Mooring System for Hywind Scotland

NORCOVE - Offshore Wind Energy
Science meets industry

Jon Høvik, 6th April 2016
Cargotec shapes the future of cargo handling

Hiab is the global market leading brand in customer driven on-road load handling products and solutions.

Kalmar offers the widest range of cargo handling solutions, handling one in every four containers.

MacGregor is the world’s leading brand of solutions and services for marine cargoes and offshore loads.
Strong positions in both marine and offshore markets

Marine
- Container lashing
- Hatch covers
- Cranes and self-unloaders
- RoRo

Offshore
- Offshore advanced load handling
- Offshore winches
- Mooring systems
- Loading and offloading systems

RoRo = roll-on/roll-off

05 April 2016
AOS - Pusnes Offshore Mooring Systems
The important competence

How to handle chain

- Long experience and high competence with offshore mooring design – 100 years
- Testing and detailed studies of chain behavior
- In-depth understanding of chain fatigue challenges
- Own 800 tonnes test bed
Floating offshore wind - The powerful alternative

Benefits
- Reduced installation costs
  - Finished turbine towed out
- Ability to support giant turbines
  - Potential to produce more power
  - More cost efficient
- Water depths 40 meters and more
  - Further out from shore
  - Stable wind conditions
  - Higher wind speeds
  - Better efficiency
- Not visible from shore

Challenges
- Distance to shore
  - More costly grid
- Mooring system
  - Installation
  - Fatigue

Floating offshore wind capacity (MW)
- Total 2350 MW – Early planning stage

Source: INNOSEA: Floating Offshore Wind Market Outlook

Photo: Statoil
A challenge on our own “technology home field”

Hywind Scotland Pilot Park

- 30 MW totally installed
  - 5 Floating Wind Turbines
  - 6 MW each

Design Basis - challenges

- Safe and robust installation and dis-connection
  - Without large winches on wind turbine
  - Without diver intervention
- Challenging mooring chain dynamics
  - 20 years lifetime
- Comply with offshore quality and safety requirements
- Cost efficient
Mooring equipment

Fixed Mooring Strongpoints
- 4 on each Turbine
- 132 mm R4S chain
- Chain tension and bending monitoring on two turbines

Adjustable Fairlead Chain Stoppers
- 2 on each Turbine
- 132 mm R4S chain
- Chain tension and bending monitoring on two turbines

Mooring Brackets
- 3 on each Wind Turbine

Tools
- Chain pull-in tool
- ROT (Remote Operated Tools)

Schedule
- Equipment June 2016 to Jan. 2017
- Offshore installation 2017
When our expertise makes a difference

R&D cooperation with Statoil

- **Practical installation - concept study**
  - No winches
  - Simple installation and maintenance
  - Suitable for ROV operation

- **Chain fatigue life**
  - Rainflow load cycle data from coupled analysis (OO-Aibel)
  - Analysis of tension and bending (OPB) fatigue in combination
  - Large no of cycles
  - Equipment designed to give optimum fatigue life for chain

New mindset – the big difference

- **Offshore oil field**
  - One vessel, limited number of mooring lines, many rig moves

- **Offshore wind turbine park**
  - Hundred or more turbines, possibly 600 mooring lines, minimal mooring line adjustment

- **This call for a different mind-set**
  - Permanently installed equipment must be minimal and simple
  - Tools to be used during installation and maintenance may be advanced
  - Allow for using the less expensive Anchor Handling Vessels (AHV)
MacGregor multi-axis motion compensated crane

- «ISV Siem Moxie» at work - German “Amrumbank West” - Windfarm
- 3D / heave compensated crane
- Crane tip stable despite moving vessel
- Heave compensated winch
- New developed compensation in crane foundation (foundation is tilting)
- 5 ton lifting capacity on 25m outreach
- Typical operational weather window $H_s = 4$ - dependent on vessel design (and RAO data).
- Winner of “Innovation of the Year” award @ OSJ London 2015
- In service for a year on «ISV Siem Moxie»
MacGregor motion compensated gangway

- Using new 3D / heave compensation technology
- Pedestal multi-axis compensation
- Outreach and operational weather window to suit client requirement
- Designed according to DNV ST-0358 «Certification of Offshore Gangways for personnel transfer»

05 April 2016
Thank you!