ENERGY

Floating Wind Turbine Design Standard

DNV-OS-J103

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17 JUNE 2014

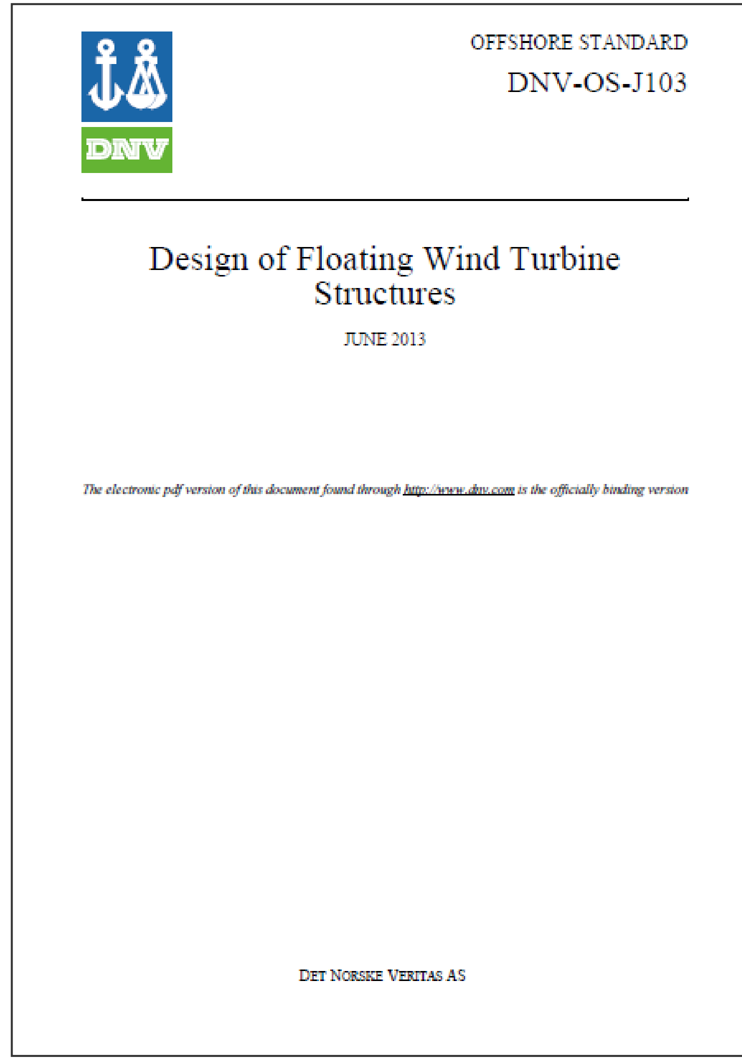
Outline

- DNV-OS-J103 – design standard for floating wind turbine structures
- Third party services for floating wind turbines

DNV-OS-J103

DNV-OS-J103 Design of Floating Wind Turbine Structures

- Provides **principles**, **technical requirements** and **guidance** for **design**, **construction** and **in-service inspection** of floating wind turbine structures
- Transportation, installation and inspection issues are taken into account to the extent necessary in the context of structural design
- The standard should be used in conjunction with the fixed structures counterpart, **DNV-OS-J101**



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DNV-OS-J103

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The process of developing DNV-OS-J103

- Published June 2013
- Can be downloaded for free on **www.dnvgl.com**
- Developed through a Joint Industry Project (JIP) during 2011 – 2013
- Industry hearing April 2013
- Participants:

Contents of DNV-OS-J103 – Technical issues covered

- Safety philosophy and design principles
- Site conditions, loads and response
- Materials and corrosion protection
- Structural design
- Design of anchor foundations
- Station keeping
- Floating stability
- Control system
- Mechanical system
- Transport and installation
- In-service inspection, maintenance and monitoring
- Cable design (structural)
- Guidance for coupled analysis (appendix)

Kabashima demo FOWT, Goto Project, Japan
Photo: Knut Ronold, DNV

Safety philosophy

- DNV-OS-J103 is based on safety class methodology
- A safety class is characterized by a target annual failure probability
- Requirements for load factors to be used in design depend on the target safety level of the specified safety class

Low	Normal	High
10^{-3}	10^{-4}	10^{-5}

- In DNV-OS-J101, DNV-OS-J103 and IEC rules: safety class Normal
- Non-redundant station keeping systems: safety class High

Structural design

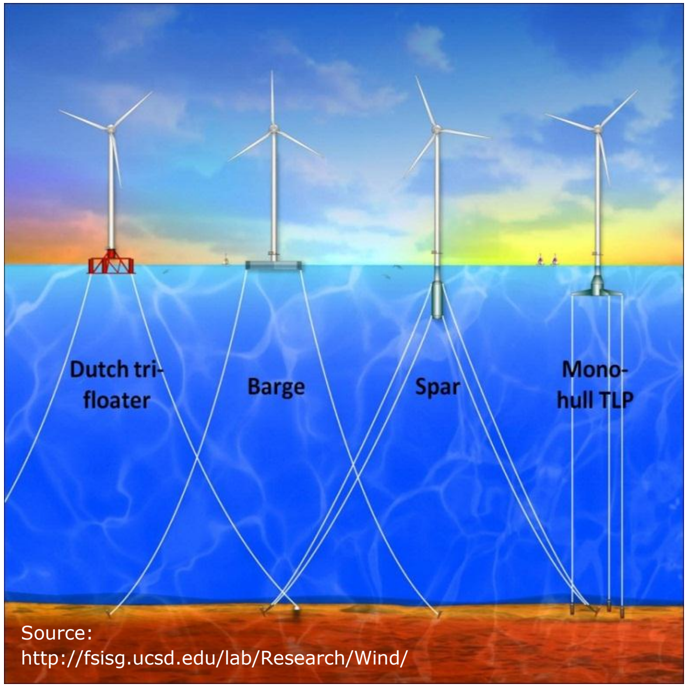
- Special provisions for the different floater types and for floater specific issues
- Design rules and partial safety factors for structural components
  - Ultimate Limit State (ULS)
  - Fatigue Limit State (FLS)
  - Accidental Limit State (ALS)
- Design Fatigue Factors (DFFs) specific for floating support structures and station keeping system
- Capitalized on existing design standards from oil & gas industry:
  - DNV-OS-C101 for offshore structures
  - DNV-OS-C105 for tendons
  - DNV-OS-E301 for mooring lines

Kabashima demonstration turbine
Photo: Knut Ronold, DNV

Kabashima demonstration turbine
Photo: Knut Ronold, DNV

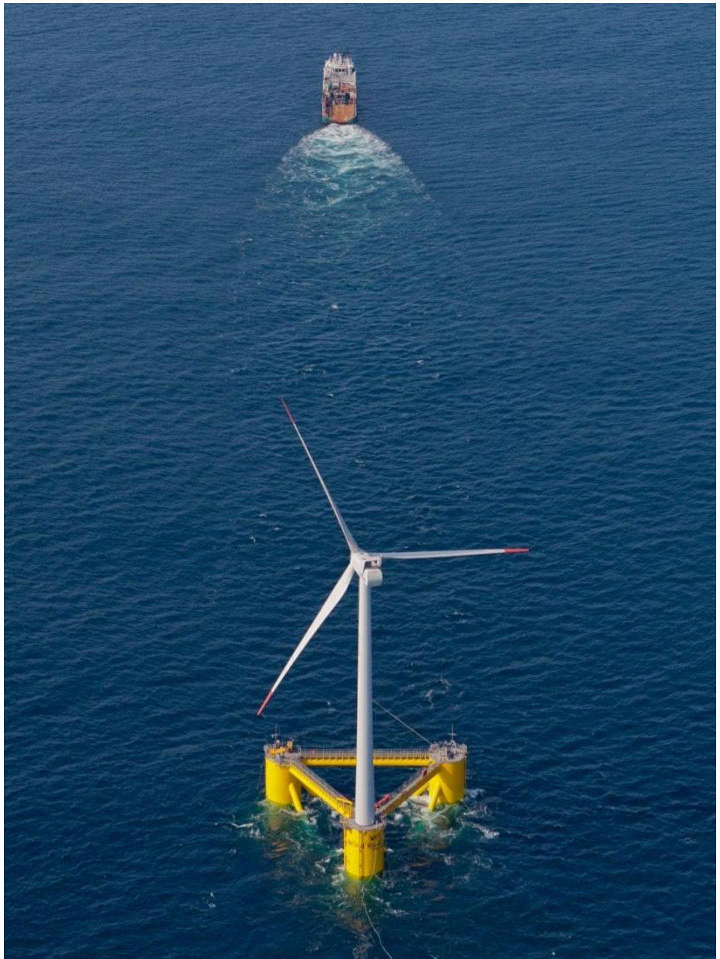
Station keeping

- Design rules and requirements for station keeping of floating wind turbines
- Load factors for tendons and mooring lines for different safety classes
- Capitalized on “PosMoor” rules (DNV-OS-E301)
- Reliability-based validation of load factors were performed during the JIP based on received data from three developers
  - Hywind (full-scale data, mooring lines)
  - Pelastar (analysis data, tendons)
  - WindFloat (analysis / full scale data, mooring lines)



Floating stability

- Floating stability of a floating unit is required in the following service modes:
  – Operation
  – Temporary conditions
  – Survival condition
- For permanently manned units:
  – sufficient floating stability is an absolute requirement
- For unmanned units:
  – sufficient floating stability is an absolute requirement in intact condition
  – sufficient floating stability is optional in damaged condition
  – additional compartmentalization is not required


WindFloat
Photo: Principle Power

Third party services for floating wind turbines

Why third party involvement?

- Important risk mitigation measure
- Ensures latest knowledge is included
- Builds trust and confidence between all parties, internally between project partners and external stakeholders
- Assures that the documentation is in order and complete
- A mean for the industry to reduce costs
- Legislation, insurance or financial requirements
- Requirement from turbine supplier

WindFloat
Photo: Principle Power

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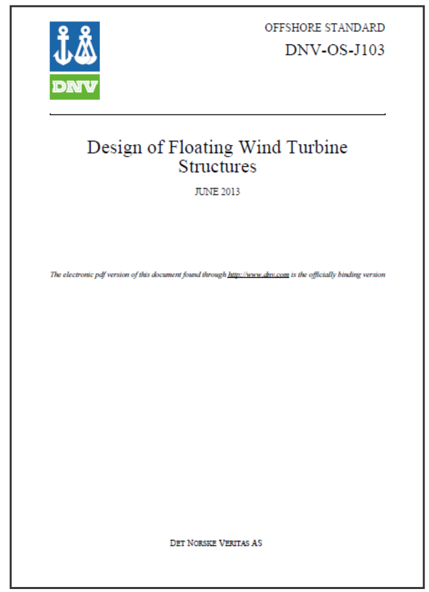
Two levels of third party involvement

- An emerging industry with technology concepts in different development stages

- DNV GL has a divided the verification/certification service portfolio into two levels
  - **Project Certification (DNV-OSS-901)**
    - Prototype
    - Single unit
    - Wind farm
  - **Verification**
    - Early phase
    - Parts of system
    - Selected phases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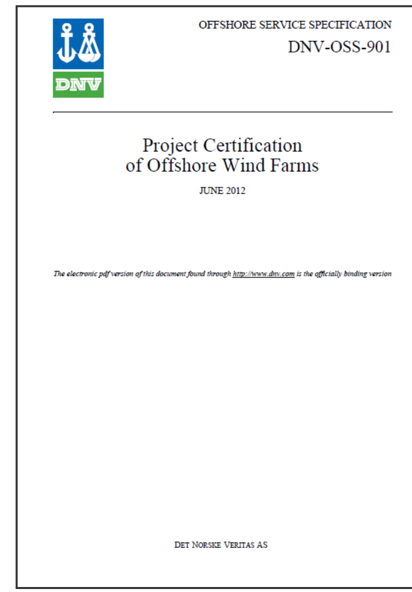
OFFSHORE SERVICE SPECIFICATION
DNV-OSS-901

Project Certification of Offshore Wind Farms

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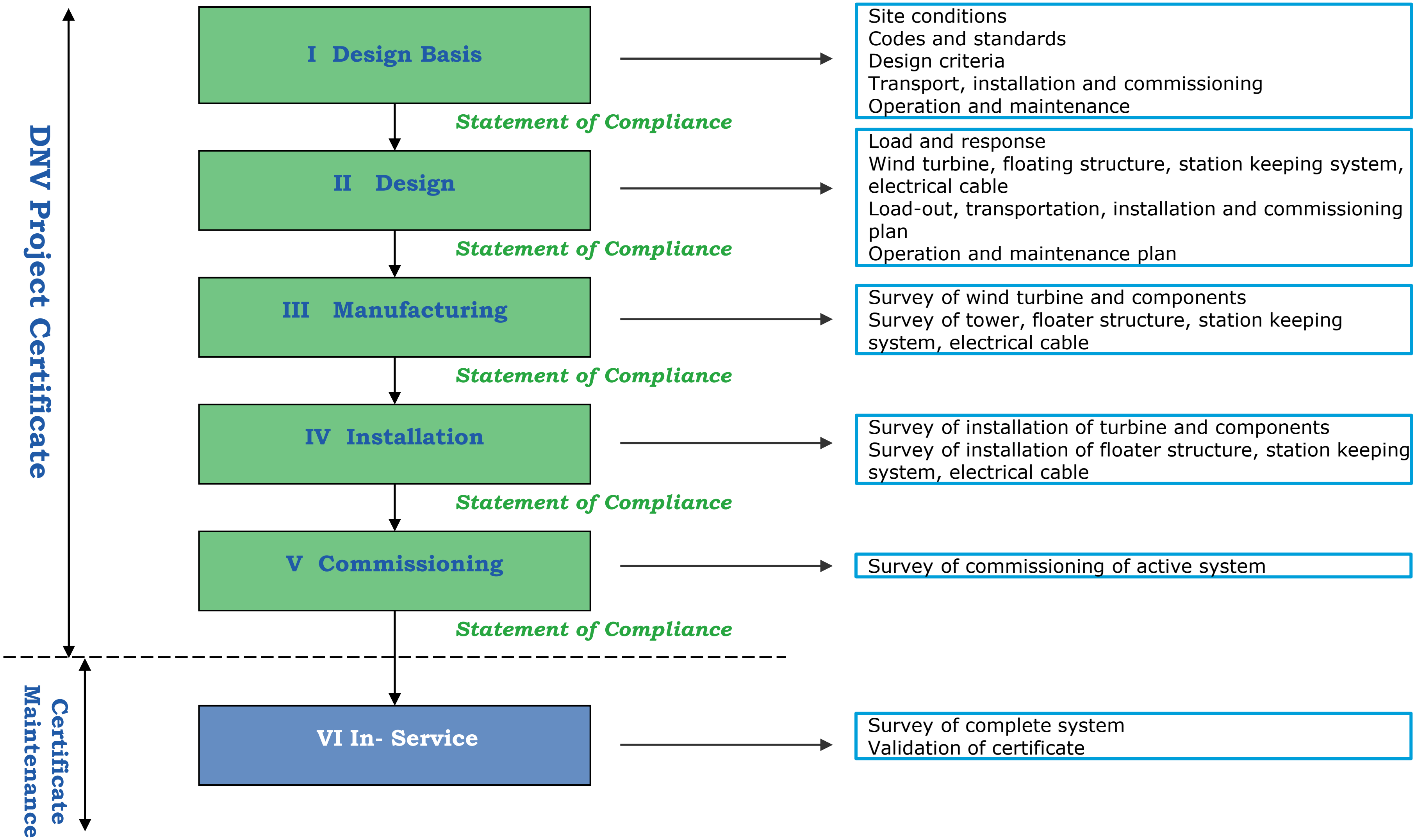
Work process for Project Certification



Work process for Design Verification

- Conceptual Design Verification
  - Early phase projects
- Design Verification
  - Parts of a system
  - Selected systems/phases
- Deliverables:
  - Verification comments
  - Verification reports
  - Statement of Compliance

1. Agree on Basis for Verification
- Describe the system /phases to be verified (Client)
- Define the system boundaries (Client)
- Define functional requirements (Client)
- Selection of design elements to be considered (Client)
- Define target confidence level (Client / DNV GL)

2. Design Basis
- A Design Basis shall be provided to DNV in order to evaluate the concepts feasibility towards established design criteria. (Client)
- Verification of Design Basis. (DNV GL)

3. Design verification
- Verification of design towards selected standards and Design Basis. (DNV GL)
- Independent analysis of selected critical aspects such as load and response, structural integrity etc.

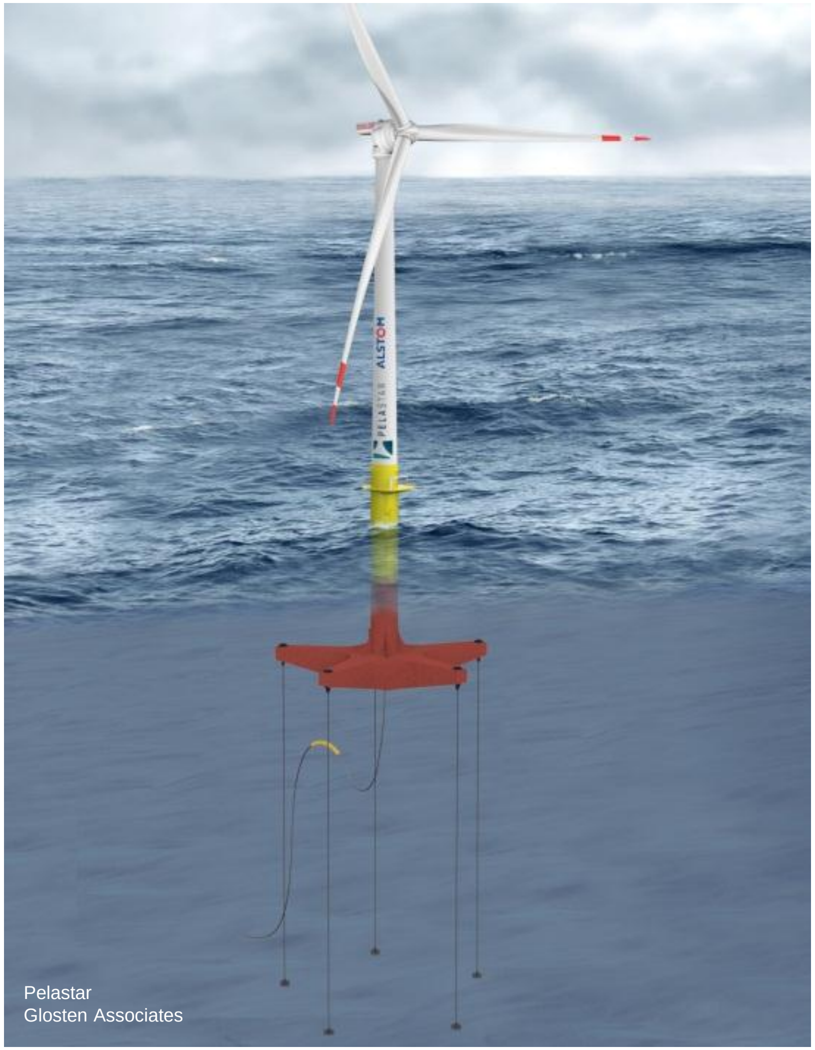
3. Survey(s)
- Manufacturing Survey (DNV GL)
- Installation Survey (DNV GL)
- Commissioning Survey (DNV GL)
- O & M Survey (DNV GL)

4. Verification / Survey Report(s)
- Verification /Survey report stating the scope of work undertaken by DNV GL, the concepts development status, key observations and comments on design. Future development steps will be suggested by DNV GL.

5. Statement (s)of Compliance
- Issuance of Statement of Compliance

Pelastar TLP demonstration project

- Floating wind turbine demonstration project in UK
- Funded by Energy Technology Institute (ETI)
- Glosten Associates’ Pelastar TLP design are being developed
- The TLP will support Alstom’s 6 MW Haliade turbine
- DNV performs certification of the design against the new standard, DNV-OS-J103
- The project is currently in Front End Engineering Design (FEED) phase



Pelastar
Glosten Associates

Thank you

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