
KIVI NIRIA
avans
hogeschool
Offshore: groter, sneller, efficiënter
10 november 2011
‘s-Hertogenbosch

Seaway Heavy Lifting

Offshore Wind Installation
Experienced, Safe, Reliable

Avans Hogeschool 10 November 2011 – “Offshore: groter, sneller, efficiënter””

Jan-Peter Breedeveld

Index

1) Introduction SHL
2) Comparison Oil & Gas
3) Case study
   - Greater Gabbard
   - Sheringham Shoal
4) Jacket installation
5) Turbine installation
6) Substation installation
7) To conclude

SHL Installation
Experienced, Safe, Reliable

- 20 years of installation experience in Oil & Gas and Offshore Wind market
- Over 140 platforms and over 200 foundations installed (80% North Sea)
- Own and operates monohull crane vessels Stanislav Yudin (2,500 mT) and Oleg Strashnov (5,000 mT) and key installation equipment, such as piling hammers
- Extensive in-house engineering expertise and experienced offshore crew
- Offering lump-sum, fixed price contracts (full weather risk taken by SHL)
- Deliver a safe, sound, reliable and economic offshore installation solution based on an as-installed cost basis

SHL Premises

Cyprus Office Limassol

Netherlands Office Zoetermeer

SHL installation equipment; perfect for foundation and substation installation

Stanislav Yudin

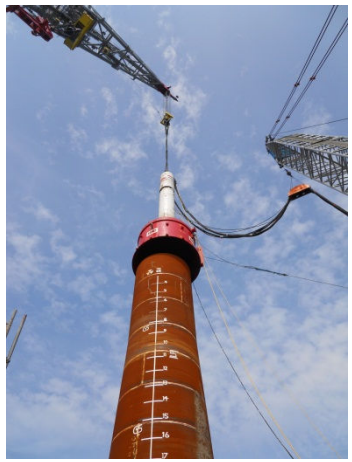
- 2,500 mT revolving capacity
- Length 183 m / Breadth 36 m / 140 pob
- 2,500 m^2 deck space
- 5.5 m minimum draught
- Anchors

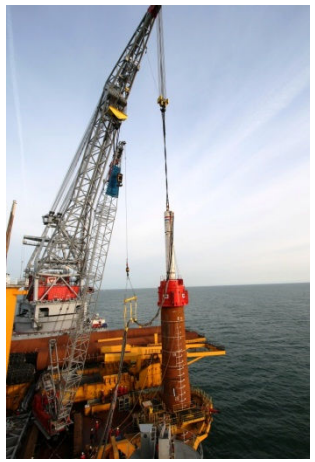
Oleg Strashnov

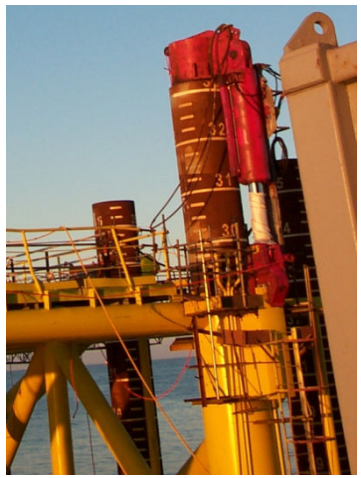
- 5,000 mT revolving capacity
- Length 183 m / Breadth 47 m / 220 pob
- 4,000 m^2 deck space
- 8.5 m minimum draught
- Anchors and DP 3

SHL owns all key installation equipment

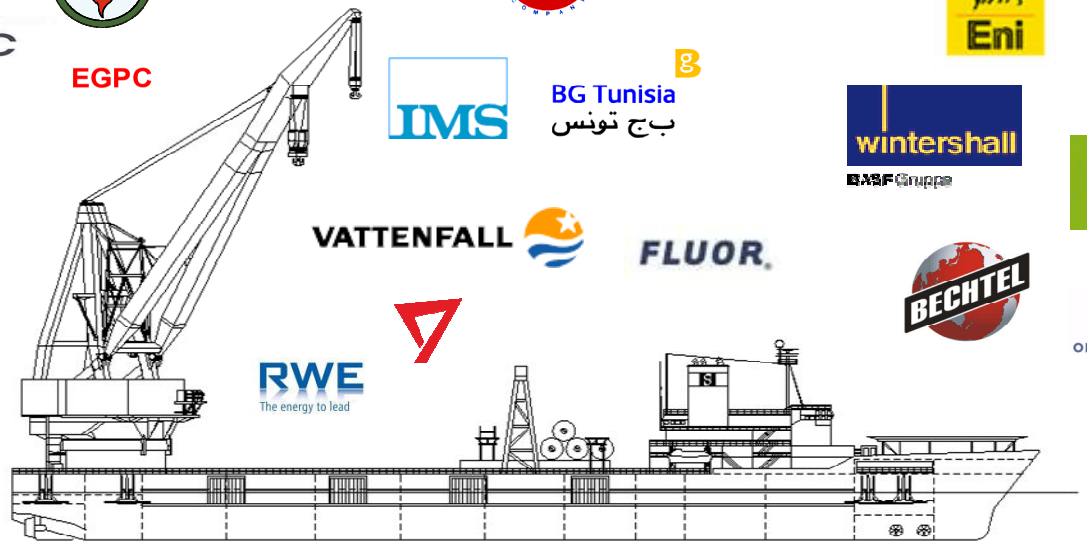
- Hydraulic piling hammers
  - IHC S-500
  - IHC S-600
  - IHC S-900
  - IHC S-1200
  - IHC S-1800
- Pile top drill rig
- 400 mT levelling tools
- Internal pile lifting tools (up to 84”)
- Slings and (hydraulic) shackles





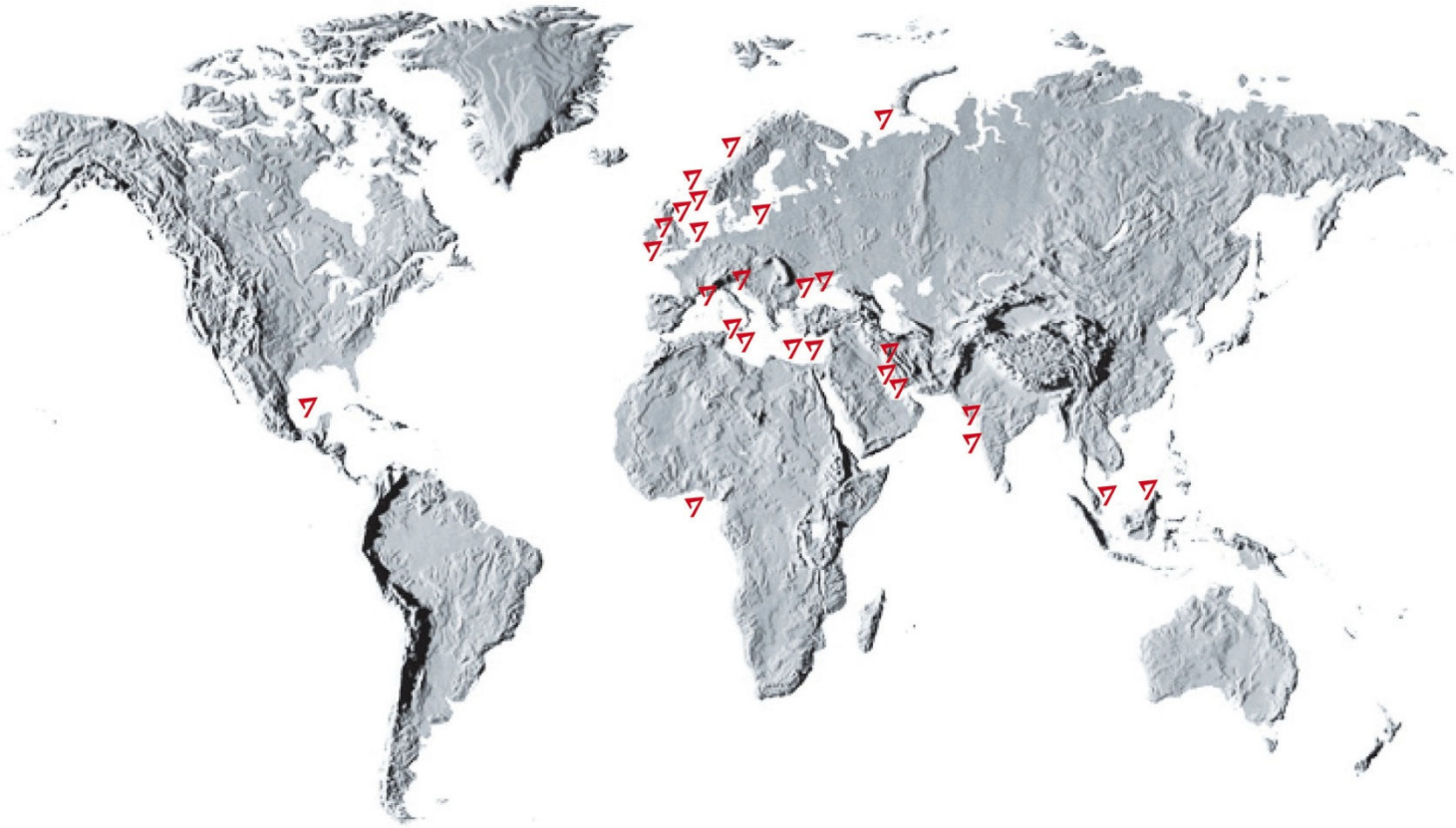


An impressive client portfolio



MAERSK
HYDRO
TULLOW OIL plc
ConocoPhillips
bp
HESS
IOEC.com
NIKO RESOURCES LTD
Incorporated in Canada
BUNDUQ COMPANY
N.I.O.C
Pars Oil & Gas Company
P.M.S.
Petroleum Marine Services Co.
Eni
GSPC
EGPC
UNOCAL 76
IMS
BG Tunisia
بـ ج تونس
wintershall
BASF Gruppe
TOTAL
NAM
Petropars Ltd.
VATTENFALL
FLUOR
BECHTEL
ATP
OIL & GAS (UK) LIMITED
NPCC
RWE
The energy to lead
ISOICO
SLP
SADRA
HYUNDAI
HEAVY INDUSTRIES CO.,LTD.
GDF SUEZ
Cairn
ChevronTexaco
COSMI
SAFF
MERCON
PETRECO
Paladin Resources plc
Statoil
J. RAY McDERMOTT
TransCanada

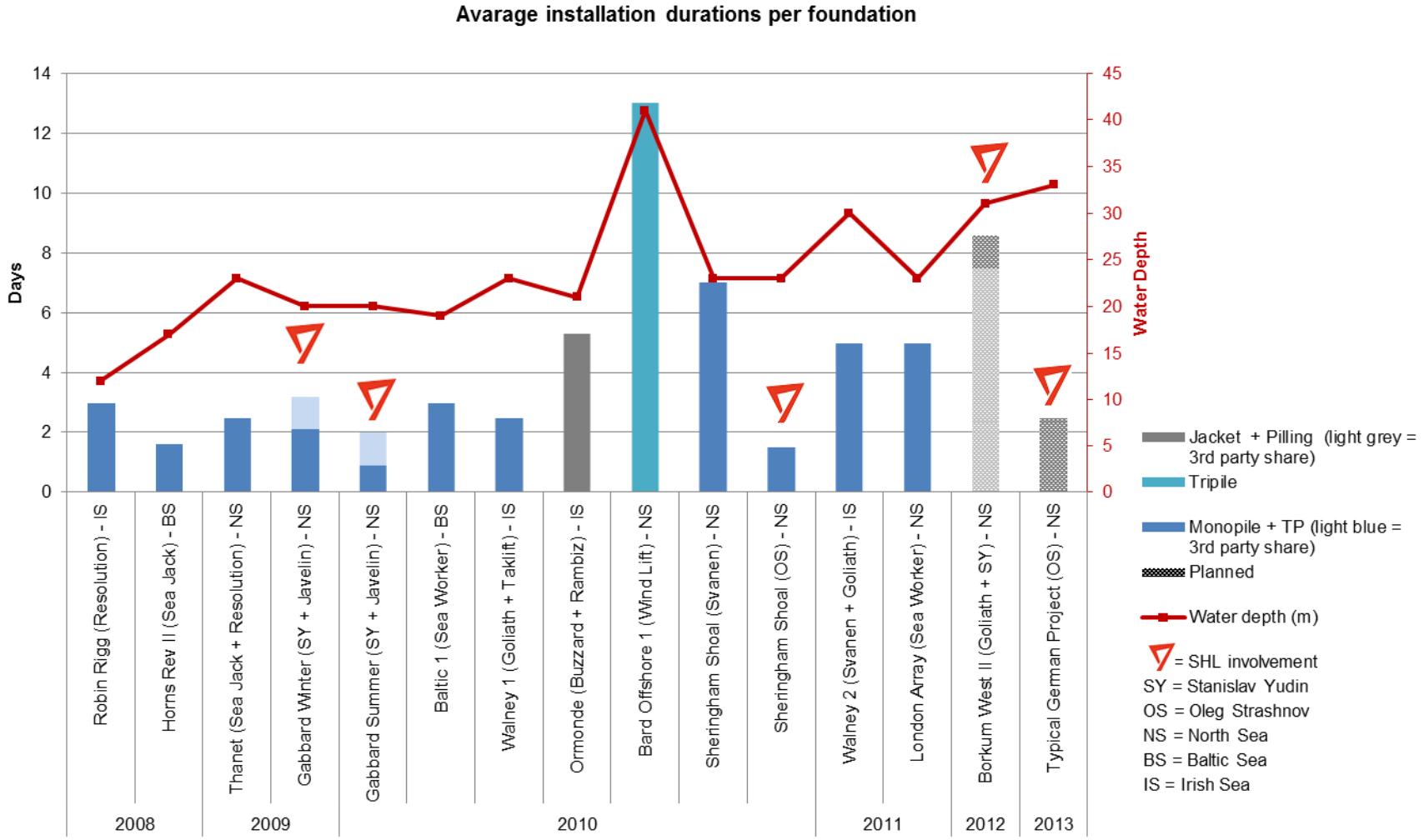
SHL Footprint on the Globe



Solid offshore wind track record

Project	Scope
Greater Gabbard	Foundations, Substations and Met Mast
Sheringham Shoal	Foundations and Substations
Borkum West II	Tripods and Substation
Riffgat	Foundations and Substation
Thanet	Substation
Dan Tysk	Substation
Meerwind	Substation
Nordsee Ost	Substation
Gwynt y Môr	Substations
Anholt	Substation

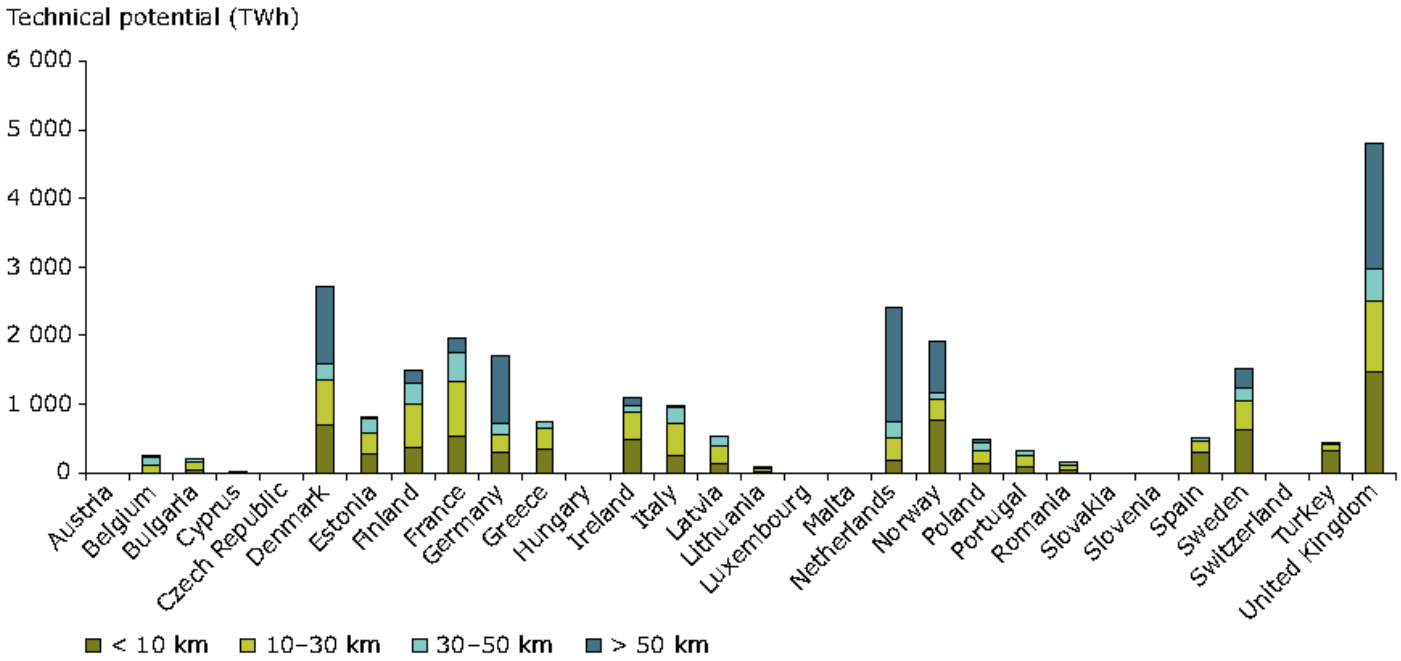
SHL provides safe and fast solutions for monopile and jacket installation



Note: “durations” are including a.o. weather, transport, levelling, grouting and breakdown

Wind Energy Potential

Figure 3.5 Unrestricted technical potential for offshore wind energy in 2030 based on average wind speed data



Note: A recent Norwegian study (NVE, 2008) estimates Norwegian offshore wind power capacity to be around 55 300 MW (at maximum depths of 50 m and minimum distances to the coast of 1 km).

Source: EEA, 2008.

Europe's onshore and offshore wind energy potential

Wind Energy Potential

Table 6.1 Overview of cost estimates for onshore and offshore wind farms

	Onshore (a)	Onshore (a)	Offshore (b)
	Share of total investment costs (%)	Typical share of other costs (%)	Share of total investment costs (%)
Turbine	74–82		30–50
Foundation	1–6	20–25	15–25
Installation	1–9	10–15	0–30
Grid connection	2–9	35–45	15–30
Consultancy	1–3	5–10	
Land	1–3	5–10	
Financial costs	1–5	5–10	
Road construction	1–5	5–10	
Others			8
Total turnkey investment costs	800–1 100 EUR/kW (b)		1 200–2 000 EUR/kW (b,c)

Note: (a) EWEA, 2003b Based on data from Germany, Denmark, Spain and the United Kingdom for 2001/2002 for a typical medium-sized wind turbine (850 kW–1 500 kW).
(b) Junginger, 2005.
(c) ECN, 2004.

Europe's onshore and offshore wind energy potential

SHL to strengthen their position in the offshore wind market in cooperation

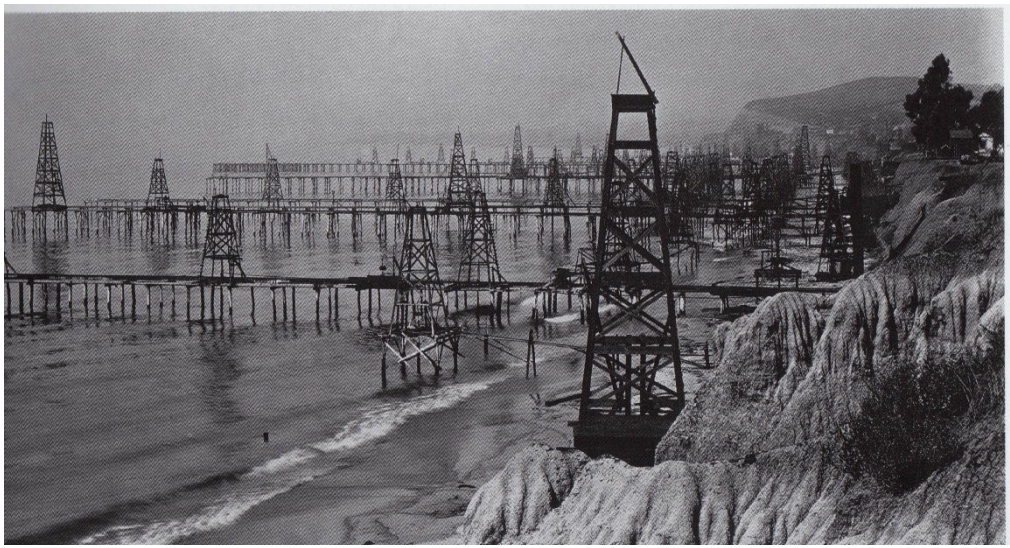
- Marine contractor for the whole offshore transport and installation scope!
- Offer lump-sum installation contracts in the offshore wind market
  - Fixed price per installation
  - Drives innovation and improvement (industrialise / lower costs)
- Enter into a Long Term Framework Contract with Utilities / Developers
- Jointly develop most efficient installation concept (early involvement)
- Invest in (purpose build) installation equipment if required
- Management of other vessels / services

Index

1) Introduction SHL
2) **Comparison Oil & Gas**
3) Case study
   - Greater Gabbard
   - Sheringham Shoal
4) Jacket installation
5) Turbine installation
6) Substation installation
7) To conclude

We all started the same…
Offshore locations

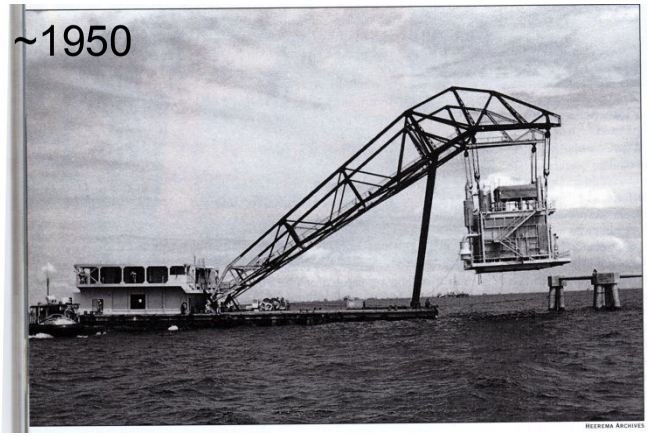
Offshore oil and gas



Offshore wind

- Near shore
- Minimum water depth
- Sheltered areas

We all started the same….
Installation equipment

	Offshore oil and gas	Offshore wind
Sheerleg		
Jack-up		

… and then we move further offshore Installation requirements

Developments

- Further offshore in deeper waters
- Heavier and larger structures
- Higher volume in repetitive installation

North Sea offshore conditions

Requirements

- Safe, sound, reliable and industrialised (installation) solution
- Experienced offshore (construction) crew
- Equipment able to work in harsh offshore conditions
- Substantial crane capacity (outreach and lift capacity)
- Equipment able to stay offshore and take cargo barge alongside (feeder system)
- Dedicated (handling) equipment (hammer, lifting tools, upending tools, …)

Some mishaps Oil & Gas

1966

Topside installation with Sheerleg

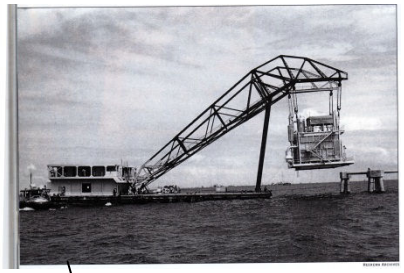
2010

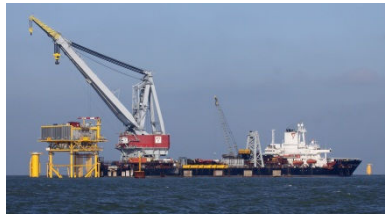
Jack-up punch through (example)

Some mishaps Offshore Wind

- **Various projects**
  - Min. 6 months delay due to poor workability of installation equipment
  - Grout failure (poor design)
  - Large variation in pile driving resistance
  - Logistic problems (supply of material, load out, etc)
  - …….

From near-shore to off-shore (in Oil & Gas)
Equipment selection is key





Technology

Distance to shore

1950 1960 1970 1980 1990 2000 2011

Let's continue in Offshore Wind, using Oil & Gas experience

From day-rate to lump-sum contracting in Oil & Gas

- Oil and gas started with day-rate contracts => more days, more $
  - Vessels chartered for series of platforms
  - The bill was paid at the end of the contract by the Oil Company
- Oil Companies soon started to demand for performance driven / lump-sum contracts
- Contractors had to be more innovative to deliver and earn their money
  - Use weather statistics for understanding exposure
  - Develop improved installation methods and (handling) equipment
  - Develop hydraulic piling hammers versus steam hammers
  - Use of back-up equipment

From day-rate to lump-sum contracting in Offshore wind

- Projects will meet installation schedule / deadlines
- Risks are put to the party who is able to manage it
- Installation costs are known upfront
  - no cost overruns, no pre-investments, no loss of project income
- Installation in compliance with HSE and Marine Warranty Surveyor requirements
- Continues innovation / improvement on installation
  - With proven concepts as a starting point

Safety & Schedule Reliability & Fixed Cost

Groter, Sneller, Efficienter

Index

1) Introduction SHL
2) Comparison Oil & Gas
3) **Case study**
   - **Greater Gabbard**
   - **Sheringham Shoal**
4) Jacket installation
5) Turbine installation
6) Substation installation
7) To conclude

Project comparison

Projects		Greater Gabbard	Sheringham Shoal
Water depth	m LAT	22 - 32	14 - 24
MP's by SHL / Total	#	140 / 140	66 / 90
TP's by SHL / Total	#	0 / 140	71 / 90
MP Top Diameter	m	5.1	4.7
MP Foot Diameter	m	5.5 - 6.3	5.2 - 5.7
MP Length	m	58 - 68	44 - 61
MP Penetration	m	28 - 33	23 - 37
TP Height	m		25
MP Weight	mt	510 - 676	375 - 531
TP Weight	mt		220
Current (Max.)	kn	3.0	2.5
Tidual range	m HAT-LAT	4	3

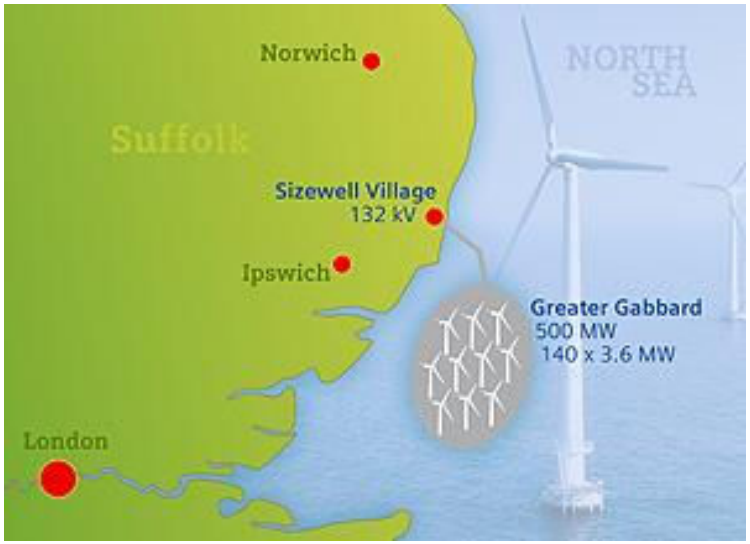
Key issues

- **Safety and quality -** maximised by SHL's adherence to industry standards
- **Project installation schedule -** optimised by SHL's own installation vessels, equipment and skilled, experienced offshore crew
- **Project bankability -** maximised by SHL's 20 years offshore installation experience and strong balance sheet
- **Installation budget -** transparent due to SHL's Lump sum installation contract, including weather risk
- **Interface risk -** minimised by SHL's extensive experience as an installation project member
- **Foundation and installation solution –** optimisation ensured by SHL's own in-house engineering expertise

Greater Gabbard offshore wind farm

- Second largest offshore wind farm (504 MW, 140 turbines, area of 146 km2) with largest foundations to date (up to: W 680 mT / L 70 m / D 6.3 m)

- located in the North Sea, 25km off the Suffolk coast



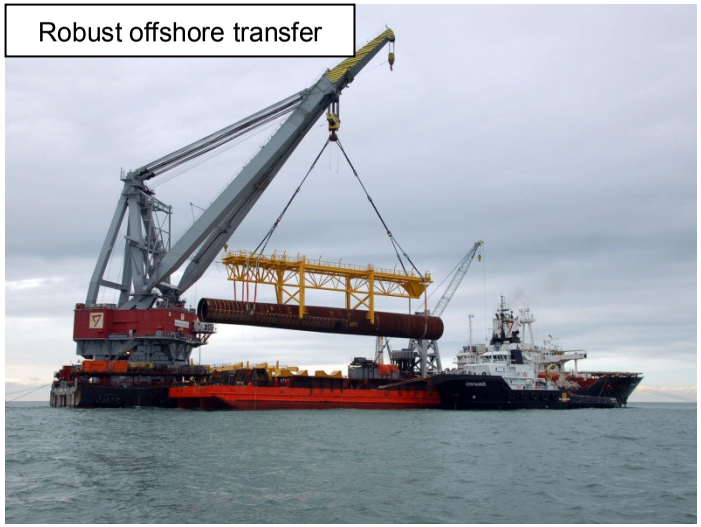
- Developed by SSE in a joint venture with RWE npower renewables

- Transport and installation of 140 foundations and two substations; subcontracted by Fluor Limited to SHL

- Installation split over two seasons due to piling restrictions

Vessel size and sufficient lift capacity improves safety, efficiency and creates high workability

Robust offshore transfer



Fast & Safe handling

Own piling hammers

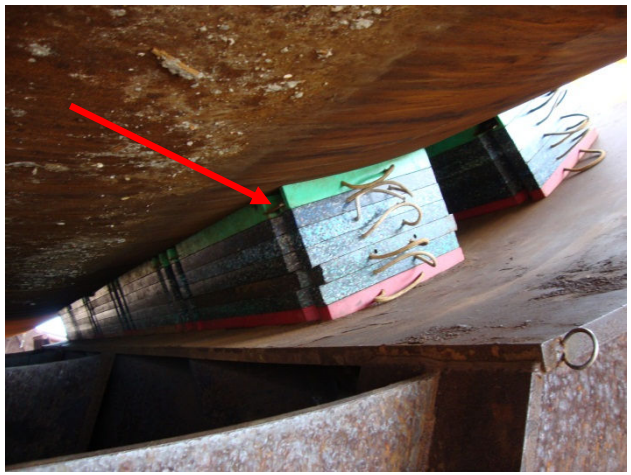
Excellent workability

Greater Gabbard - Net duration Average 16 hours / mono pile

- Performance-driven contracts drive innovation, safety and lower costs

Dyneema Fiber Slings

High density PE liner plates



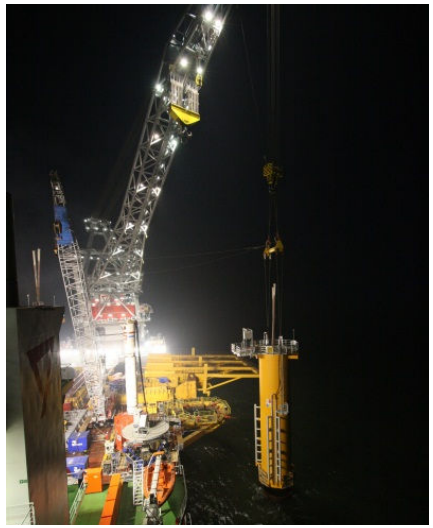
- Net duration (average): 16 hours / mono pile
  - Average pile driving: 2.8 hours
- Gross duration (average): 0.9 day (summer) – 2.1 day (winter) / mono pile

High workability created flexibility and delivery, 8 weeks ahead of schedule

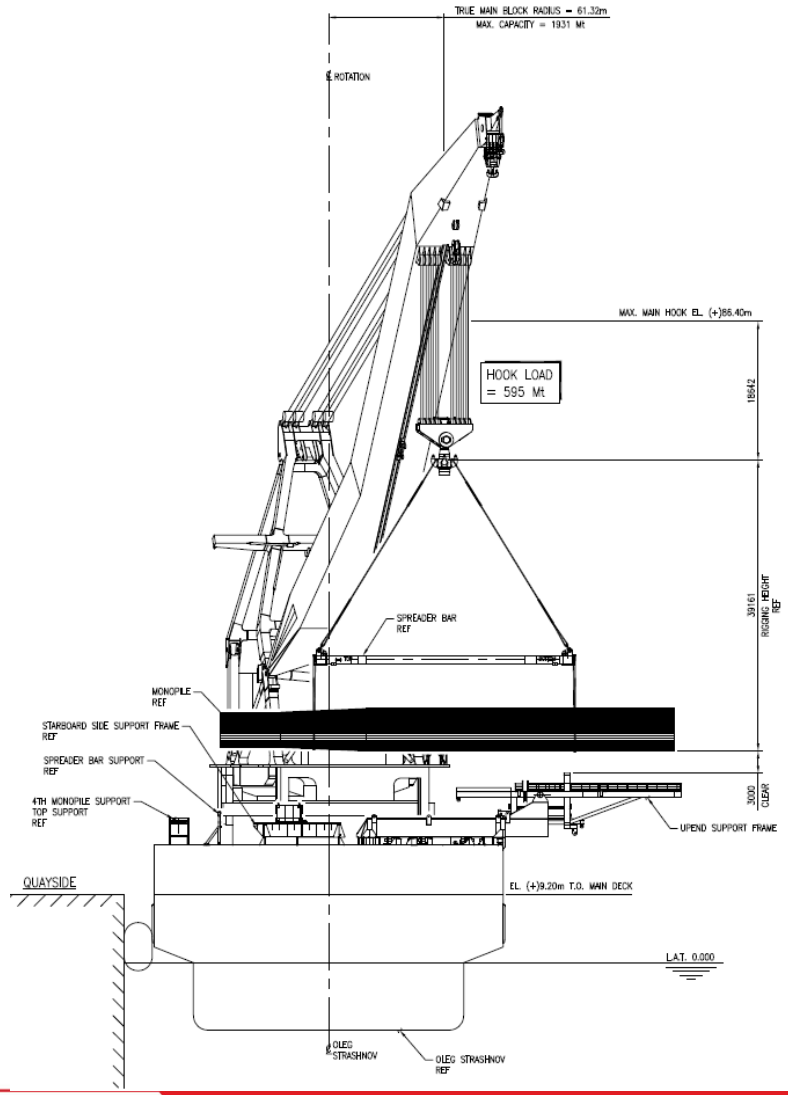
- All mono piles installed within tolerances, 8 weeks ahead of schedule
- 39 mono piles installed in July; 23 mono piles installed in January (Winter)
- Continued during Winter; possible due to high workability
  - Fixed price lump-sum contract provided flexibility on schedule
  - Both substations installed in 8 - 9 days (each)
  - Topsides were installed fully commissioned and tested
- Traditional substation design (jacket & topside) installed with HLV to meet project schedule and create flexibility

Sheringham Shoal
Challenging installation conditions

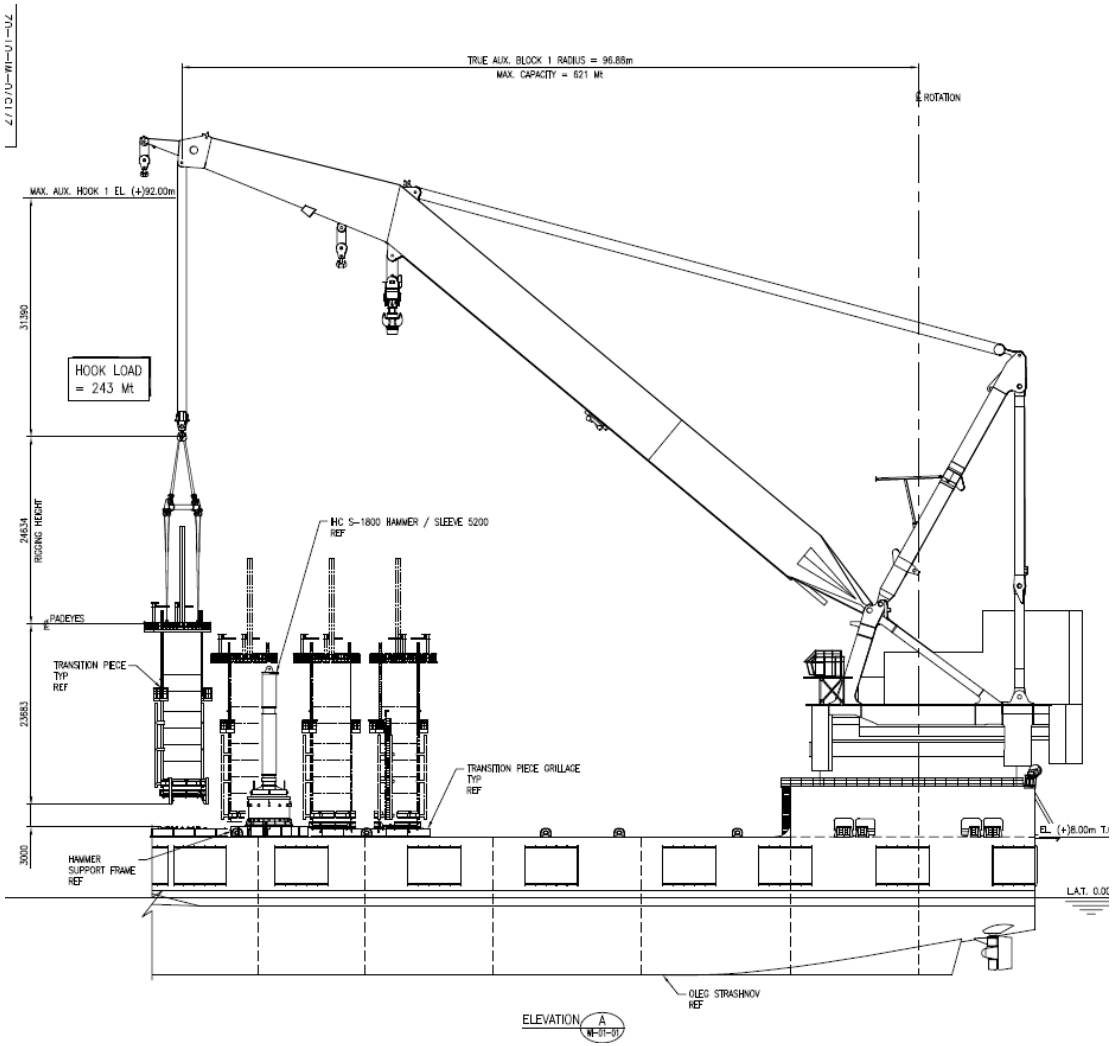
- 317 MW (88 turbines, Area of 35 km2)
- Developed by Scira (Joint Venture between Statoil and Statkraft)
- Located in the Greater Wash, 17 - 23km off the Norfolk coast (14 - 24 m LAT)
- Contract with Seaway Heavy Lifting replaces the Master Marine and MTHøjgaard contract related to the remaining substations and foundation installation work
- Transport and installation of (remaining)
  - 66 mono piles (up to 530mT / 61 x 5.7 m)
  - 71 transition pieces (220mT / 61 x 5.0 m)
  - two substations (each 1,000 mT)



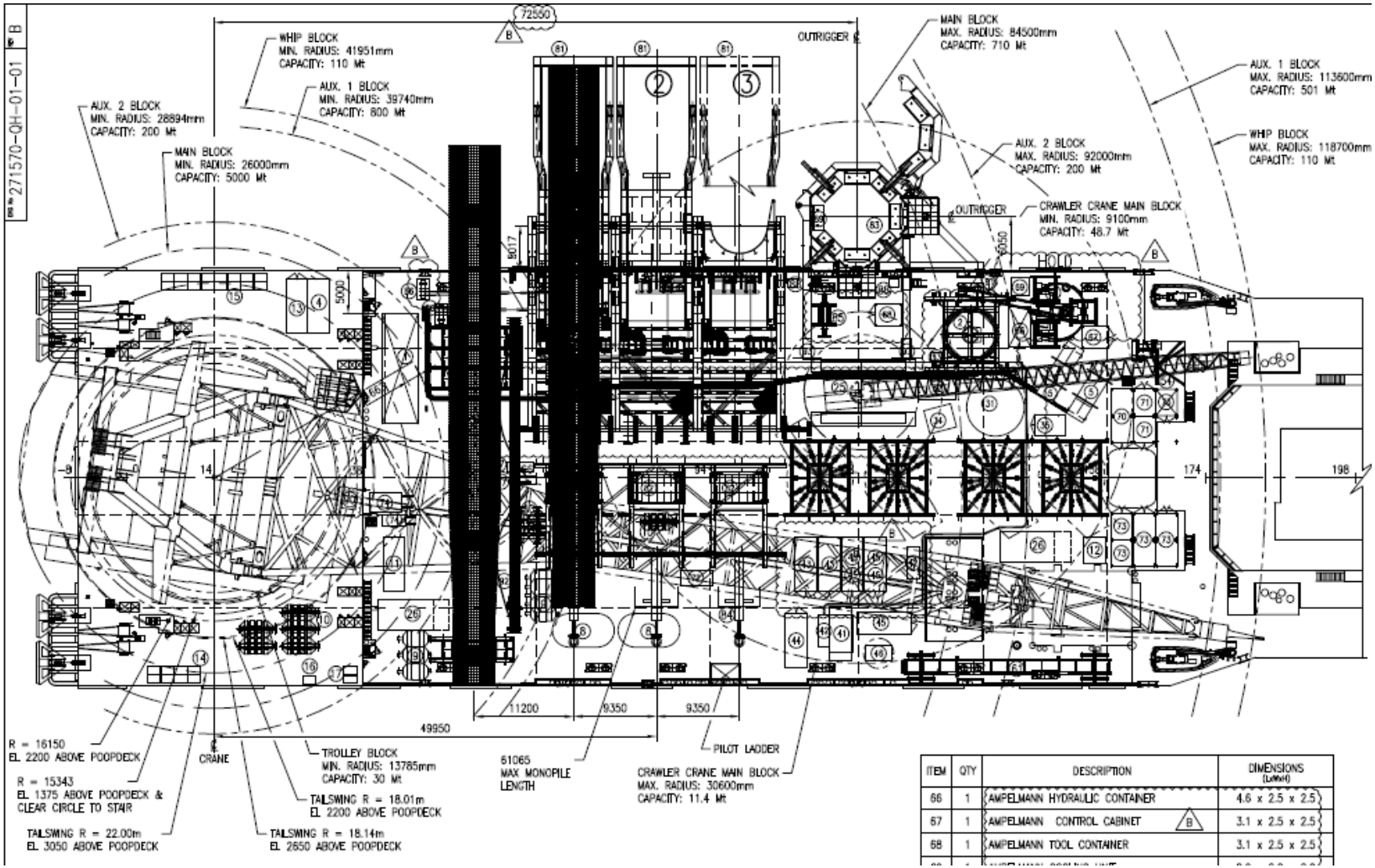
Inshore transfer (Mono Piles)



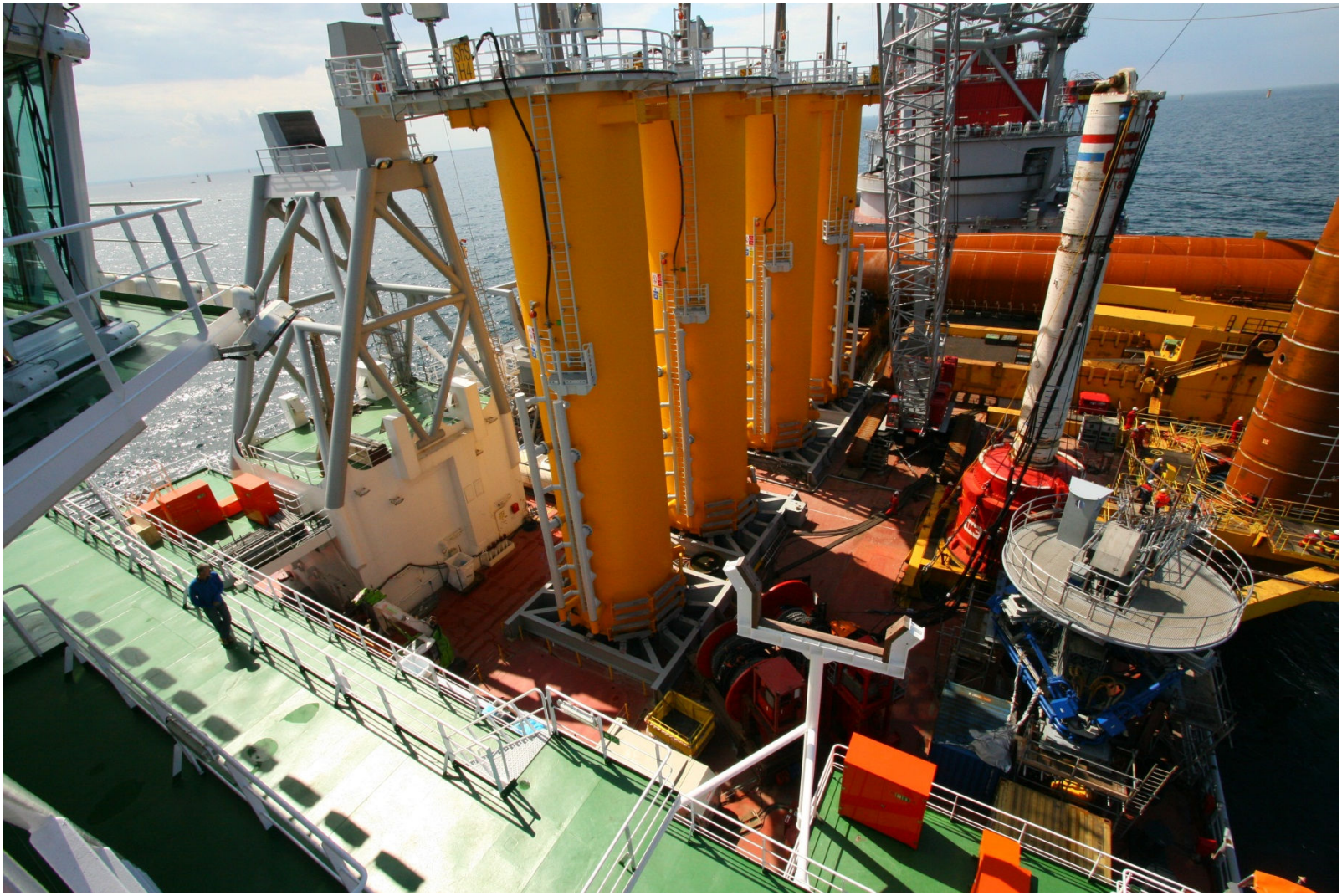
Inshore transfer (Transition Pieces)



Deck layout (1)



Deck layout (2)

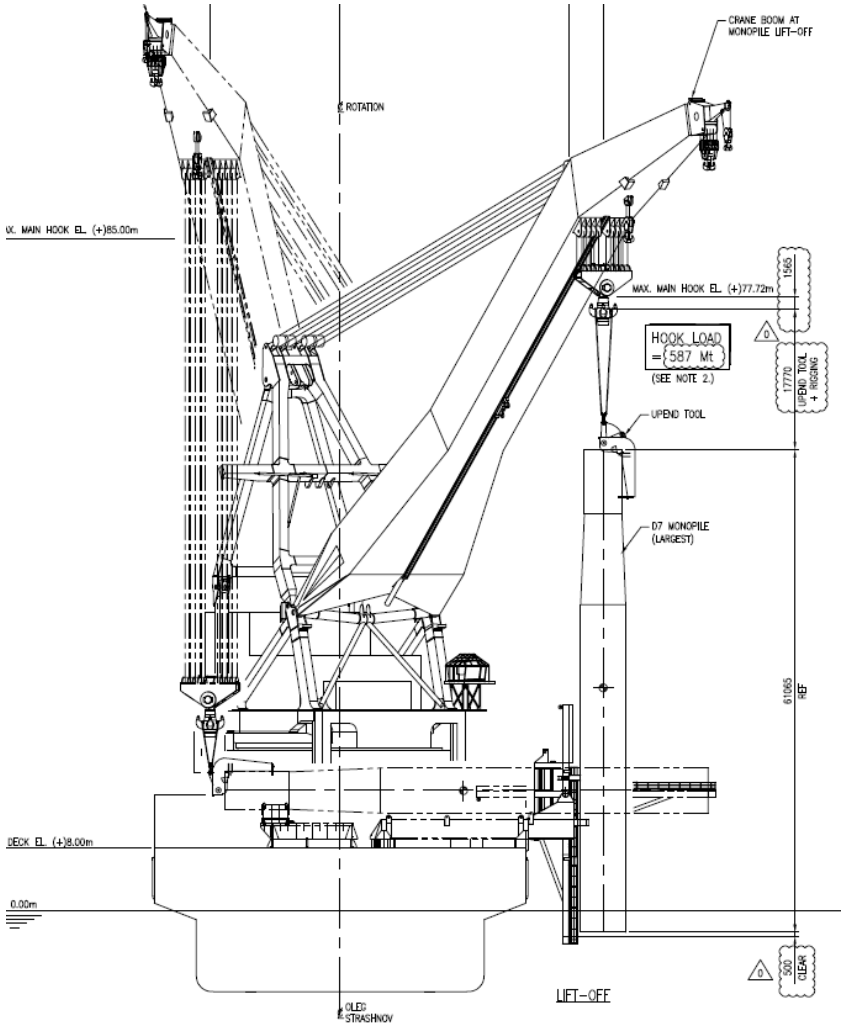


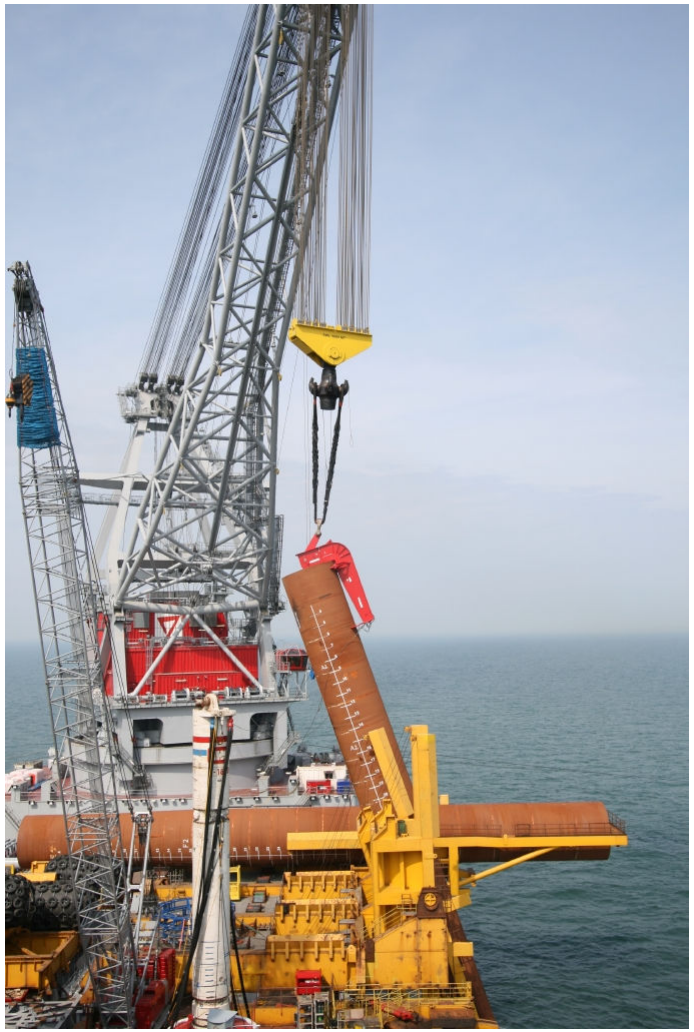
Deck layout (3)

Deck layout (4)

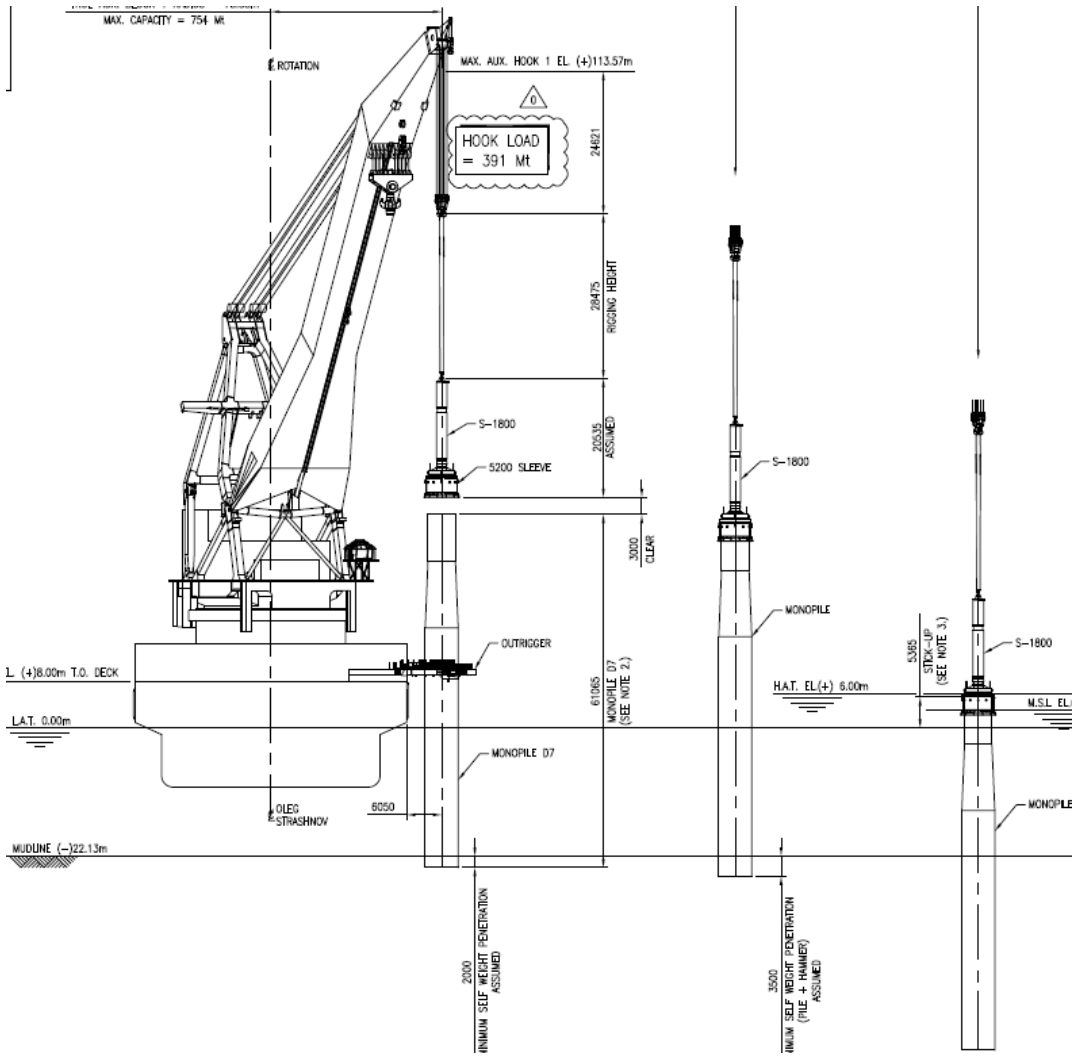
Courtesy of Statoil

Pile upending (Lifting tool)





Pile driving



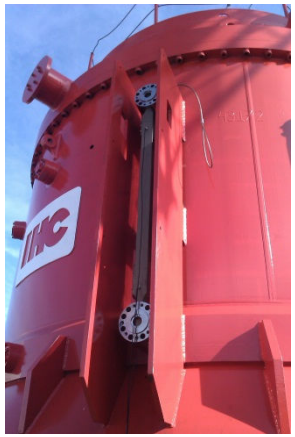
Pile verticality measurement systems

Along pile wall (Mini tilt)

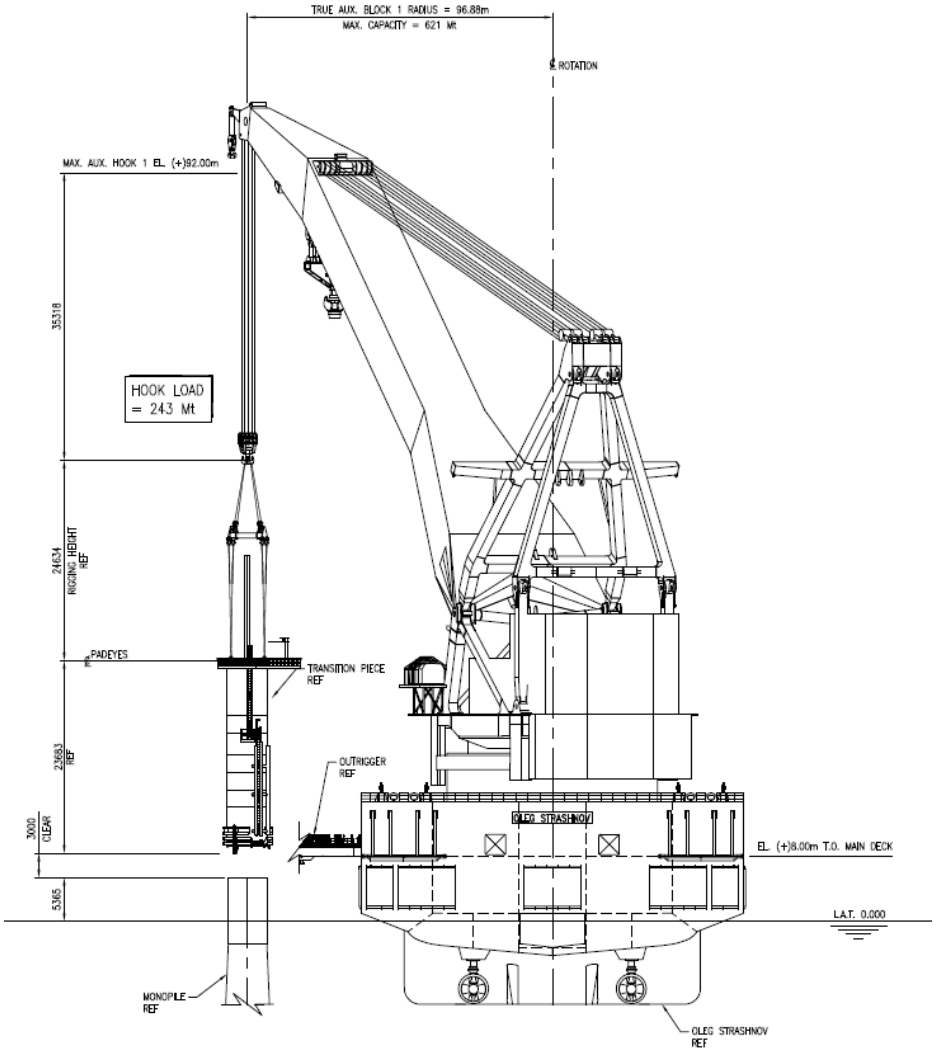
Top of hammer sleeve (Octans)

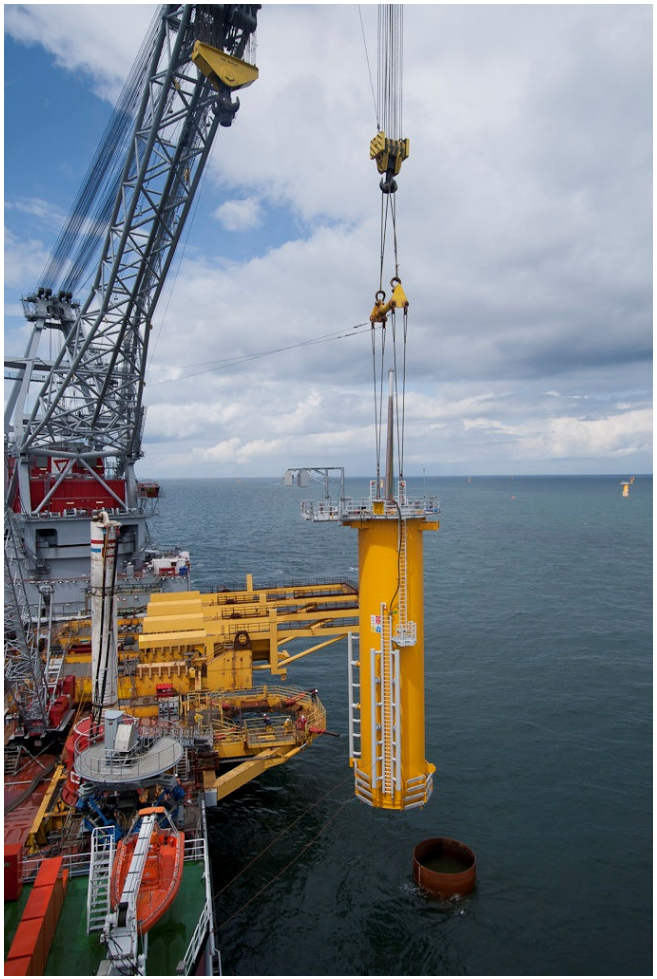
Top of pile

Side of hammer sleeve (Cilinders)



Transition Piece Installation



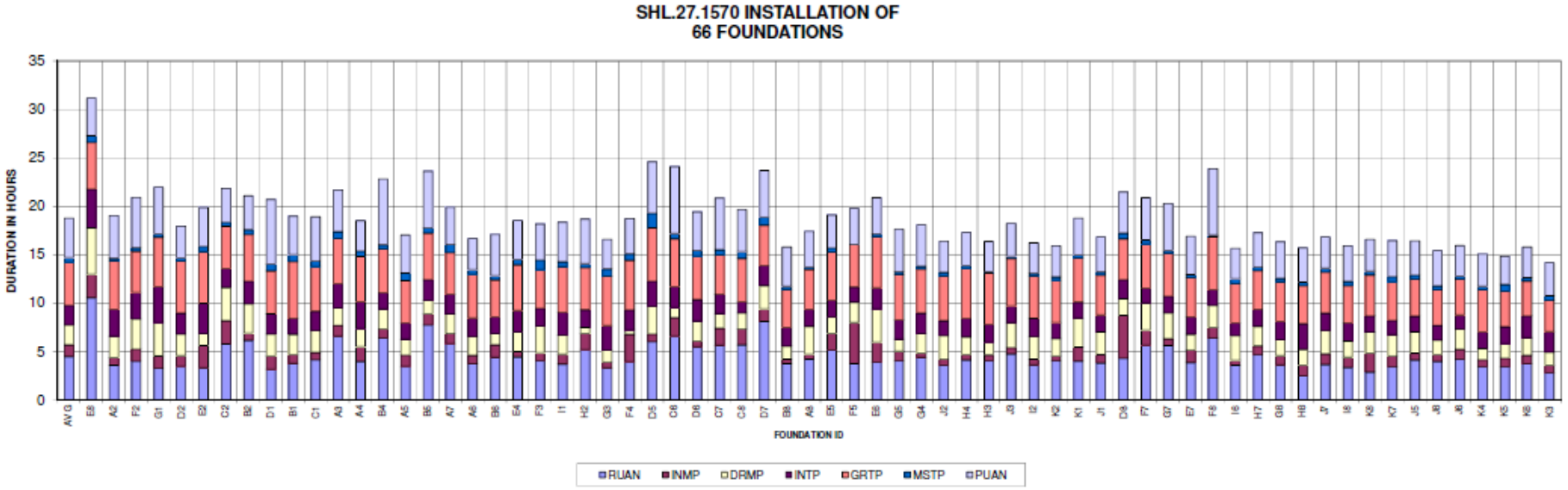


Sheringham Shoal; installation completed 3 weeks ahead of schedule

- Maiden project for HLV Oleg Strashnov
- Transport of foundations from Flushing to offshore location on HLV deck
- Both substations topsides successfully installed in 2 days (May 2011)
- Foundation installation (Mono pile + TP) (transport, levelling, grouting included)
  - May 2011: 15
  - June 2011: 20
  - July 2011: 16
  - August 2011: 15 (finished 21-08-2011)
  - Average 1.7 day / foundation

Courtesy of Statoil

Sheringham Shoal- Net duration



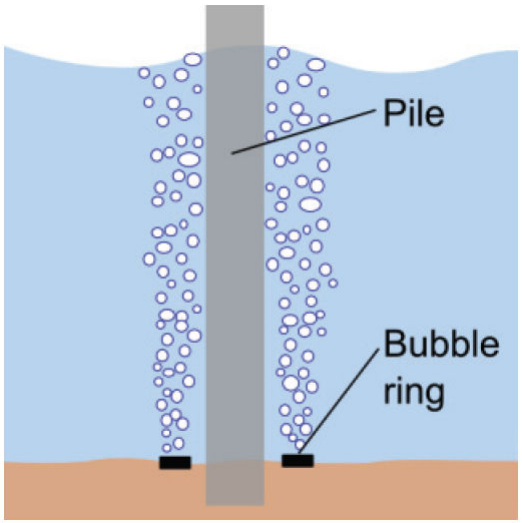
- Net duration (average): 18 hours / foundation
  - Average pile driving: 2.2 hours
- Gross duration (average): 1.7 day / foundation

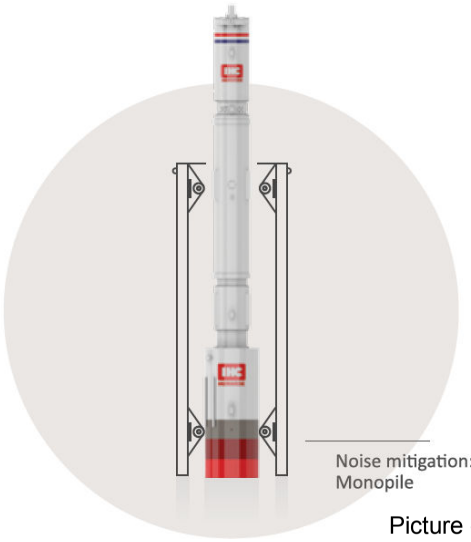
Index

1) Introduction SHL
2) Comparison Oil & Gas
3) Case study
   - Greater Gabbard
   - Sheringham Shoal
4) **Jacket installation**
5) Turbine installation
6) Substation installation
7) To conclude

Jacket Installation – Noise Mitigation

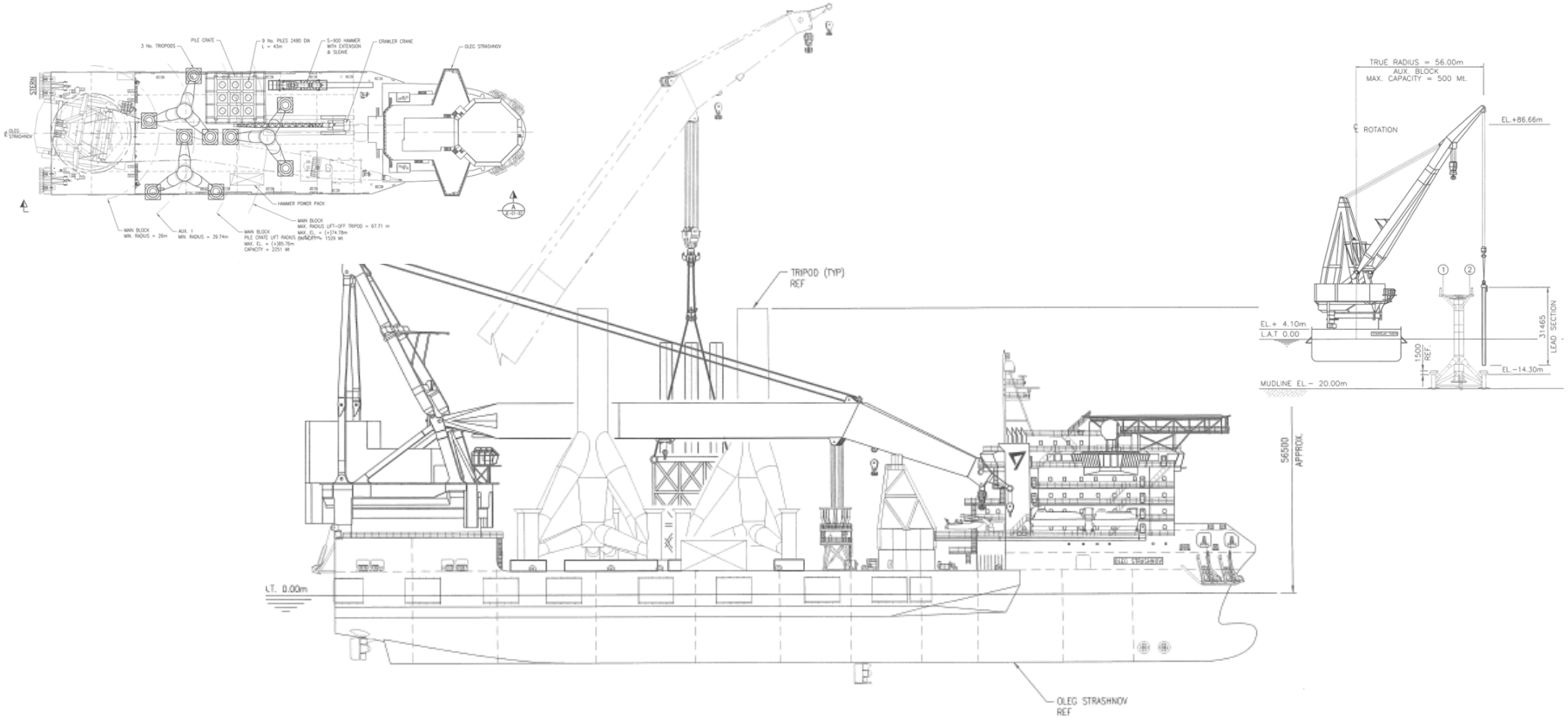
- Allowable subsea noise levels 160dB at 750m distance
- Pile driving hammers produce > 166dB at this distance
- Noise mitigation required.
  - Air bubble screens
  - Single or double wall silencer in combination with air bubbles





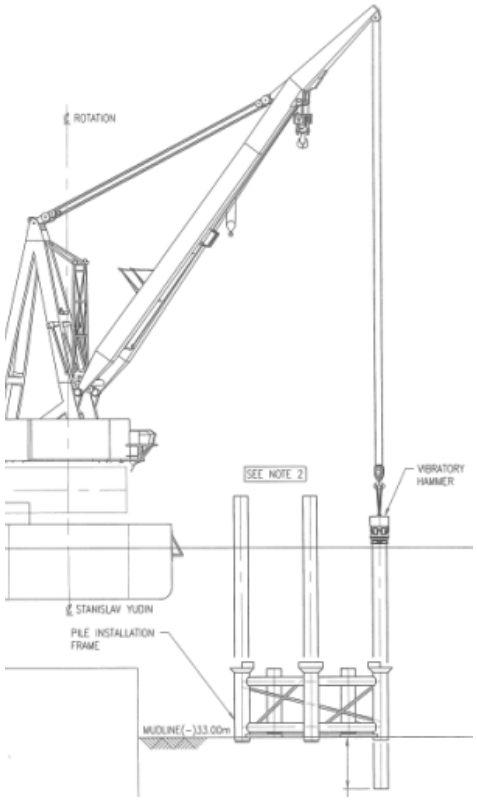
Picture courtesy of IHC Hydrohammer

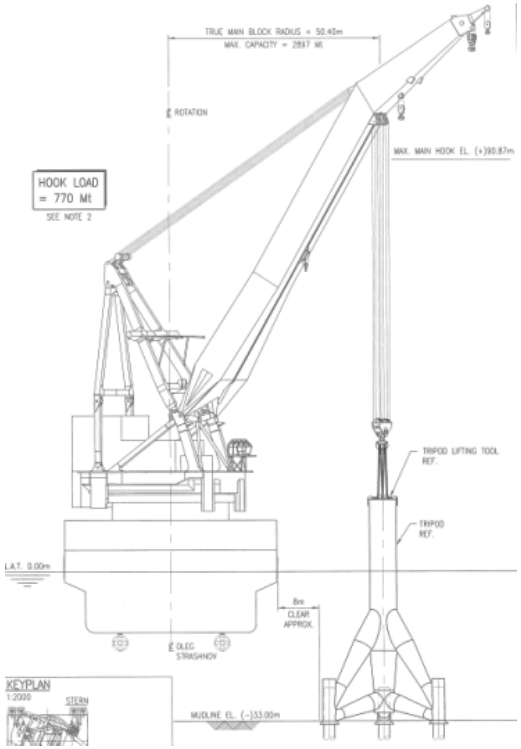
Jacket installation + Post piling



- Post piling provides challenges for noise mitigation and installation acceleration

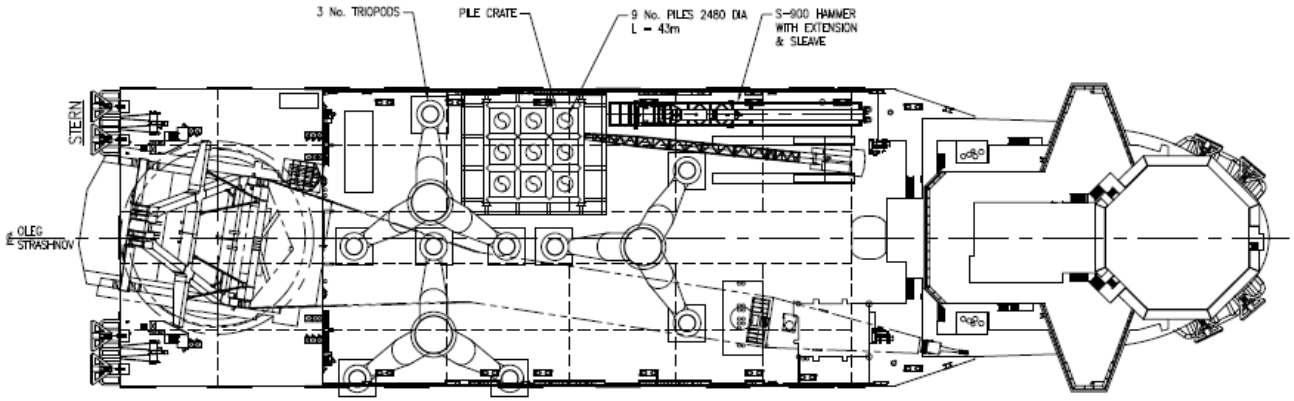
Jacket installation + Pre piling

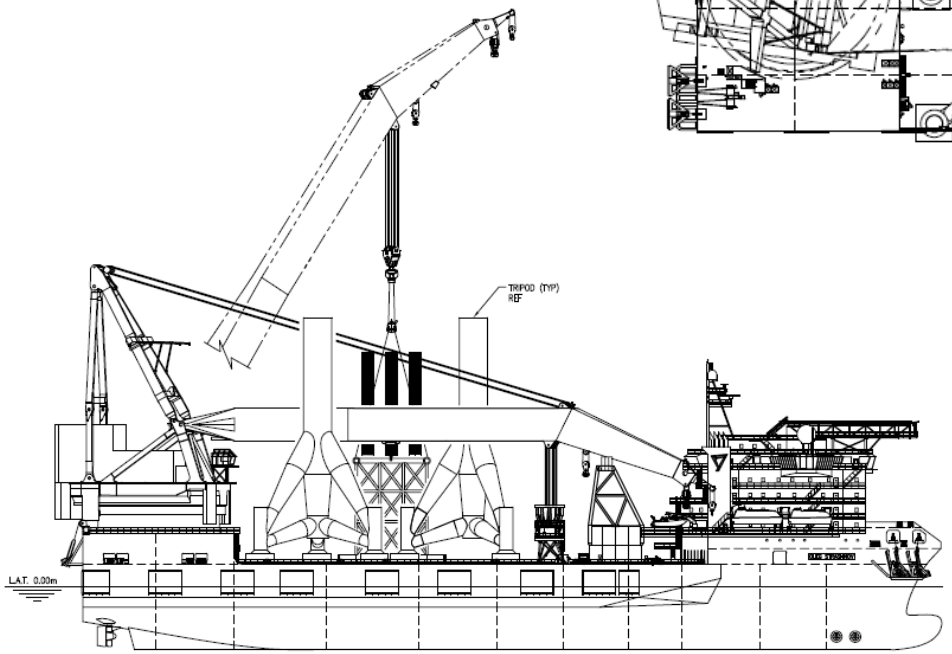




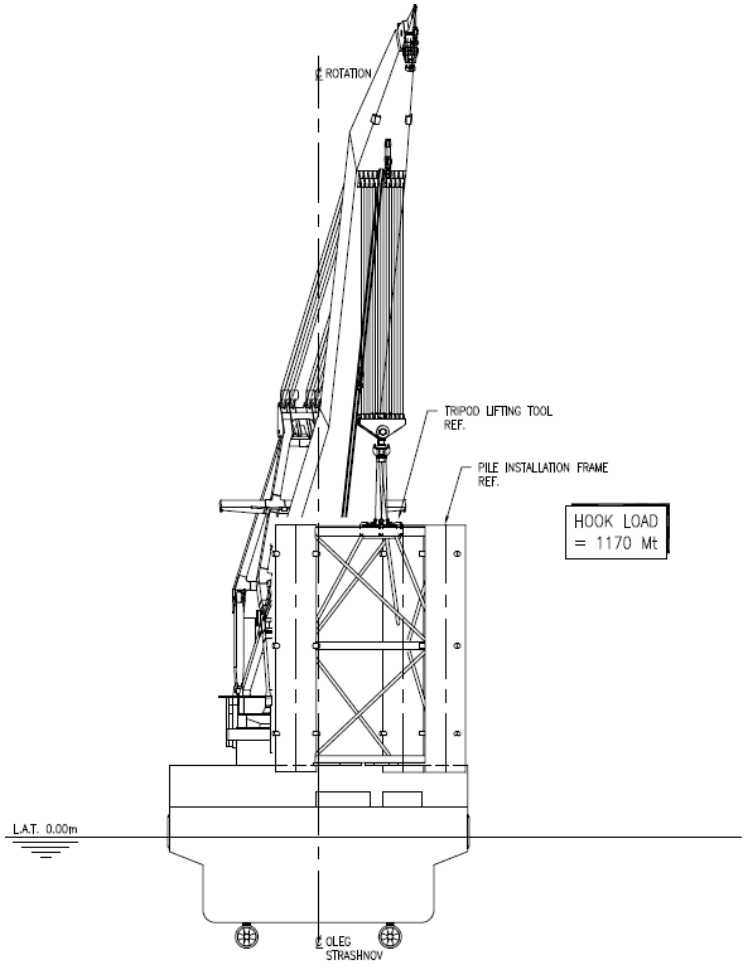
- Use a template, combined with a vibratory and impact hammer

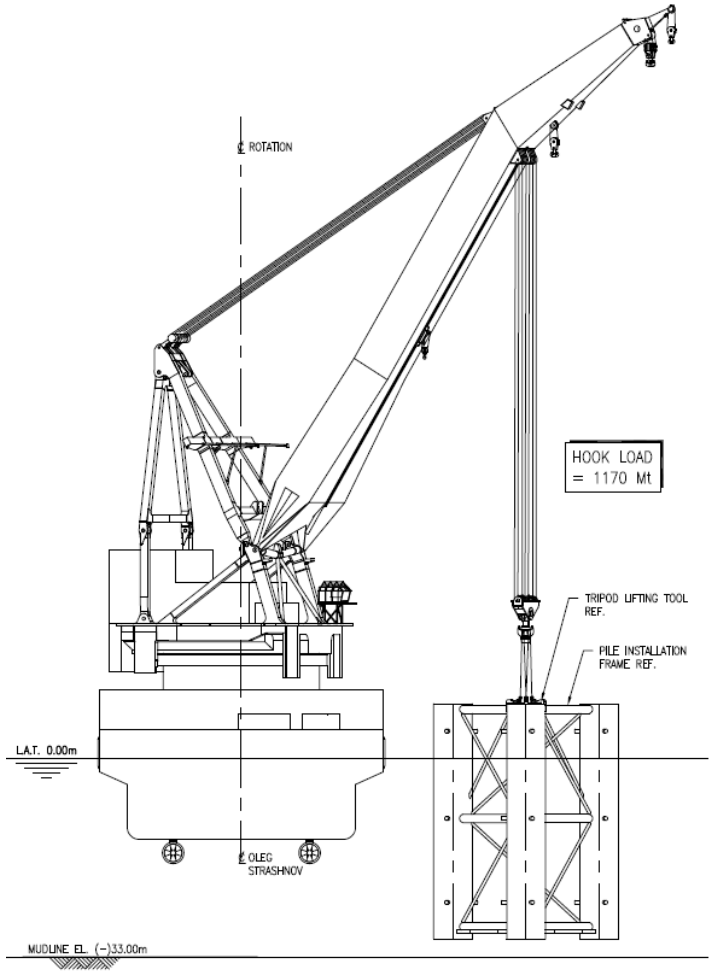
Jacket installation + Pre piling
Tripods and Piles on HLV



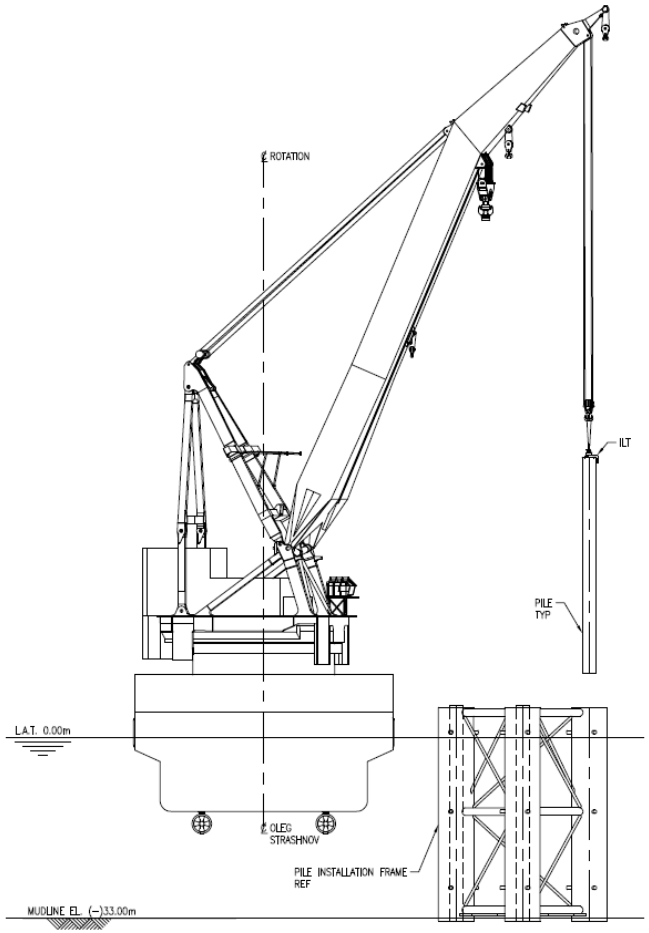


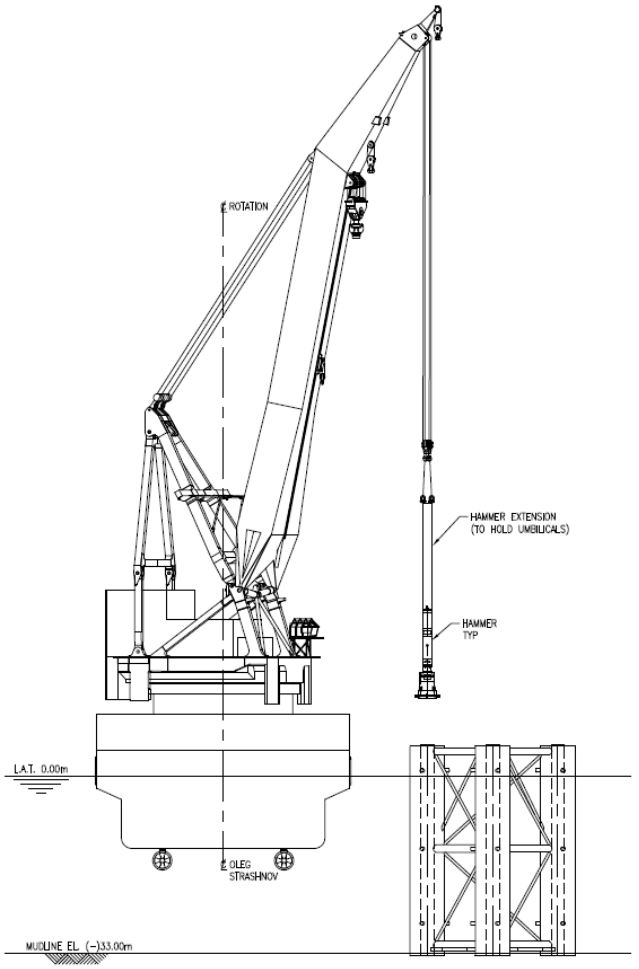
Jacket installation + Pre piling
Use of Silencer Frame



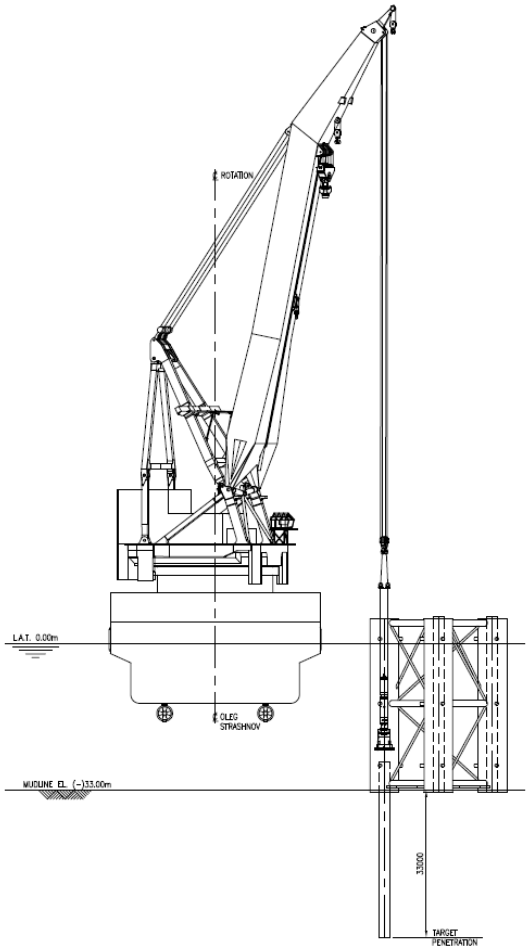


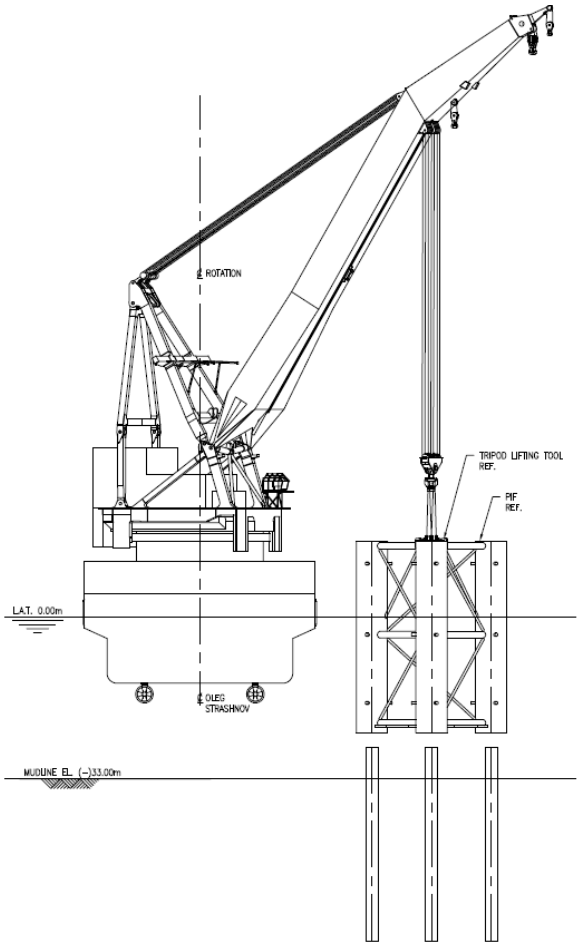
Jacket installation + Pre piling
Installation of Piles



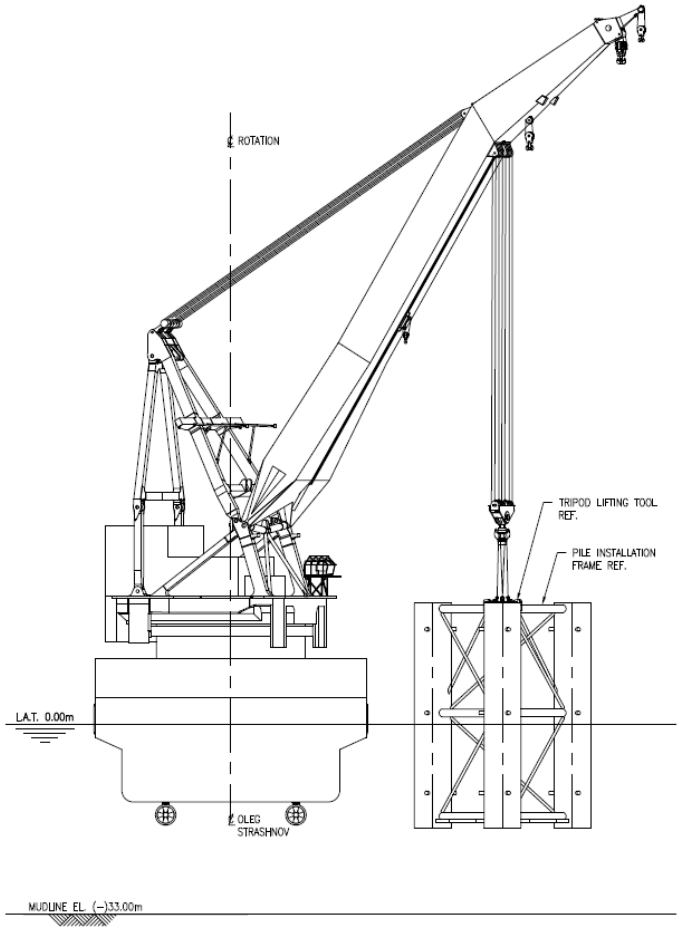


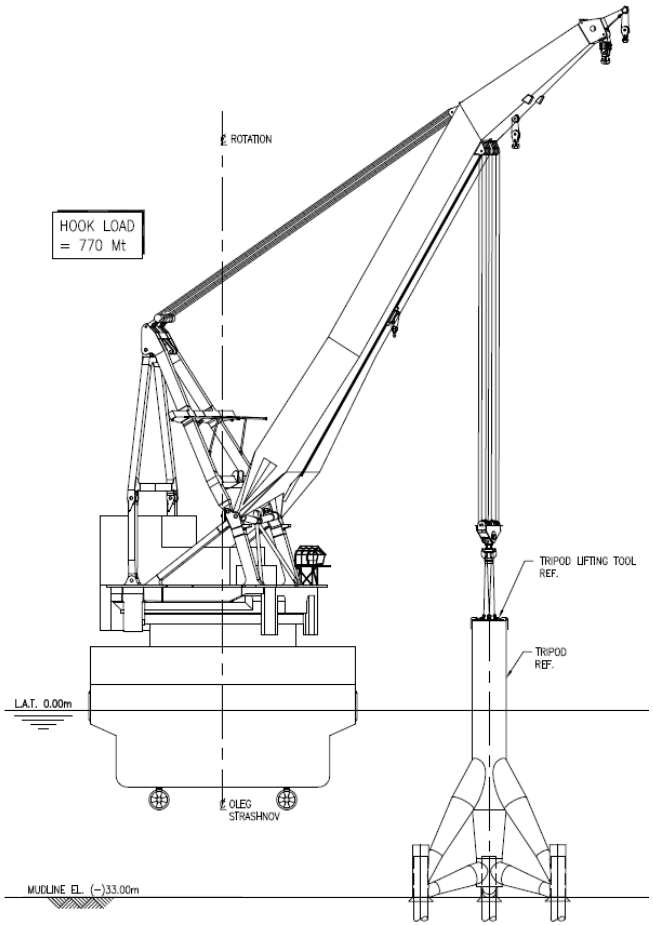
Jacket installation + Pre piling
Installation of Piles



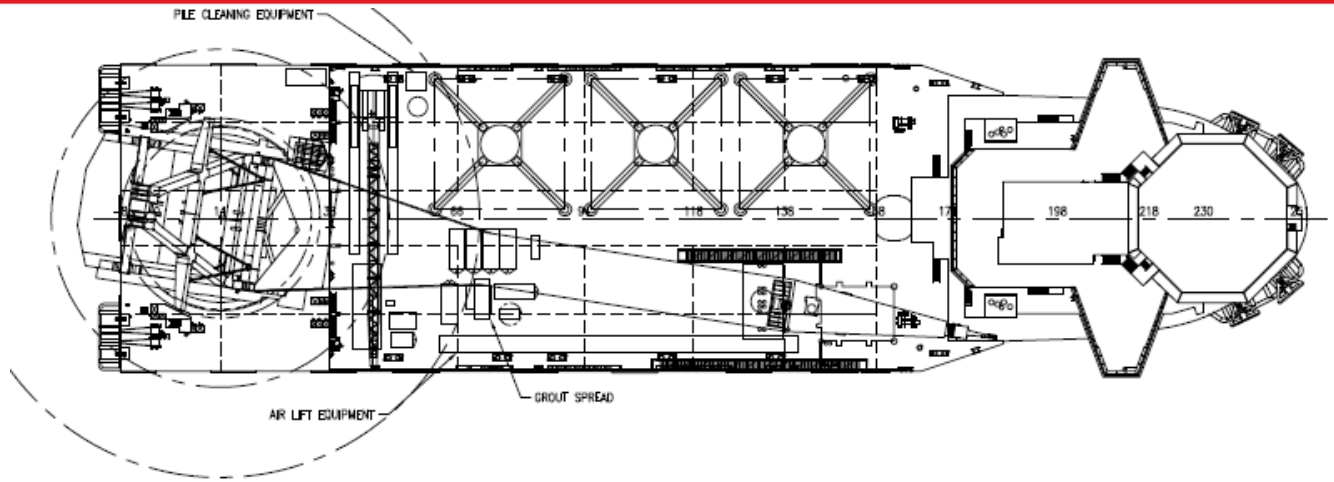


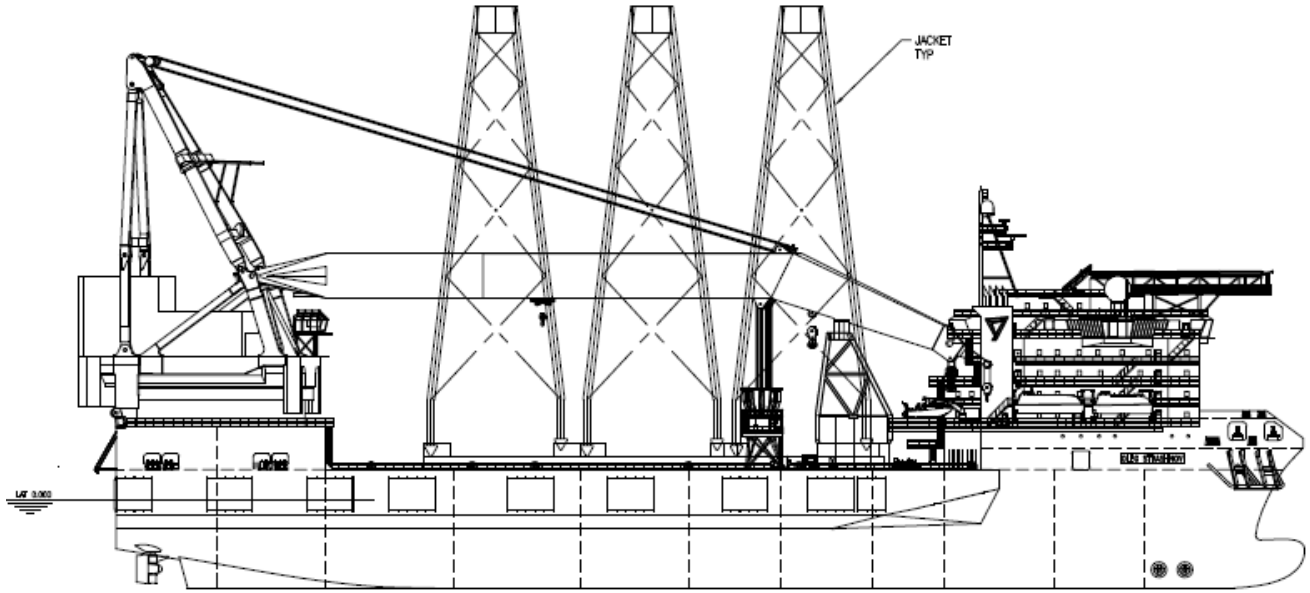
Jacket installation + Pre piling
Install Tripods onto Piles





Jacket installation + Pre piling
Deck Layout





Index

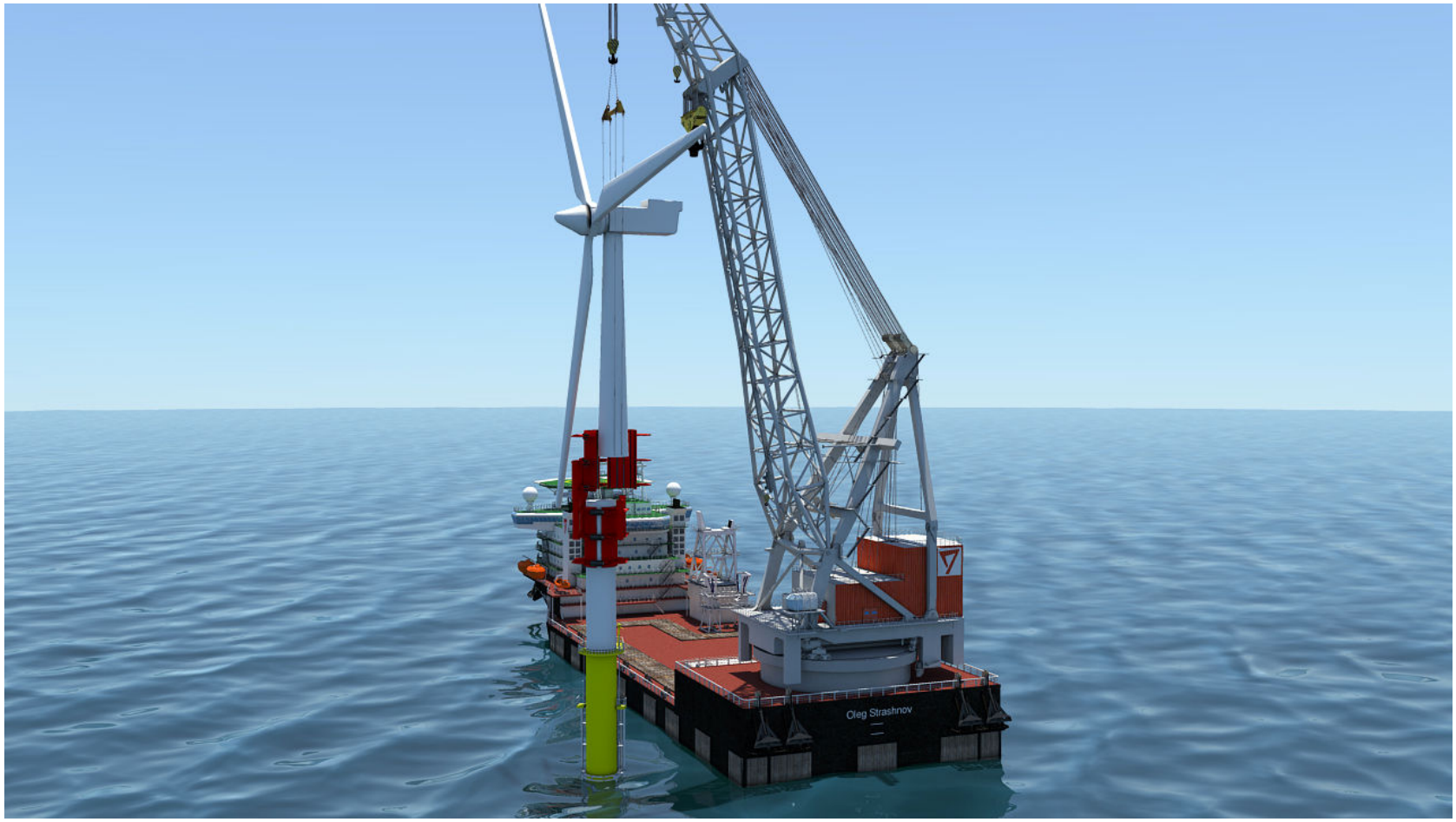
1) Introduction SHL
2) Comparison Oil & Gas
3) Case study
   - Greater Gabbard
   - Sheringham Shoal
4) Jacket installation
5) **Turbine installation**
6) Substation installation
7) To conclude

Current way of turbine installation is not the way forward

Current way of turbine installation is not the way forward

- Currently turbines are mainly installed with jack-up vessels
- Currently turbines are mainly installed offshore in 5-6 lifts
- Current turbine installation durations exceed 1 week or more
- Future projects are further offshore in deeper waters in even more challenging soil and weather conditions
- Future projects ask for at least 1 turbine installation / day (/ project)
- Current installation method need to change i.e. to deal with these requirements
- Installation need to be included in the turbine design; this might require slight changes/additional installation aids

Turbine installation

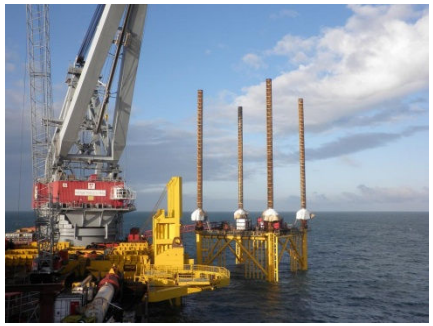


Turbine installation

Index

1) Introduction SHL
2) Comparison Oil & Gas
3) Case study
   - Greater Gabbard
   - Sheringham Shoal
4) Jacket installation
5) Turbine installation
6) **Substation installation**
7) To conclude

Traditional jacket topside design provides maximum flexibility and minimum risks



Index

1) Introduction SHL
2) Comparison Oil & Gas
3) Case study
   - Greater Gabbard
   - Sheringham Shoal
4) Jacket installation
5) Turbine installation
6) Substation installation
7) **To conclude**

Summary and conclusions

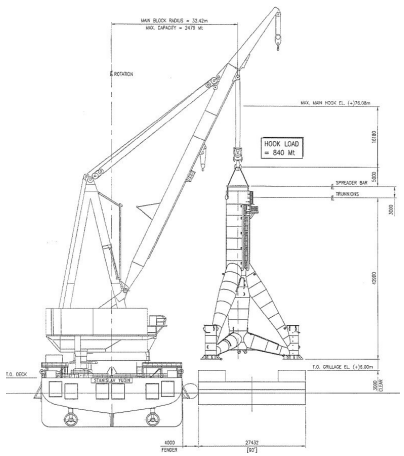
- Apply the lessons learned from Oil & Gas in Offshore Wind
- Equipment selection is key; not just select equipment because it is available
- Workability of marine spread is a key issue in developing offshore windfarms
- Wind turbine shall be (re-)designed taking into account offshore installation methods
- Develop innovative (technical) solutions to decrease installation time, mitigate subsea noise levels and minimise (weather) delays

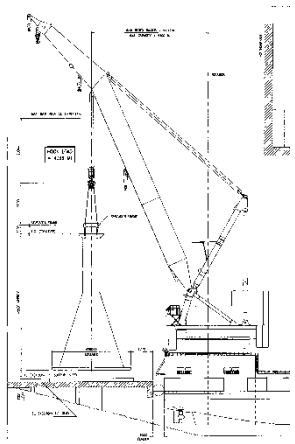
Fiber Slings
(Greater Gabbard)

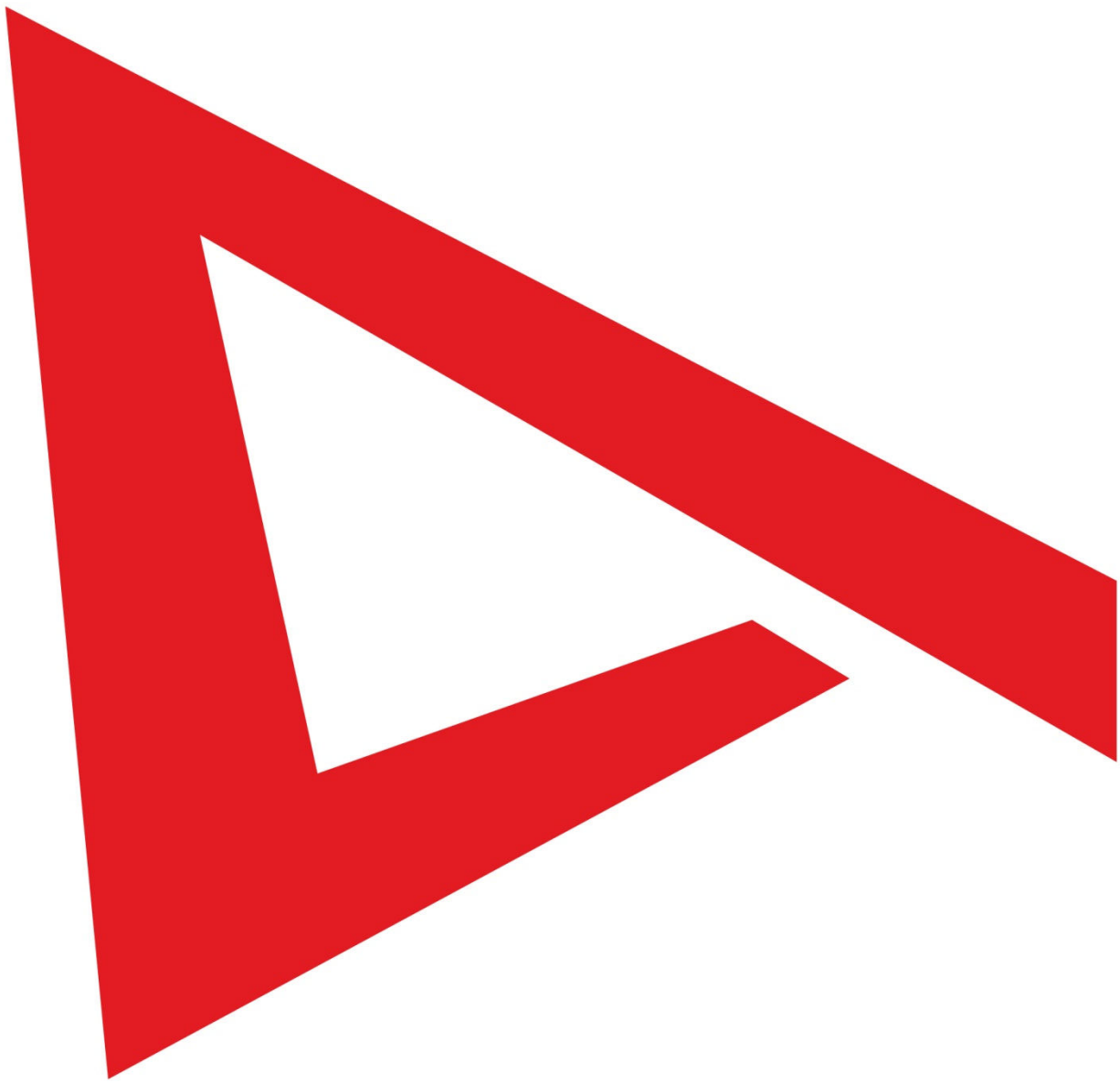
Offshore Wind Installation:
"groter, sneller, efficiënter"……

….an industry challenge !!

Thank you for your attention!








KIVI NIRIA
avans
hogeschool
Offshore: groter, sneller, efficiënter
10 november 2011
‘s-Hertogenbosch