Type and Project Certification
Agenda

1. DNV Wind Energy – Certification
2. Type Certification
3. Project Certification
4. DNV Standards & Guidelines
DNV – an independent foundation

Our Purpose
To safeguard life, property and the environment

Our Vision
Global impact for a safe and sustainable future
More than 145 Years of Managing Risk

- DNV (Det Norske Veritas) was established in 1864 in Norway
- DNV is a leading international provider of services for managing risk
- DNV is a foundation and reinvests all profits in services, research and development
DNV – An Independent Foundation

- 300 offices
- 100 countries
- 9,000 employees, of which 76% have a university degree

Singapore Asia Headquarter
A trusted player in shipping

- Authorised by more than 80 flag administrations
- DNV classed 21.9% of all new-building of ships in 2008 (in Gross Tonnes)
- 15.5% of the world fleet is to DNV Class (in Gross Tonnes per 08/2009)
Expert role in the oil and gas industry

- 65% of the world’s offshore pipelines are designed and installed to DNV’s pipeline standard
- 40% of the world’s Floating Production, Storage and Offloading vessels (FPSOs) are to DNV class
- 30% of the world LNG terminal projects are supported by DNV
Impacting climate change issues

- **1st**
  - Released the world’s first standard for qualification of carbon capture technology

- **48%**
  - 48% of all Clean Development Mechanism (CDM) projects are validated by DNV

- **50%**
  - 50% of the world’s offshore wind projects are certified and verified by DNV

- **Global**
  - Developed a global rating scheme for monitoring ships’ environmental performance
Services to the Wind Industry

Advisory Services

- Wind Resource Assessment
- Project Development Support
- Due Diligence
- Marine Advisory Services
- Asset Risk Management
- Wind Turbine Technology
- Health, Safety and Environmental Risk Management
- Training and Educational Programs

Accredited Services

- Project Certification
- Type Certification
- Testing Services
  - Power Performance Testing
  - Loads Testing

Type and Project Certification
October 2011
© Det Norske Veritas AS. All rights reserved.
Setting standards in the wind energy industry

- **DNV Offshore Standards**
  - Provide technical provisions and acceptance criteria for offshore wind industry
  - Published for a range of offshore topics including: structures, materials technology, asset operation, etc.

- **DNV Standard DNV-OS-J101: Design of Offshore Wind Turbine Structures**
  - Principles, technical requirements, and guidance for offshore wind turbine structures
  - Life cycle approach covering design principles through decommissioning

- **DNV Standard - DNV-OS-J102: Design and Manufacture of Wind Turbine Blades**
  - Detailed interpretation of the basic requirements for blades including design, manufacturing, and testing

- **DNV Standard - DNV-OS-J201: Design of Offshore Substations**
  - Standard describing the baseline for safe design, layout, and operations of offshore wind substations
Type Certification

Design Basis Evaluation
  Design Evaluation
  Manufacturing Evaluation
    Type Testing
      Type Characteristics Measurements
        Final Evaluation
          Type Certificate

IEC 61400-22
  Mandatory
  Optional

DNV-OS-J101

Project Certification

Type Certificate
  Site Conditions Assessment
    Design Basis Evaluation
      Wind Turbine / RNA Design Evaluation
        Support Structure Design Evaluation
          Other Installations Design Evaluation
            Wind Turbine / RNA Manuf. Surveillance
              Support Structure Manuf. Surveillance
                Other Installations Manuf. Surveillance
                  Transportation & Install Surveillance
                    Commissioning Surveillance
                      Project Characteristics Measurements
                        Final Evaluation
                          Project Certificate
                            Operations & Maintenance Surveillance

Design Basis
  Design Evaluation
  Manufacturing Evaluation
    Wind Turbine / RNA Design Evaluation
      Support Structure Design Evaluation
        Other Installations Design Evaluation
          Wind Turbine / RNA Manuf. Surveillance
            Support Structure Manuf. Surveillance
              Other Installations Manuf. Surveillance
                Transportation & Install Surveillance
                  Commissioning Surveillance
                    Project Characteristics Measurements
                      Final Evaluation
                        Project Certificate
                          Operations & Maintenance Surveillance
Type Certification
Type Certification

Type Certification creates confidence between manufacturer and stakeholders

- DNV Type Certification of some of the most applied wind turbines:
  - Siemens SWT-3.6-107
  - Siemens SWT-2.3-93
  - Vestas V90
Type Certification – National requirements

- **Denmark**
  - BEK 651, 'Bekendtgørelse om teknisk godkendelsesordning for konstruktion, fremstilling, opstilling, vedligeholdelse og service af vindmøller', 28/06/2008
  - Based on IEC WT 01
  - Latest version of DS/EN 61400 series shall be used

- **The Netherlands**
  - NVN 11400-0
    - Load definition as IEC 61400-1 ed. 2
    - Will be replaced by IEC WT 01 (IEC 61400-22)

- **Germany**
  - Lastgutachten – Approval of Tower and Foundation loads
  - Maschinengutachten – Rotor-Nacelle approval

- **India**
  - TAPS-2000 (mainly IEC)

- **USA (Nothing)**
Type Certification – IEC 61400-22

Design Basis Evaluation

Design Evaluation

Manufacturing Evaluation

Foundation Design Evaluation

Foundation Manufacturing Evaluation

Type Testing

Type Characteristics Measurements

Final Evaluation

Type Certificate

Mandatory

Optional
IEC 61400 series of standards

- IEC 61400-1, Design Requirements
  - IEC 61400-2, Design requirements for small wind turbines
  - IEC 61400-3, Design requirements for offshore wind turbines
  - ISO/IEC 81400-4, Design requirements for wind turbine gearboxes -> IEC 61400-4
  - DNV OS-J102 Design and manufacture of wind turbine blades -> IEC 61400-5

- IEC 61400-11, Acoustic noise measurement techniques
- IEC 61400-12-1, Power performance measurements
- IEC 61400-13 (TS), Measurement of mechanical loads
- IEC 61400-14, Declaration of sound power level and tonality
- IEC 61400-21, Measurement of power quality characteristics

- IEC 61400-22, Conformity Testing and Certification of Wind Turbines
  - IEC 61400-23 (TS), Full scale structural blade testing
  - IEC 61400-24, Lightning protection
Design Basis Evaluation

- The Design Basis shall identify all
  - **Requirements**
  - **Assumptions**
  - **Methodologies**

which are essential for the design and the design documentation, including:
- Codes and **standards**
- Design parameters
- Assumptions
- Methodologies and **principles**
- Other requirements, e.g. for
  - Manufacture
  - Transportation
  - Installation
  - Commissioning
  - Operation
  - Maintenance

### Table 1 – Basic parameters for wind turbine classes

<table>
<thead>
<tr>
<th>Wind turbine class</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{\text{ref}}$ (m/s)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td></td>
<td>0,16</td>
<td></td>
<td>Values specified by the designer</td>
</tr>
<tr>
<td>B</td>
<td>0,14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>0,12</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The requirement for evaluation of the quality system is satisfied if the quality system is certified to be in conformance with ISO 9001

DNV shall verify by inspection that at least one representative specimen is manufactured according to the design under certification

Ensure that the requirements identified during the design evaluation with regard to critical components and critical manufacturing processes are observed and implemented in production and assembly
**Type Testing**

- **Type Testing shall be carried out by an accredited testing laboratory** or

- **DNV shall verify** that the party conducting the testing complies with at least the criteria of **ISO/IEC 17025** or **ISO/IEC 17020**, as applicable

**DNV assessment**
- Review of test reports
- Participation in Safety and Function Test
- Inspect that **critical personnel safety features** have been satisfactorily implemented in the installed test wind turbine
Type Testing

- Safety and Function Tests
  - IEC 61400-22 Annex D

- Power Performance Measurements
  - IEC 61400-12-1

- Load Measurements
  - IEC/TS 61400-13
  - Measurements shall be made on a wind turbine that is dynamically and structurally similar to wind turbine submitted for certification

- Blade Tests
  - IEC/TS 61400-23
  - Required for every new type of blade
  - New tests shall be required following any significant changes in blade design
Static Blade Test
Fatigue Blade Test
The purpose of Final Evaluation
- Provide documentation of the findings in the evaluation of the elements of the type certification

The Final Evaluation Report
- Reference list of all supporting product documentation
- Evaluation of whether
  - The detailed documentation is complete
  - The type test results confirm all relevant requirements set out in the design documentation
- Review of the final product documentation, including
  - Drawings
  - Component lists
  - Procurement specifications
  - Manuals (Final)
- To confirm that they are consistent with the manufacturing evaluation report and with the supporting design calculations and relevant design assumptions
Type Certificate

- Issued based on a satisfactory Final Evaluation

- Validity 5 years

- Refers to **Conformity Statements** issued for the completed modules
  - Design Basis Evaluation
  - Design Evaluation
  - Manufacturing Evaluation
  - Type Testing
  - Type Characteristics Evaluation (optional)
  - Foundation Design Evaluation (optional)
  - Foundation Manufacturing Evaluation (optional)

Time: 12 month ideal, in practise 24 month.
Price: 1,500 hours
Project Certification
Project Certification – IEC 61400-22

Purpose of Project Certification
Evaluate whether type certified wind turbines and particular support structure/foundation(s) designs are in conformity with
- External conditions
- Applicable construction
- Electrical codes
- Other requirements relevant to a specific site

![Diagram of Project Certification Process]
Project Certification – DNV-OS-J101

**Project Certification phases:**

- Phase I: Design Basis
- Phase II: Design
- Phase III: Manufacturing
- Phase IV: Installation
- Phase V: Commissioning
- Phase VI: In-Service

Each phase will be completed by a Statement of Compliance

- Phase I-V => Project Certificate
- Phase VI => Certificate Validation
Design Basis

- Site conditions evaluation
  - Examine whether the environmental, electrical and soil properties at a site conform to the parameter values defined in the design documentation
  - Site conditions evaluation conformity statement

- Design basis evaluation
  - Examine that the design basis is properly documented and sufficient for a safe design and execution of the project
  - Design basis conformity statement

- Type Certificate – Wind Turbine / RNA
  - According to IEC 61400-22
Site Conditions

- Assessment of the **external conditions at the site**
  - As detailed in IEC 61400-1, IEC 61400-2 or IEC 61400-3
  - Have been adequately undertaken and documented

- Wind conditions
- Other environmental conditions
- Earthquake conditions
- Electrical power network conditions
- Geotechnical conditions

- Marine conditions
- Weather windows and weather downtime
Design Basis Evaluation

- **Design parameters** for the external conditions
- Design **methodologies** and principles
- **Codes and standards**
- Other relevant **statutory requirements**
- **Wind turbine type**
- **Support structure concept**
- Requirements for manufacturing, transportation, installation and commissioning
- Requirements for operation and maintenance
- Requirements for grid connection
- Other project requirements
Type Certificate

- **Wind Turbine** / Rotor-Nacelle Assembly
- Main specifications or
- Type certificate
  - with identifications of deviations
Examine whether the **site-specific loads and load effects** on the integrated structure are derived in conformity with the design basis.

Evaluate the **site-specific wind turbine** for compliance with the design basis.

Evaluate the **site-specific support structure** design for compliance with the design basis and standards.

Evaluate the **other installations** design for compliance with the design basis and site-specific loads and conditions.
Integrated Load Analysis

- Rotor-Nacelle assembly
- Support structure
  - Tower
  - Sub-structure
  - Foundation
- Supporting soils

**Interaction** between
- Wind turbine design
- Wind turbine control system
- Wind, turbulence, ...
- Foundation design
- Wave, current, ...
- Soil
Wind Turbine / RNA Design Evaluation

Comparison of

- **Actual site conditions** to conditions for **Type Certificate**
- **Site-specific loads** to design loads for **Type Certification**
- Other relevant conditions such as
  - Corrosion protection
  - Site-specific conditions on electrical components

- **Reinforcement** or modification of components
Support Structure Design Evaluation

- **Loads** from the integrated load analysis

- Compare **stiffness and damping** to load assumptions

- **Design** of the support structure

- **Geotechnical** design

- Manufacturing, transportation, installation and maintenance plans
  - Only with respect to the structural integrity of the **final installed** (permanent) support structure

- **Corrosion** protection system(s)
Other Installations Design Evaluation

- Substation (DNV-OS-J201)
- Cables
- J-Tubes

- **Loads** from the integrated load analysis / **site-specific** loads and conditions
- **Structural** design
- **Geotechnical** design
- **Corrosion** protection system(s)
Manufacturing

- Verify that the **manufacturing** for the **specific project** is carried out according to the **approved design** and with the **intended quality**

- Covers manufacturing of
  - **Wind turbines / RNA**
  - **Support structure(s)**
  - **Other installations**

- The **extent** of inspection and audits will be evaluated for each single project
Wind Turbine / RNA Manufacturing Surveillance

- **Scope of work** for inspection to be tailored depending on …

- **Critical** items/processes

- **Approved** design documentation

- …

- The manufacturer’s **experience**

- The **certification body**’s experience with the manufacturer

- **Time schedule** and **number** of items

- Type of **manufacturing process** and **quality control**

- **Appropriateness** of the manufacturer’s quality system

- …
Support Structure Manufacturing Surveillance

- Precondition that the manufacturer operates a **quality system**
- **Scope of work** for inspection to be tailored
- The inspection/audit activities focus on
  - The quality system **implemented** during manufacture
  - Evaluation of whether the quality system is **appropriate**
Other Installations Manufacturing Surveillance

- Precondition that the manufacturer operates a **quality system**
- **Scope of work** for inspection to be tailored
Installation

- Verify **conformity** with the requirements of the design basis

- Verify that the **loads** on components and subsystems of the wind turbines are **not exceeding** the design envelope during transportation and Installation

- **Possible** transportation and/or handling damages are being **detected**
Transportation and installation surveillance

- If a **quality management system** is **in place** for the transportation and installation processes surveillance **may be** carried out by **auditing**

- **If not**, the certification body shall perform the surveillance by **inspection**

© Det Norske Veritas AS. All rights reserved.
Transportation and installation surveillance

- Evaluate from documentation whether the transportation and installation processes are in conformance with the design basis and the requirements in the relevant IEC 61400 series standard.

- Ensure that components are inspected for damage that may have occurred during transport and handling.

- **Surveillance** for offshore projects shall include:
  - Monitoring of sea-transportation
  - Compliance with respect to acceptable weather conditions during transport and installation
  - Compliance with the support structure and wind turbine installation procedures
Commissioning

- Verify that the wind turbines installed in a specific project at a specific site are **commissioned** in conformity with the relevant manuals.
Commissioning surveillance

- Examination of commissioning records

- **Witness** the commissioning of **at least one wind turbine** and **additionally** at least one wind turbine per every 50 turbines in the project

- **Surveillance** shall as a minimum cover:
  - Verification that the commissioning **instructions** are **adequate**
  - The instructions are **followed** during commissioning
  - The final commissioning reports are **complete**
Project Characteristics Measurements

- Performance-related characteristics of a **specific** wind turbine (project) at a **specific site**

- **In addition** to the measurements done for a single turbine within the type certification

- **Optional** measurements

- Relevant **IEC 61400** series standards apply

- The measurements shall be carried out by an **accredited** test laboratory
Project Characteristics Measurements

- One or more of the measurements shall be performed:
  - For a specific wind turbine or the wind turbine project

- **Grid connection compatibility**
  - Comparison of the measurements (e.g. during grid fault conditions) with the electrical network and conditions given in the grid codes applicable to the site

- **Power performance**
  - Comparison with the reference individual performance of the wind turbines
  - IEC 61400-12 series of standards

- **Acoustic noise emission**
  - Compliance with specific acoustic noise emission criteria established either by the client or by local codes
  - IEC 61400-11
Project Certificate

- **Final Evaluation**
  - Evaluation of the evaluation reports and conformity statements for all elements of project certification
  - Report containing reference list of all supporting product and project documentation
  - Report of all conformity statements issued for the project certification modules for outstanding issues

- **Project Certificate**
  - **Valid** for wind turbines and additional installations as installed at the site specified in the certificate at the date of issue
  - The validity of the project certificate may be confirmed at periodic intervals during operation and maintenance surveillance
In-service / Maintenance of Project Certificate

- Verification that a specific wind turbine installation or wind turbine project at a specific site is **operated and maintained** in conformity with the relevant manuals

- Examination of operation and maintenance **records** as well as **inspection**

- Shall be carried out at **regular intervals** on the basis of an agreement between applicant and certification body

- The agreement shall **specify** the intervals and the **extent** of the surveillance
Operation and maintenance surveillance

- **Evaluation** of operation and maintenance records and reports
  - Maintenance has been carried out by authorised and qualified personnel in accordance with and at the intervals specified in the maintenance manual
  - The control settings have been checked with regard to conformance with the limiting values specified in the design documentation
  - All repair, modification and replacement (RMR) has been carried out in accordance with the certificate by reviewing RMR-reports

- **Inspection** of the general condition. **Extent** of inspections based on:
  - The evaluation of operation and maintenance records and reports
  - Status of outstanding findings from previous inspections
  - Status of outstanding recommendations from previous inspections
  - Status of ongoing RMR-projects
Maintenance of Project Certificate

- **Annual Reporting**
  - Abnormal and deviant *operating experience*

- **Major failures or safety issues** to be reported to DNV immediately

- **Operation and Maintenance surveillance**
  - At least every 2½ year
  - **Confirm** that the wind turbine project is operated and maintained in conformity with the relevant manuals
DNV-OS-J101 – Offshore Wind Turbine Structures

- Provides principles, technical requirements and guidance for offshore wind turbine structures
- In compliance with IEC 61400-3: "Design requirements for offshore wind turbines"
DNV-OS-J101 – Content

A life cycle approach

- Design principles
- Safety levels
- Site conditions
- Loadings
- Structural design
- Materials
- Corrosion
- Manufacturing
- Transport
- Installation
- Maintenance
- Decommissioning

1st edition was issued in 2004, 2nd edition 2007, 3rd edition planned 2010

Covers loads, partial safety factors and detailed structural design of steel, concrete and grouted joints

Implementation of the new IEC 61400-3 Design Criteria for Offshore Wind Turbines

Accommodate new developments in experiences and practices, and

Facilitate the use of EN 1992 and EN 1993 for Concrete and Steel Structures
DNV-OS-J102 – Blades

- A detailed interpretation of the basic requirements to blade:
  - Design
  - Manufacturing
  - Testing

- In line with IEC 61400-1 and IEC 61400-23
DNV/Risø Guideline

- Guidelines for Design of Wind Turbines
  - Best practice / guidelines for design
  - Wind Turbine Concepts
  - Safety and Reliability
  - External Conditions
  - Loads
  - Rotor
  - Nacelle
  - Tower
  - Foundations
  - Electrical System
  - Manuals
  - Tests and Measurements
Safeguarding life, property and the environment

www.dnv.com