x JIC-6 FM-FM (8m) 3 x JIC-6 FM-FM (8m)	3 x JIC-6 M - BSP 3/8" M 3 x JIC-6 M - BSP 3/8" M	Ø43 TP Stab 4k Interv uCV BSP 3/8" ID8,5mm	H7 H8	Subsea basket Subsea basket
ART Flushing	Exxon Mobile EAL 32 Shell Tellus S2V15				Hardwired	(1 and 5/16" JIC 12 M) - JIC 6 M	1 x JIC-12 FM-FM (5m)	1 x JIC-12 M - BSP 3/8" M	Hardwired	H10	ART ops
MPCT	Exxon Mobile EAL 32 Shell Tellus S2V15				Hardwired	(1 and 5/16" JIC 12 M) - JIC 6 M	1 x JIC-12 FM-FM (5m)	1 x JIC-12 M - BSP 3/8" M	Ø43 TP Stab 5k Interv uCV BSP 3/8" ID8,5mm	H11	Subsea basket
GRINDER	Exxon Mobile EAL 32 Shell Tellus S2V15				Hardwired	(1 and 5/16" JIC 12 M) - JIC 6 M	1 x JIC-12 FM-FM (5m)	1 x JIC-12 M - BSP 3/8" M	Ø43 TP Stab 5k Interv uCV BSP 3/8" ID8,5mm	H12	Subsea basket
H frame					GISMA and HP waterstab				GISMA and HP waterstab JIC 8 P and R	H13	Contingecy

uad Receptacle	
Port	Function
A	Flow in
B	Flow out
A	Flow in/drain
B	Flow out

ylinders	
Port	Function
A	Extend West
B	Retract West
A	
B	

lass 6 TT	
Port	Function
A	Flow in
B	Flow out
A	Drain
B	

troke cylinders	
Port	Function
A	Extend
B	Retract
A	Drain/return

itch cylinders	
Port	Function
A	Retract
B	Extend
A	Drain/return

ARD WIRED	
Port	Function
A	Flow in

ROV work packs

subsea 7

seabed-to-surface