IEC 61400-3-2: Technical Specification for Floating Offshore Wind Turbines (FOWTs)

Workshop on Offshore Wind Energy Standards and Guidelines

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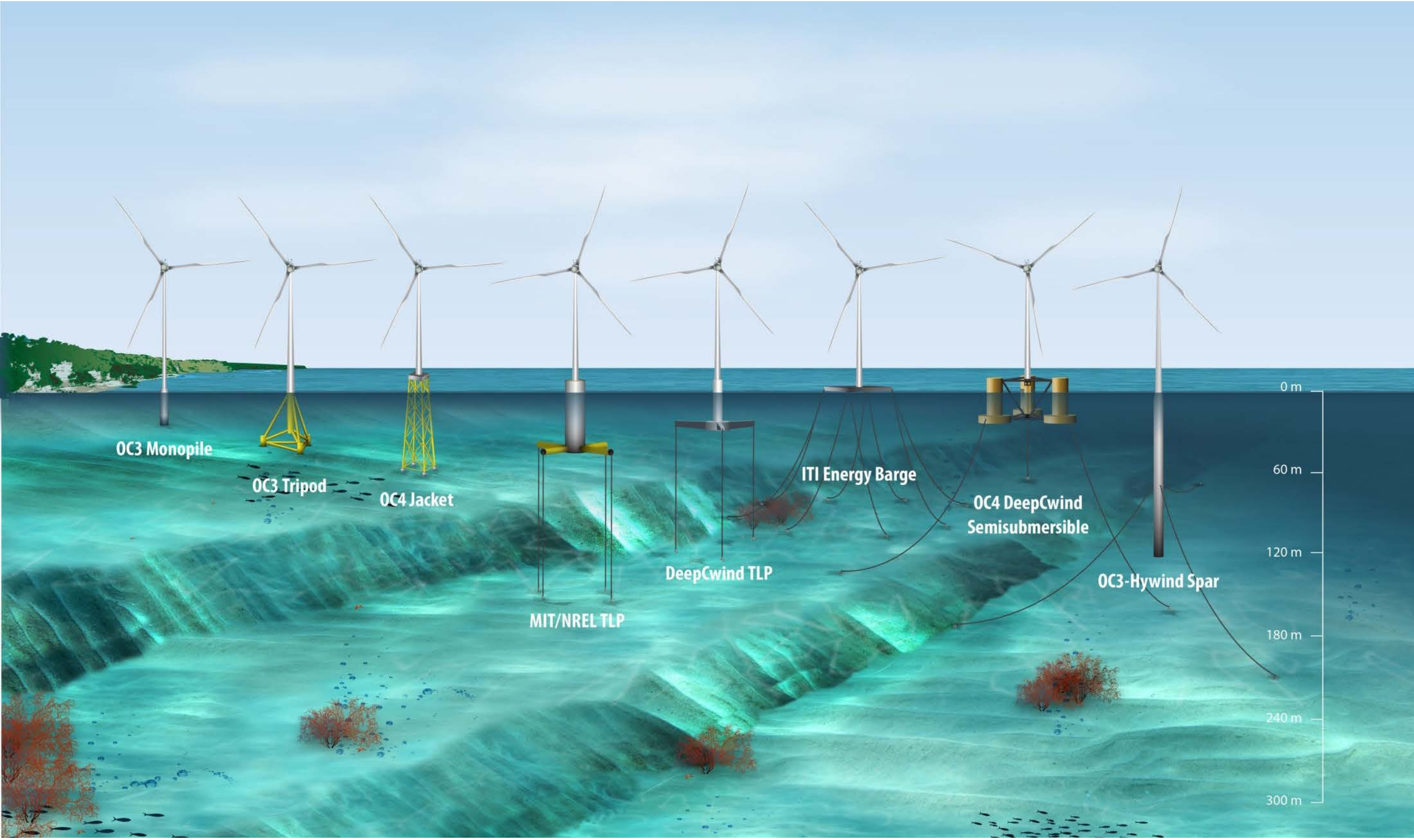
Introduction & Background

FOWT Concepts



Introduction & Background

Floating Wind Industry Status

Developer	• Statoil, Norway	• PPI & EDP, Portugal	• METI, Japan	• MOE, Japan
Platform	• "Hywind" spar buoy with catenary moorings	• "WindFloat" semi-submersible with catenary moorings	• Mitsui semi-submersible with catenary moorings	• Spar buoy with catenary moorings
Wind Turbine	• Siemens 2.3 MW	• Vestas V80, 2 MW	• Hitachi 2-MW downwind	• Hitachi 2-MW downwind
Status	• $70M demonstration project in North Sea • First PoC installed in Summer 2009 • More optimized demonstrator under development	• $25M demonstration project in Portugal • First PoC installed Fall 2011 • EU FP7-funded "Demofloat" testing & validation project • US project underway	• Installed in Summer 2013 near Fukushima • Part of the $189M "Fukushima Forward" project in 2011-2015, which will also have two 7-MW turbines	• 2-MW full-scale system installed in Fall 2013 in Kabashima, Japan • Followed 100-kW half-scale system • Testing & validation underway

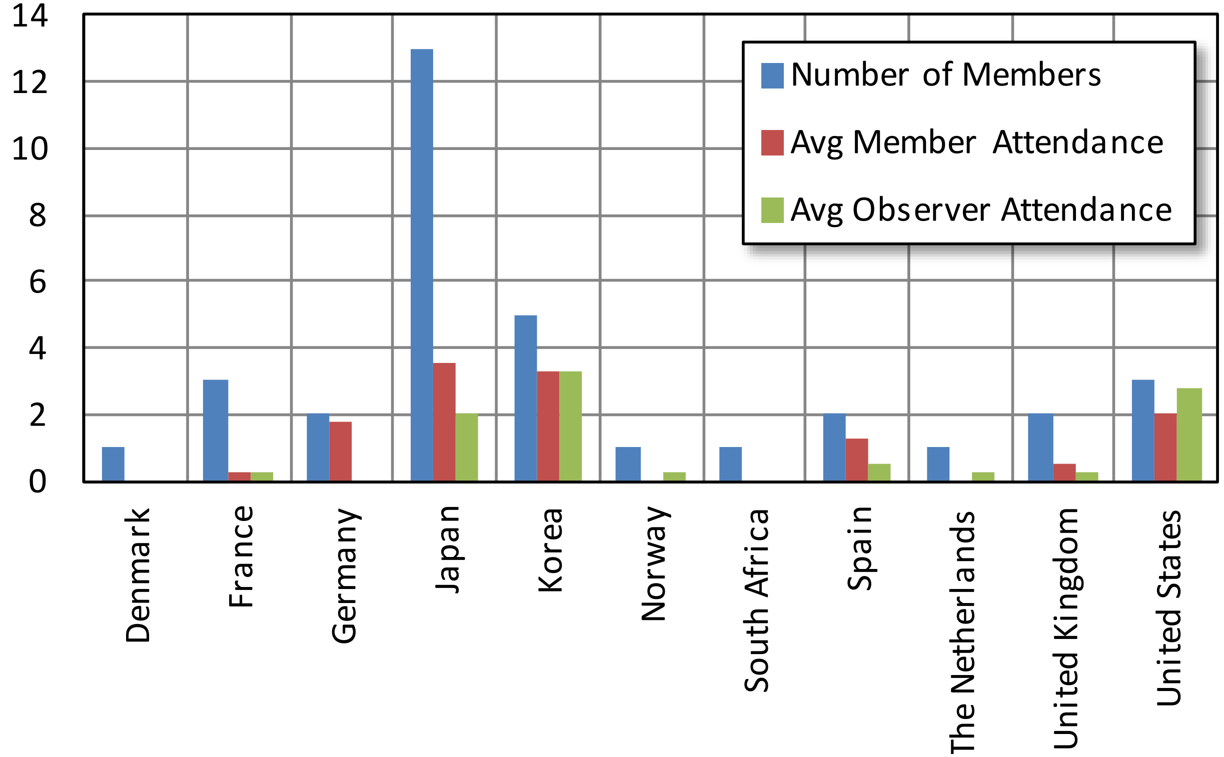
Introduction & Background

Objectives, Approach, & Outcome

- Objective: Develop a Technical Specification (TS) for ensuring the engineering integrity of FOWTs
- Approach: Develop a document that is as aligned with the -3 as much as possible, but with differences where needed
- Outcome: Depending on the differences in the end, the new requirements could become:
  - Merged into the -3
  - An appendix to the -3
  - An entirely new standard

Introduction & Background
Participants

- Convener: Lars Samuelson – ABS (USA)
  Hyun Kyoung Shin – University of Ulsan (Korea)
- Secretary: Denis Matha – University of Stuttgart (Germany)
- Doc Master: Jason Jonkman – NREL (USA)



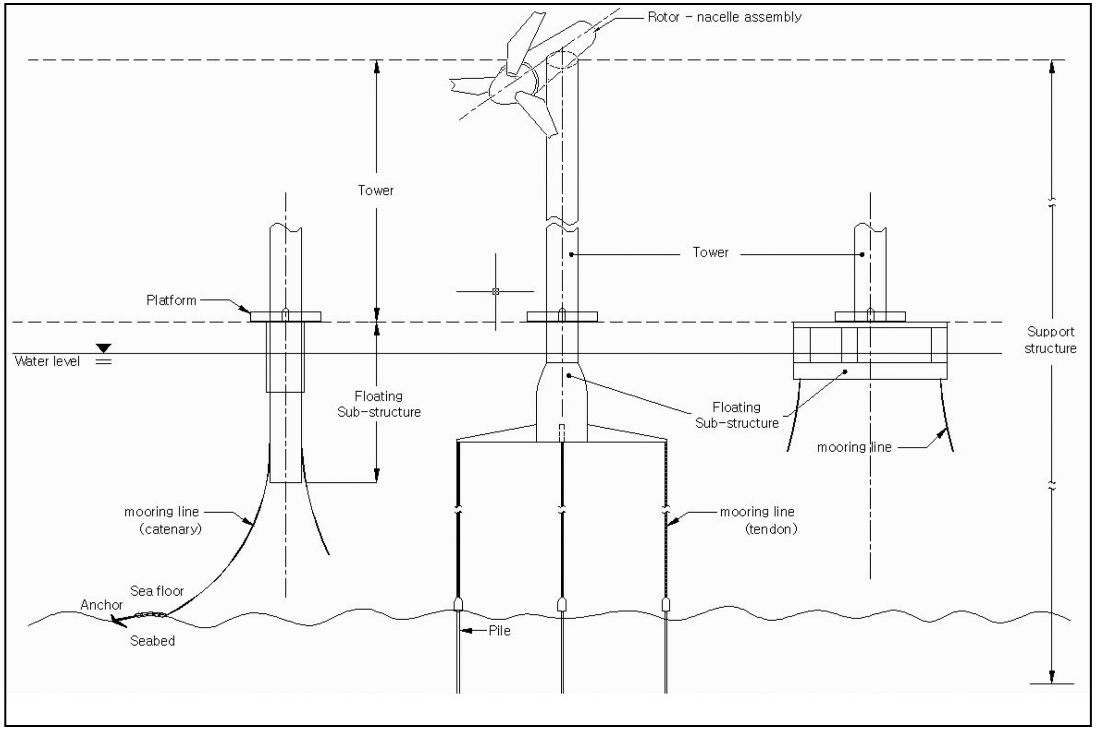
Introduction & Background

Coordination with Related Projects

- MT1 for land-based wind
- MT3-1 for fixed-bottom offshore wind
- AWEA Recommended Practice
- BSEE Technology Assessment & Research (TA&R) project 669 on FOWTs
- DNV JIP for FOWTs
- GL Offshore Wind Guideline 2012
- ABS Guide for Building & Classing FOWTs
- IEC TC-114 for Marine Energy Converters

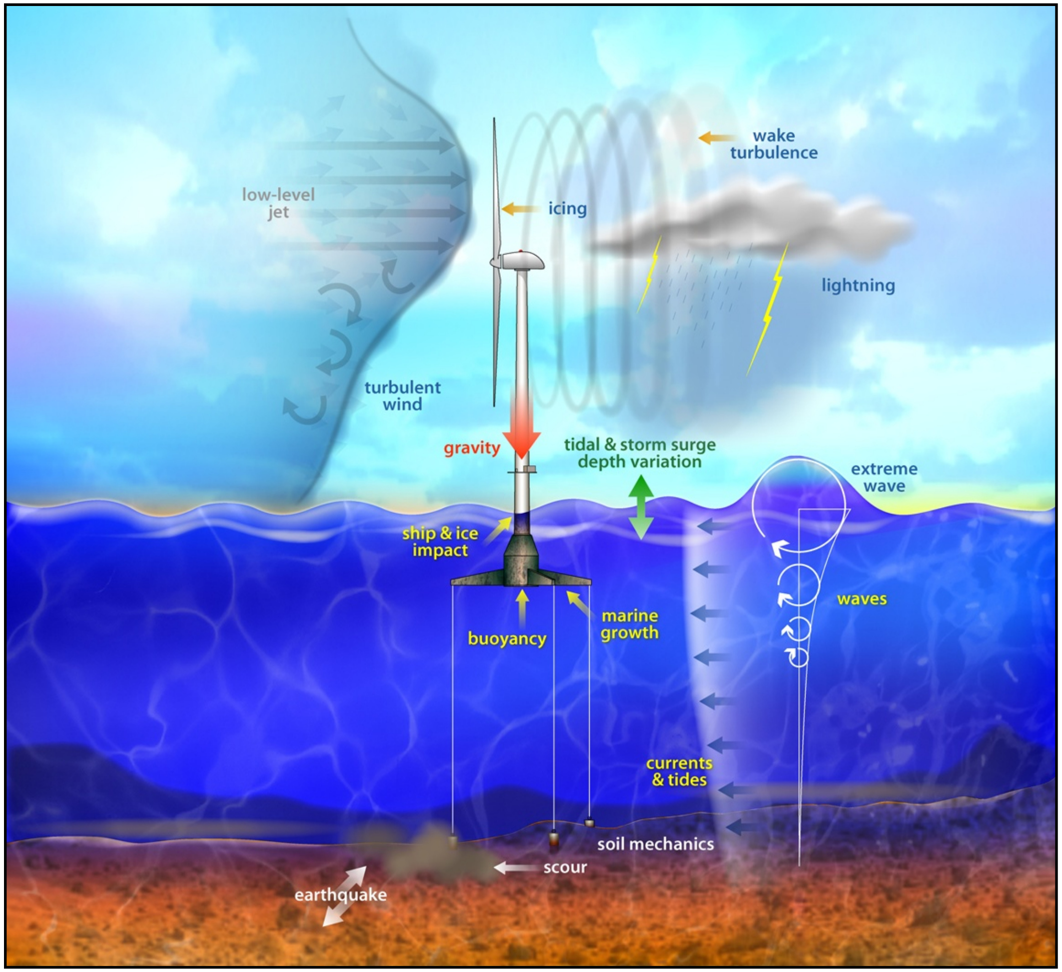
Key Features
Scope

- Primarily applicable to:
  - One single HAWT
  - Unmanned units
  - Spar buoys, TLPs/TLBs, semi-submersibles, or hybrids
- Additional requirements may be needed for:
  - Multi-turbine units
  - VAWTs
  - Units with permanent personnel
  - Wind/wave-combined units



Key Features
External Conditions & Assessment

- Wind gusts (EOG, EDC, ECD):
  - Durations corresponding to FOWT natural frequencies
- New appendix for seismic analysis (especially for TLP/TLB)
- New appendix for tsunami analysis (high surge & strong current)



Key Features
Design Load Cases

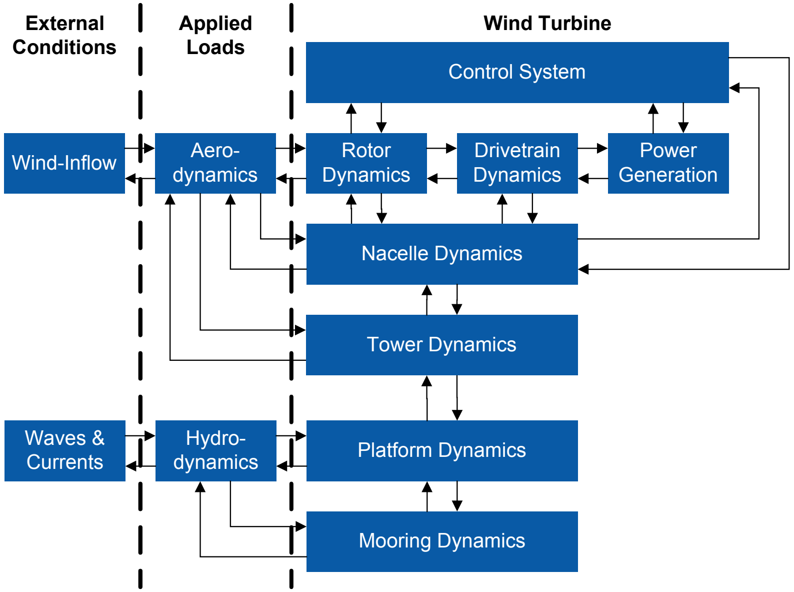
- Operational sea-state limits (modified 1.6; new 2.5 & 4.3)
- Redundancy check (after line loss):
  - Transient situation & afterword
  - Neglected for non-redundant stationkeeping system, but higher safety factors then required
  - During both power-production & parked/idling
- Damage stability (flooded compartment):
  - During both power-production & parked/idling

Design Situation	DLC	Wind Condition	Wave Condition	Directionality	Other Conditions	Type of Analysis
Power production	1.x					
Power production plus occurrence of fault	2.x					
Start up	3.x					
Normal shut down	4.x					
Emergency shut down	5.x					
Parked	6.x					
Parked with fault	7.x					
Transport, assembly, and maintenance	8.x					

Key Features

Simulation Requirements

- Modeling requirements:
  - 6 DOF floater motion
  - Stationkeeping system
  - Radiation/diffraction (where applicable)
  - Second-order hydro.
- Strongly recommended for model validation:
  - Tank testing for floater
  - Prototype of turbine onshore

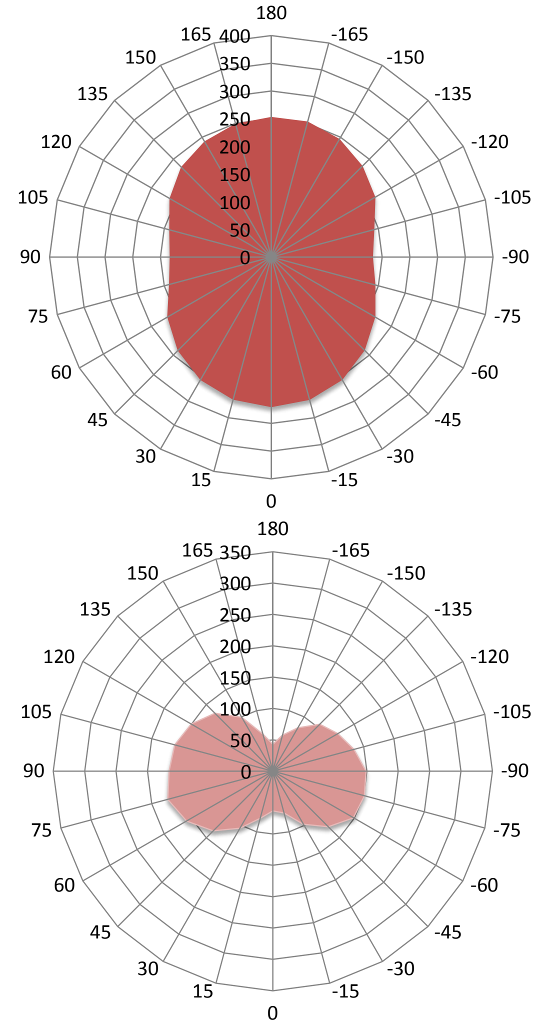


- Limitation of aerodynamic models with large floater motion
- Frequency-domain analysis permitted only when shown to achieve equal or higher level of safety

Key Features

Simulation Requirements (cont)

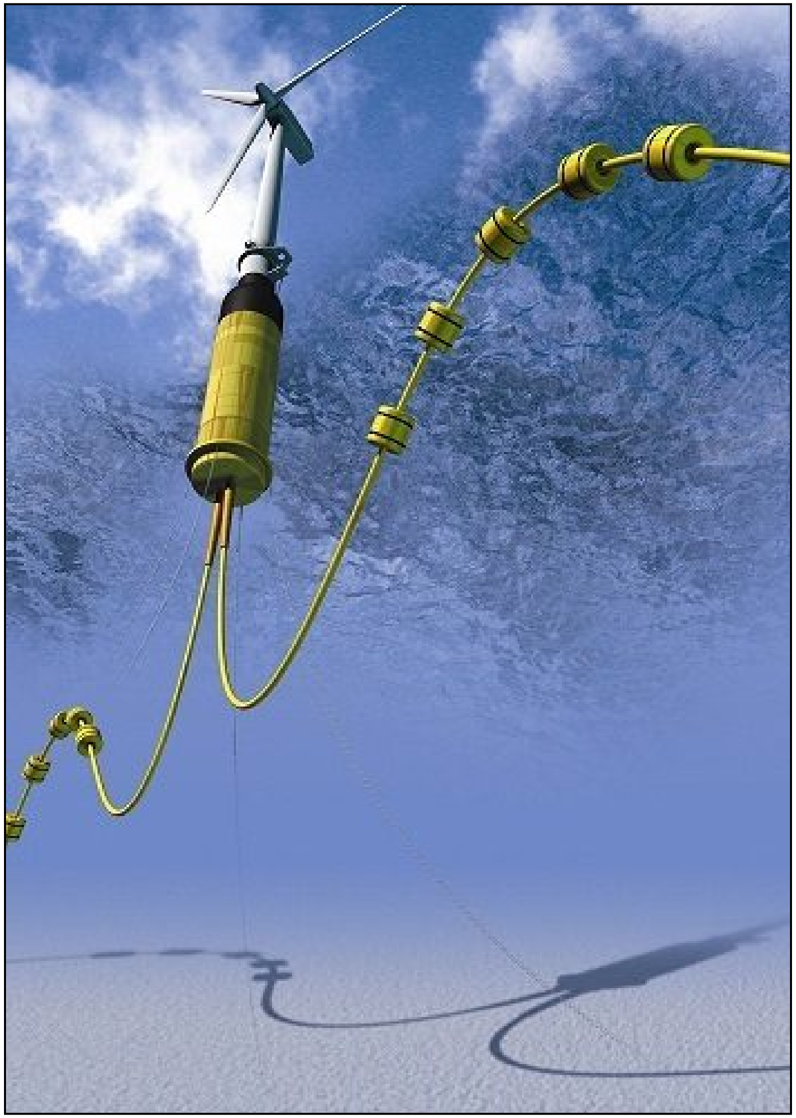
- Treatment of wind/wave directionality:
  - Importance of potentially large motions & little damping side-to-side
- Longer simulation length:
  - Importance of low-frequency floater motion & slow-drift effects
  - Use of periodic wind data is recommended
- Longer start-up transients & better initial conditions



50-yr Load Roses for Tower-Base FA (Top) & SS (Bottom)

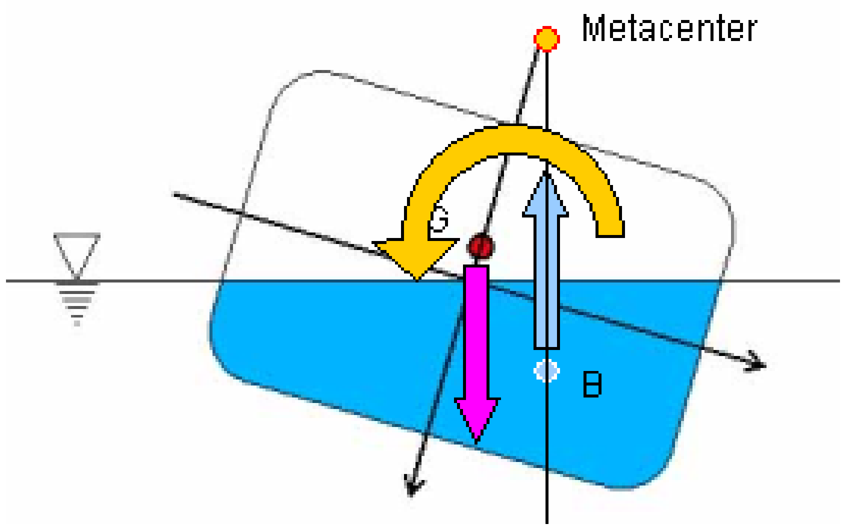
Key Features
Stationkeeping System

- Basically design in accordance to ISO 19901-7
- Loads from DLC simulations
- Non-redundant systems allowed via an increase in safety factors



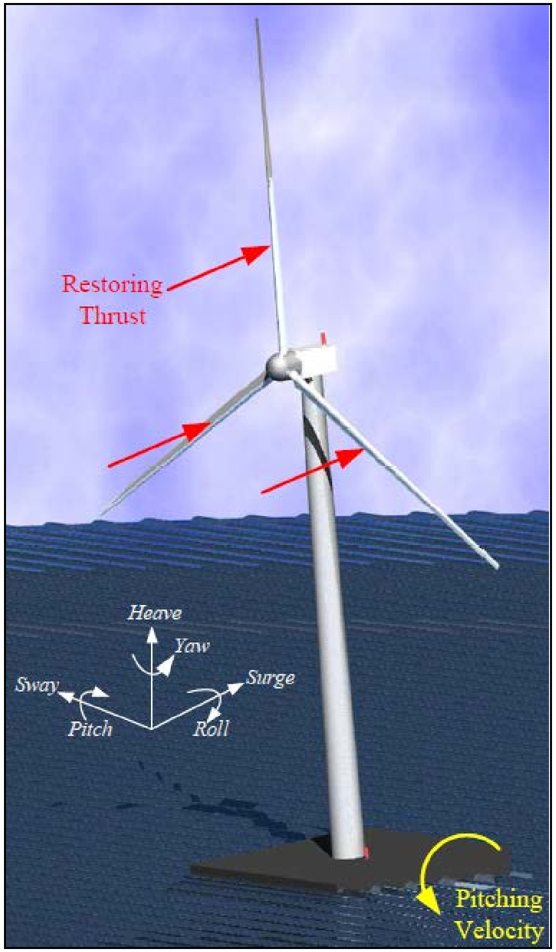
Key Features
Floating Stability

- Intact static stability criteria following IMO code
- Alternative intact stability criteria based on dynamic response
- Damage stability:
  - Flooding of any single watertight compartment
  - Not required if there is no danger for human safety or damage to the environment & neighboring facilities
  - Local authority requirements may supersede



Key Features
Other

- Design methodology:
  - Rigorous description of limit states (ULS, FLS, & SLS)
  - WSD method allowed as alternative to LRFD
- Control & protection systems:
  - Turbine operational controller shall not bring about instability of low-frequency floater motions
  - Protection system activated for excessive motions of tower & floater
- Assembly, transportation, & installation – ISO 19901-6 for floating-specific items
- Commissioning, operation, & maintenance – ISO 19901-6 for floating-specific items



Key Features
Other (cont)

- Mechanical systems – Must be able to support heel angles (especially lubrication)
- Materials – Of floater & stationkeeping system to follow 19904-1
- Marine support systems – Generally follow ISO 19901-4

Status

Schedule & Status

- New work proposal (draft standard) from Korea
- Kicked-off WG in September 2011
- Major revision of Korean draft proposed by Japan
- Rewrote entire document within WG
- Most controversial topics:
  - Use of the term “scantling”
  - Loss of floating stability
  - Corrosion protection
- CD to be submitted June 2014
- Final to be published after national comments in 2015

Questions?

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