Deepwater Mooring – Deeper and Leaner

Subsea 2012

Brian Green – 8 February 2012
Deepwater Trends

Wide agreement that operators will need to develop more deepwater fields

Key areas: GoM, Brazil, West Africa, Asia, Arctic

Diversity of platforms FPSO, FPU, Spar, STP Buoys

Further offshore - adverse sea / weather, greater mechanical demands on mooring system

Lack of infrastructure, field hub platform
Deepwater Mooring

Focus on:

- Mooring Technology: Connectors, Lines
- Mooring System Deployment
- New Mooring Developments
- 'Lean Installation' framework
Deepwater Mooring

Deepwater and ultradeepwater moorings – 800m - > 2,000m

Permanent moorings

Subsea mooring connectors

Fibre Rope mooring lines

Deployment: multi-vessel, multi-segment lines, platform dependent
Mooring System Deployment

Speed and cost of deployment increasing

Cost of installation now greater than cost of mooring line

Mooring technology response - Lean Installation
Lean Installation Framework

Based on 'Lean' principles of:

- Reducing Waste
- Adding Value
- Improving Processes

Use to guide connector developments and mooring methodologies
Lean Installation

In practice, Lean Installation of mooring lines:

Reduces waste – cut installation time, cut boat time, reduced top chain length.

Adds value – faster installation, changes in mooring line deployment methodology, greater connector integrity

Transforms mooring process: quicker, safer, improved rope splice integrity
Ball & Taper Connectors

'Plug-in' Lean Installation Ball & Taper mooring connector

Multi-point grip in direct proportion to load - Self-aligning and self-energising

Two part connection: different times, different vessels

'Lean Installation' Ball & Taper – DBSC, buoy retrieval, pipe handling tools
Subsea Connector Research

'Next Generation' subsea mooring connectors – deeper moorings, challenging environments

Increasing engineering integrity of mooring components

Lack of understanding of Forged Metal Processes
Subsea Connector Research

Research with First Subsea, University of Sheffield’s IMMPETUS, and Somers Forge.

Provide foundational knowledge of what happens during metals forging.

Determine optimum Heat Treatment process, forging process, ideal steel composition for best forged material.
Subsea Connector Research

Validated heat transfer model to predict mechanical properties linked to microstructures and cooling rates

Established solid foundation of knowledge about heat treatment and effects of chemical composition, cooling rates and sampling position

Jack and St Malo FPU connector – largest so far – uncorroded 2,599 mT

Toughness: 140J

35J

33J
Mooring Deployment

Mooring deployment flexibility to suit
- platforms / buoys
- field conditions

Mooring line installation: surface to seabed
- FPSO / Spars, STP buoys
Mooring Deployment

Traditional mooring line installation: surface to seabed

Female receptacle, attached to ground chain

Male connector lowered from surface and inserted into receptacle
Mooring Deployment

Seabed to surface – STP buoy mooring

Female receptacles pre-installed on STP buoy

Mooring lines installed with piles, held midwater

Easier lift and tow out

Fewer tow out vessels needed
Mooring Line

Multi-components in line:
anchor, chain, subsea
mooring connector, chain,
fibre rope, connectors and
chain

Focus on reducing
deployment times

Longer deepwater mooring
lines mean more connectors
Mooring Line Interconnects

Efficiency of rope splicing, mooring techniques maximised – focus now on rope connector

Lankofirst fibre rope connector

Lankofirst - new mooring connectors for rope-rope and rope-chain
New Connector Developments

Sliding ice sheets cause lateral toppling loads on floating vessels in arctic waters

Quick Emergency Disconnect mooring connector for load monitored lines:

- Prevents damage to vessels and turrets
- Allows automatic breakaway of mooring lines under emergency loads up to 750mT per line

Breakaway of vessel from moorings to be achieved within 15 minutes of emergency notification
Mooring Rope Testing

Lankhorst Ropes / Offspring International - 'What If' scenario rope testing

Higher MBL ropes, +2,000 T → safety issues and significantly higher installation costs

Beyond scope of most existing rope test machines

New pre-tensioning test: variable loads at fixed length - More representative of rope performance in-service
Mooring Rope Testing

Pre-tensioning rope based on variable loads at fixed rope length

Necessitates more rope testing at start of project, but benefits include:-

- Safer (Lower) Installation Loads
- Capital cost reduction – smaller and cheaper chain tensioning systems.
- Option of smaller installation vessels.
- Faster Installation time
- Reduced installation costs
Deepwater Mooring

Deepwater moorings – going deeper, getting leaner

Moorings connector and rope developments equal to the challenge

Technical performance

Deployment – quicker, smaller vessels

'Lean Installation' proving to be a valuable framework for screening new approaches to deepwater mooring