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Advancements in Mooring Riser Technology:

the Elastomeric Solution

Dr. David G. Aubrey, CEO April 10, 2019





OUTLINE

- Two types of mooring compliance:
 - Geometrical
 - Mechanical
- Use of traditional catenary mooring solution: outstanding issues
- Advancements in mooring technology: mechanically compliant riser elements



Courtesy of Wildlife Conservation Society



WHY MOORING COMPLIANCE?

The ocean is an unforgiving environment with persistent dynamic forces. A well-designed solution must be compliant with these dynamics.



- To reduce snap loads and failures on the mooring system
- To prevent the loss of EXPENSIVE instruments and data
- To minimize anchor and mooring "walk"



GEOMETRIC COMPLIANCE

Advantages

- Established design
- Lower cost for components (capital costs)

Disadvantages

- High risk of entanglement
- Large watch circle
- Navigational hazard
- Shortened lifespan due to significant snap loads: high operational costs
- Larger anchor requirements

MECHANICAL COMPLIANCE

Advantages

- Will not hockle or kink
- Minimal watch circle
- Likelihood-of-failure reduced
- Operational costs reduced
- Proven durability in open ocean conditions

Disadvantages

- User base limited
- Higher capital cost
- Historical shallow water use



COMPLIANCE



MULTIPLE SECTOR APPLICATIONS FOR MECHANICAL RISER TECHNOLOGY





DEEP WATER RENEWABLE ENERGY PLATFORMS



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The Carbon Trust-led Floating Wind Joint Industry has identified dynamic export cables as "**potential bottleneck for commercial deployments**. While lower voltage dynamic inter-array cables (~22-66kV) are readily available, there is a **notable gap in the market for suitable high voltage dynamic cables for export purposes** (~130-250kV) to enable efficient transmission of power back to shore."

- Floating platforms have a higher energy density, i.e. winds are stronger and more consistent.
- The technological hurdle is finding a dynamic cable that runs through the water column to transport energy from the tower to the seafloor.
- The cable is exposed to dynamic forces such as waves and currents, leading to an increase in cable failures



AQUACULTURE FARMS

Fish are among the most efficient converters of feed into high quality food. Aquaculture is an important industry, because it promises to increase food security.



- A caged system can have multiple connections points
- A large footprint presents navigational hazards and additional cost



SMALL BOAT Moorings

- The world has lost at least 30% of its seagrass meadows since 1900.
- Seagrass meadows provide important ecological services having vast economic value.
- Traditional chain and rope moorings "scar" the meadows by scraping the bottom, creating circular patterns absent flora and fauna.



Buzzards Bay, MA June 2001



Buzzards Bay, MA June 2005



OCEANOGRAPHIC MOORINGS

- Expensive to deploy and can have poor data return
- Large watch circles
 affecting acoustic path
- Limited component lifetimes due to snap loads (can be reduced by 25% or more)





INNOVATIVE SOLUTION S USING MECHANICAL COMPLIANCE

Isolate Wave Energy from Small Watch Circle Sensors Oceanographic Moorings **Conservation Moorings** Oceanographic Moorings Passive Acoustic Monitoring Passive Acoustic Monitoring (PAM) Aquaculture Floating renewable energy Lower Operational Costs **Reduce Snap Loads** Floating Renewable Energy **Platforms** All applications Aquaculture cages Conservation Moorings Passive Acoustic Monitoring



MOORING COMPLIANCE IN OFFSHORE ENERGY

- Patented High-Throughput stretch hose technology enables MW-level power transmission
- Proprietary stretch EM cable construction method adapted to contain shielded non-armored Medium Voltage conductors
- Mechanically compliant transmission cable offers advantages over geometric compliance – low risk of entanglement, minimal scope, sensitive connectors kept off seafloor, no environmental disruption of sensitive ecosystems
- Ease of installation, lower operational cost







MECHANICAL COMPLIANCE IN AQUACULTURE

- Reduce snap loads
- Reduce watch circle (allow more dense cage network)
- Reduces lease costs (based on areal footprint)





MARINE MAMMAL MONITORING

Entanglement and ships collisions are the first and second causes of death for whales



- Noise emissions are increasing, which masks communication between the animals; may affect animal health.
- Ambient noise from traditional catenary mooring lowers sensor S/N. Isolation using mechanical compliance is a solution.

MECHANICAL COMPLIANCE IN PASSIVE ACOUSTIC MONITORING

- Stretch Cable isolates the wave-induced activity from hydrophone
- Quieter environment for real-time detection.
- Provides robust operational guidance

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MECHANICAL Compliance in Small boat Moorings

08/15/2010

EOMOFFShore CLOSING REMARKS

- Mooring compliance and riser compliance are essential design criteria
- New technology solves multiple issues associated with catenary mooring
- Opportunities for mechanically compliant riser elements in different sectors

THANK YOU