

SERVICE SPECIFICATION

DNVGL-SE-0073

Edition December 2014

Project certification of wind farms according to IEC 61400-22



FOREWORD

DNV GL service specifications contain procedural requirements for obtaining and retaining certificates and other conformity statements to the objects, personnel, organisations and/or operations in question.

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CHANGES – CURRENT

General

This service specification supersedes and replaces the June 2012 edition of DNV-OSS-901.

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SECTION 1 GENERAL

1.1 Introduction

This service specification (SE) specifies DNV GL's services for project certification of onshore and offshore wind farms according to IEC 61400-22. It includes DNV GL's interpretation and detailing of IEC 61400-22 to serve as a contractual basis for project certification.

Furthermore it provides a common communication platform for describing the scope and extent of activities performed for project certification of a wind farm and its assets.

The service specification is divided into three main sections.

Sec.1 provides general information on the wind farm assets covered in this service specification and general requirements regarding project certification of wind farms.

Sec.2 provides a service overview for the defined project phases and the deliverables of project certification.

Sec.3 describes the services in detail, where:

- [3.2] refers to the complete wind farm certification with all assets
- [3.3] contains details of the services concerning the wind turbines and their support structures
- [3.4] contains details of the services concerning the substations including topsides and support structures
- [3.5] contains details of the services concerning the power cables
- [3.6] describes additional services such as onshore site-specific assessments, power characteristics and met masts
- [3.7] describes the integration of certificates in a project certification.

The DNV GL document system is organized according to a three-level document hierarchy, with these main features:

- Principles and procedures related to DNV GL's certification and verification services are separated from technical requirements and are presented in DNV GL service specifications (SE). Service specifications present the scope and extent of DNV GL's services.
- Technical requirements are issued as self-contained DNV GL standards (ST). Standards are issued as neutral technical standards to enable their use by national authorities, as international codes and as company or project specifications without reference to DNV GL's services.
- Associated product documents are issued as DNV GL recommended practices (RP). Recommended practices provide DNV GL's interpretation of safe engineering practice for general use by industry.

Guidance note:

The latest revision of all DNV GL documents can be found in the list of publications on the DNV GL website www.dnvgl.com.

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1.2 Scope

The services specified in this service specification are in compliance with the IEC project certification system described in IEC 61400-22.

DNV GL's project certification system details and clarifies the verification activities within IEC 61400-22 system and utilises DNV GL standards to fill gaps in the governing IEC standards.

The project certification concept for wind farms constitutes a robust means to provide, through independent verification, evidence to stakeholders (financiers, partners, utility companies, insurance companies, the public, governmental and non-governmental organisations) that a set of requirements laid down in standards are met during design and construction, and maintained during operation of a wind farm.

The service specification describes as well how to maintain this certificate by periodic maintenance during the service life of the wind farm.

1.3 Application

This service specification applies to project certification and related verification tasks during the design, construction, transportation, installation, commissioning and operation of wind farms.

The following assets of wind farms (see [Figure 1-1](#)) are covered by the services described herein:

- wind turbines and their support structures
- substation(s) including topside(s) and support structure(s)
- power cables.

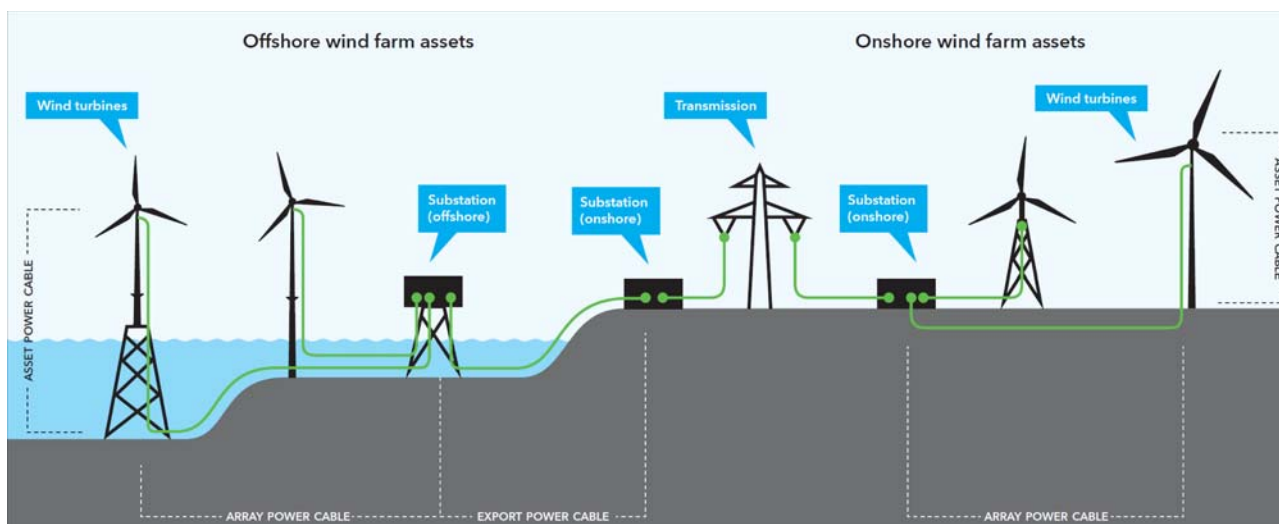


Figure 1-1 Offshore and onshore wind farm assets

Each asset may be further subdivided into components for turbines and substations, and cable sections. In this service specification, the terms component or cable sections are used for the following:

Components of a wind turbine are:

- onshore:
 - rotor-nacelle-assembly (RNA)
 - support structure – tower
 - support structure – foundation.
- offshore (see [Figure 1-2](#)):
 - rotor-nacelle-assembly (RNA)
 - support structure – tower
 - support structure – sub-structure
 - support structure – foundation.

Components of a substation are (see [Figure 1-3](#)):

- onshore:
 - transformer station incl. installations and equipment
 - support structure – foundation.
- offshore:
 - topside including installations and equipment
 - support structure – sub-structure

- support structure – foundation.

Cable sections of power cable route are (see Figure 1-1):

- onshore:
 - asset-power-cable (e.g. turbine power cable)
 - array-power-cable.
- offshore:
 - asset-power-cable (e.g. turbine power cable, substation power cable)
 - array-power-cable
 - export-power-cable.

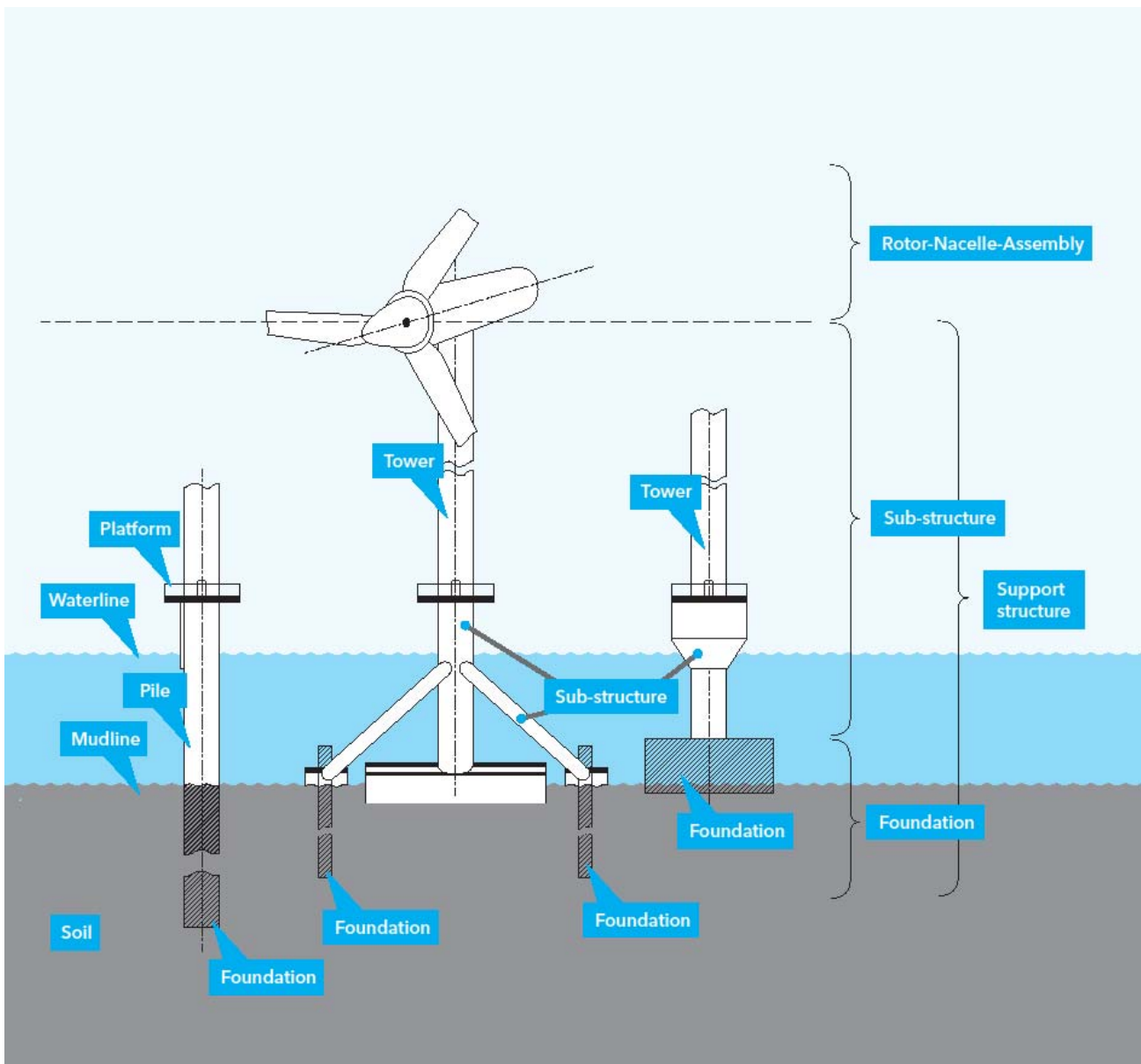


Figure 1-2 Definition of offshore wind turbine components

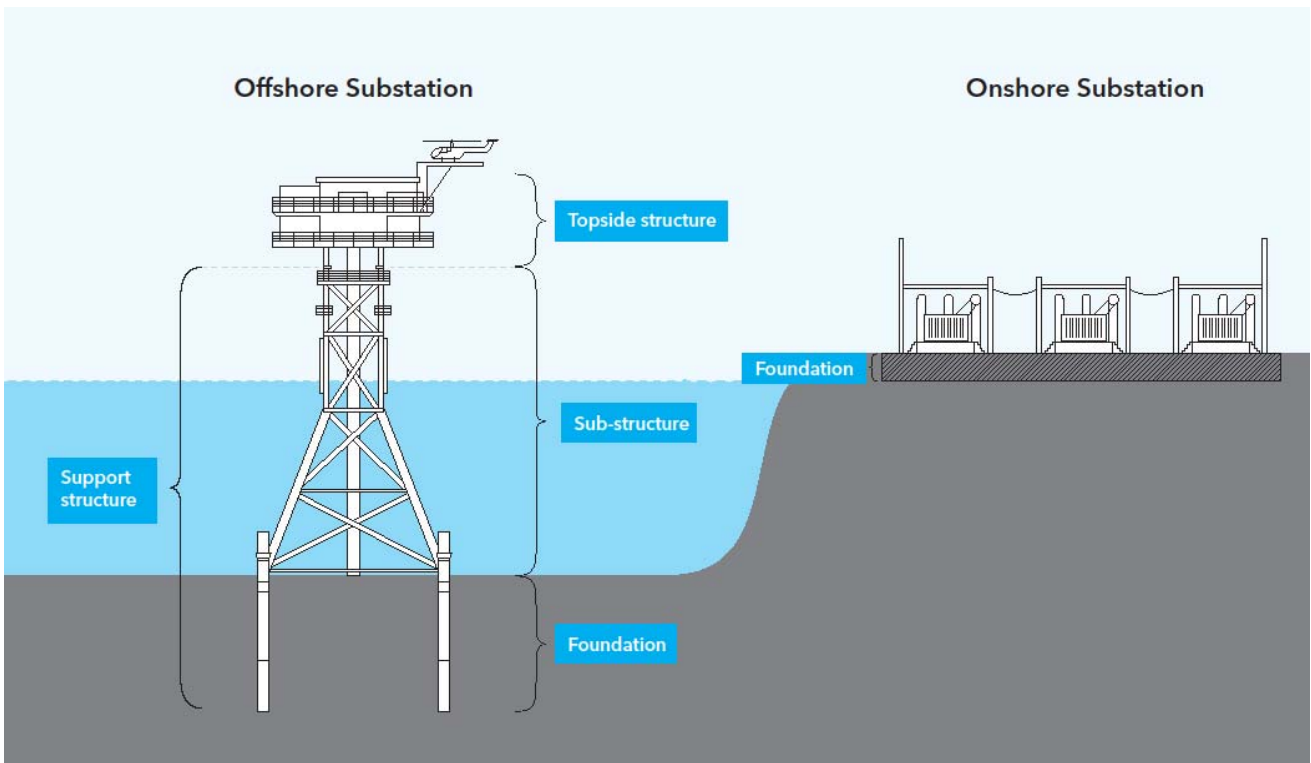


Figure 1-3 Definition of offshore and onshore substation components

The subdivision of the assets into components and cable sections is done to enable optional services in verifying single components or cable sections of an asset as well. A conformity statement will be issued after successful verification of an asset related component or cable section.

This service specification is generally applicable for fixed wind farm installations. In case of floating wind farm installations it is recommended to agree the scope of work for certification with DNV GL at an early stage.

1.4 Definitions

1.4.1 Terminology and definitions

Table 1-1 Definitions of verbal forms

<i>Verbal forms</i>	<i>Definition</i>
<i>may</i>	verbal form used to indicate a course of action permissible within the limits of the document
<i>shall</i>	verbal form used to indicate requirements strictly to be followed in order to conform to the document
<i>should</i>	verbal form used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required

Table 1-2 Definitions of terms

<i>Term</i>	<i>Definition</i>
<i>asset</i>	Term used in the context of wind farm projects to describe the project or object to be developed, manufactured and maintained. In this service specification the term refers either to "wind turbines with support structures", the "offshore substation with topside and support structure" or "power cables".
<i>cable-section</i>	This term is used to split the power cable route into different lengths, so called cable sections.
<i>certification</i>	Refers to third-party issue of a statement, based on a decision following review, that fulfilment of specified requirements has been demonstrated related to products, processes or systems (ISO 17000).
<i>component</i>	A main part of an asset. In this service specification, the term refers to rotor–nacelle-assembly, part of the support structure of the wind turbine (tower, sub-structure and foundation), topside equipment, and parts of support structure for substation (topside structure, sub-structure and foundation).
<i>customer</i>	DNV GL's contractual partner (applicant)
<i>design brief</i>	supporting document for describing methodologies for design calculations. Mostly issued by the designers
<i>foundation</i>	part of the support structure for a wind turbine or substation that transfers the loads acting on the structure into the soil
<i>J-tube</i>	curved tubular conduit designed and installed on a structure to support and guide one or more pipeline risers or cables (EN 12495)
<i>offshore wind farm project</i>	Term referring to the assets of an offshore wind farm including total number of offshore wind turbines, support structures, substations with topside and support structure and power cables.
<i>onshore wind farm project</i>	Term referring to the assets of an onshore wind farm including total number of onshore wind turbines, support structures, and if relevant, substations and power cables.
<i>optional services</i>	Optional services are services which are not part of the scope which is required in order to obtain conformity statement and project certificates.
<i>other installations</i>	installations such as meteorological mast, secondary structures and other equipment
<i>outstanding issue</i>	The term outstanding issue is used to denote a deviation from standards and technical requirements specified in the certification agreement, and which needs to be completed for full compliance.
<i>primary structure</i>	The primary structure consists of the load-bearing structure that transfers permanent loads, life loads and environmental loads, caused by gravity and environment and actions on the support structure, to the soil. Structural parts the failure of which will have substantial consequences shall be classified as primary structure.
<i>project certificate</i>	A document signed by DNV GL and affirming that, at the time of assessment, the asset referred to in the certificate met the requirements stated in the normative documents.
<i>recommendation</i>	non-mandatory advice
<i>secondary structure</i>	secondary structures are e.g. boat landings, access ladders and access platforms
<i>special structure</i>	Same as primary structure. In addition the structural parts are subject to particularly arduous conditions (e.g. stress condition that may increase the probability of brittle fracture, multi-axial stresses).
<i>substation</i>	Term referring to transformer stations or converter stations or platforms, with or without accommodations. An onshore or offshore substation may be defined as an integral asset of the wind farm project or as a separate asset for DNV GL project certification. Whenever, in this service specification the term is used in general, it describes the substation including the support structure, as this is the power transferring unit.

Table 1-2 Definitions of terms (Continued)

<i>sub-structure</i>	Term referring to the part of the support structure for a wind turbine which extends upwards from the soil and connects the foundation and the tower. The term is also used to designate the part of the support structure for a substation which extends upwards from the soil and connects the foundation and the topside or platform.
<i>support structure</i>	The support structure of a wind turbine is defined as the structure below the yaw system of the rotor-nacelle-assembly and includes tower structure, sub-structure and foundation. The term is also used to designate the structure below of the topside structure and includes sub-structure and foundation of a substation.
<i>verification</i>	refers to the confirmation, through the provision of objective evidence, that specified requirements have been fulfilled (ISO 9000)
<i>wind turbine</i>	System which converts kinetic wind energy into electrical energy. Whenever, in this service specification the term is used to describe the wind turbine in general, it describes the rotor-nacelle-assembly including the support structure, as this is the power generating unit.

1.4.2 Abbreviations and symbols

Abbreviations and symbols used in this service specification.

Table 1-3 Abbreviations

<i>Abbreviation</i>	<i>In full</i>
AC	alternating current
ALS	accidental limit state
BOEM	Bureau of Ocean Energy Management
BSH	Bundesamt für Seeschifffahrt und Hydrographie (Federal Maritime and Hydrographic Agency)
CIGRÉ	Conseil International des Grands Réseaux Électriques
CVA	certified verification agent
DC	direct current
DT	destructive testing
FAT	factory acceptance test
FEM	finite element method
FLS	fatigue limit state
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
met	meteorological
NDT	non-destructive testing
RNA	rotor-nacelle-assembly
RP	DNV GL recommended practice
SDC	site design conditions
SE	DNV GL service specification
SLS	serviceability limit state
SSDA	site specific design assessment
ST	DNV GL standard
ULS	ultimate limit state

1.5 References

This document makes reference to relevant international documents and DNV GL documents. Unless otherwise specified in the certification agreement or in this service specification, the latest valid revision of each referenced document applies.

Table 1-4 DNV GL documents

<i>Reference</i>	<i>Title</i>
DNV CN No. 30.4	<i>Foundations</i>
DNVGL-SE-0074	<i>Type and component certification of wind turbines according to IEC 61400-22</i>
DNV-OS-C101	<i>Design of Offshore Steel Structures, General (LRFD Method)</i>
DNV-OS-C502	<i>Offshore Concrete Structures</i>
DNV-OS-J101	<i>Design of Offshore Wind Turbine Structures</i>
DNV-OS-J201	<i>Offshore Substations for Wind Farms</i>

Table 1-4 DNV GL documents (Continued)

DNVGL-RP-0005	<i>RP-C203: Fatigue design of offshore steel structures</i>
DNV-RP-J301	<i>Subsea Power Cables in Shallow Water Renewable Energy Applications</i>
GL-IV-1	<i>Rules and Guidelines – IV Industrial Services –Part 1: Guideline for the Certification of Wind Turbines</i>
GL-IV-2	<i>Rules and Guidelines – IV Industrial Services –Part 2: Guideline for the Certification of Offshore Wind Turbines</i>
GL-IV-7	<i>Rules for the Certification and Construction – IV Industrial Services – Part 7: Offshore Substations</i>
GL TN Grouted Connections	<i>GL Renewables Certification Technical Note – Grouted Connections for Offshore Wind Turbines, Edition 2013</i>
GL TN GCC	<i>GL Renewables Certification Technical Note – Certification of Grid Code Compliance</i>

Table 1-5 IEC documents

<i>Reference</i>	<i>Title</i>
IEC 61400-1	Wind Turbines – Part 1: Design requirements
IEC 61400-3	Wind Turbines – Part 3: Design requirements for offshore wind turbines
IEC 61400-12-1	Wind Turbines – Part 12-1: Power performance measurements of electricity producing wind turbines
IEC 61400-21	Wind turbines - Part 21: Measurement and assessment of power quality characteristics of grid connected wind turbines
IEC 61400-22	Wind Turbines – Part 22: Conformity Testing and Certification
IEC 60364	Electrical installations for buildings
IEC 60204-1	Safety of machinery - Electrical equipment of machines - Part 1: General requirements
IEC 60204-11	Safety of machinery - Electrical equipment of machines - Part 11: Requirements for HV equipment for voltages above 1 000 V a.c. or 1 500 V d.c. and not exceeding 36 kV
IEC 61936-1	Power installations exceeding 1 kV a.c. - Part 1: Common rules
IEC CS CBC 6A	IEC Clarification Sheet, Project Certification, Recognition arrangement, no. CBC 6A

Table 1-6 ISO documents

<i>Reference</i>	<i>Title</i>
ISO 9000	Quality management systems - Fundamentals and vocabulary
ISO 9001	Quality management systems – Requirements
ISO/IEC 17000	Conformity assessment - Vocabulary and general principles
ISO/IEC 17020	Conformity assessment - Requirements for the operation of various types of bodies performing inspection
ISO/IEC 17065	Conformity assessment - Requirements for bodies certifying products, processes and services
ISO/IEC 17025	General requirements for the competence of calibration and testing laboratories

Table 1-7 Other documents

<i>Reference</i>	<i>Title</i>
EN 12495	Cathodic protection for fixed steel offshore structures
EN 1997-2	Eurocode 7: Geotechnical design – Part 2: Ground investigation and testing
BSH no. 7005	Standard Design of Offshore Wind Turbines, Edition 2007

1.6 Procedural requirements

1.6.1 Customer - DNV GL interaction

The project certification provides the customer a third party verification and conformity of his wind farm project considering specific needs.

This document has a dual objective. It serves as a publicly available description of DNV GL's project certification services for wind farms and it should be referred to as a contractual document in the project certification agreement between the customer and DNV GL. The document specifies the obligations of the customer when his wind farm or its assets are to become certified, as well as DNV GL's service obligations to the customer.

The deliverables by DNV GL shall be agreed in detail between the customer and DNV GL as part of the contract. In general the DNV GL project certificate is issued when all of the required conformity statements according to the project certification system have been issued and the final evaluation is done successfully. The deliverables are listed in [2.4].

Each certification phase for a component or cable section can be verified independently according to the

DNV GL project certification system and will be completed with the issue of a conformity statement for the asset under verification. Final timeframes of the verification and certification activities shall be discussed and agreed between the customer, DNV GL, and suppliers before commencement of the work.

The typical project certification applicant is the wind farm developer, owner or operator. The splitting of the project certificate per asset allows the involvement of asset related contractors in the project set-up. This allows the involvement of additional resources from an applicant perspective.

1.6.2 Certification requirements, quality management

In general subsequent phases shall not be initiated before previous or dependent phases are completed and approved. For example, prior to verification of the manufacturing phase, the design basis phase and the design phase shall both be completed and approved. Therefore the manufacturing of the components for the project shall not be started before the design is approved and surveillance is agreed. Alternative ways and the related risks shall be discussed and agreed with DNV GL in advance.

The customer shall provide evidence of a consistent quality management system covering all aspects of the development and operation of the wind farm or its assets. In particular the customer shall show quality relevant procedures to DNV GL for his procedures and his suppliers, covering design, manufacturing, transportation, installation, inspection, operation and documentation processes. When a valid certificate for ISO 9001 of an accredited certification body is in place, the project certification body may reduce this assessment to a plausibility check.

In general test reports delivered shall be prepared by accredited testing laboratories and meet the requirements of ISO IEC 17025 and relevant standards. For non-accredited test laboratories, DNV GL shall verify that the testing is carried out according IEC/ISO 17025, as applicable.

1.6.3 Documentation requirements

The documentation submitted for the certification process shall be complete and self-explanatory. The content shall meet the requirements of the applied standards. All relevant documentation shall be subject oriented and in a logical sequence to facilitate cross checking between documents (e.g. design basis, design, manufacturing, transport, installation, commissioning etc.). Each document shall be named explicitly by e.g. title, report no., page no., date and a revision description table. Furthermore the documents should be signed officially at least by the author and/or the approver to identify responsibilities. Alternatively the documentation submitted shall bear unambiguous evidence of having been subject to designer's and/or owner's own quality approval system.

The documentation, including standards and codes as well as other requirements and specifications, shall be prepared in the English language, unless otherwise agreed in writing between DNV GL and the customer.

All documentation for verification shall be forwarded to DNV GL in electronic form, preferably as pdf-files. Other forms of documentation such as print-outs can be an alternative, if agreed.

Guidance note:

The documents submitted should be on a logical work package basis per phase (see [Figure 2-1](#) and cover the requirements as stipulated in [Sec.3](#) to facilitate the process.

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1.6.4 Standards, codes and additional requirements

The standards, codes and requirements which form the basis for the wind farm project shall be listed and agreed in the so-called design basis document at a very early stage. For the site in question, relevant statutory requirements shall also be listed. Such requirements could be de-commissioning and safety related issues such as requirements for embarkation and rescue.

Other requirements relevant for the project certification such as requirements for the grid connection and other specific requirements of the owner and the grid operator shall be listed as well.

The standards, codes and additional requirements which are applicable for the project and site in question, will be verified for compliance with the design prerequisites of the project and for completeness and adequate suitability and applicability. The verification of the choice of standards, codes and requirements shall be conducted early in the project phase in order to avoid fundamental discussions on this basic aspect

of the design basis.

For dated standards and codes, only the edition cited applies. For undated references, the latest edition of the referenced document including any amendments applies. In case of deviations from this rule, it shall be agreed on an individual basis and in advance with DNV GL.

1.6.5 Combination of standards

DNV GL certification according to internationally recognized standards shall follow the principles described in this service specification. Wherever combinations of such standards and external criteria are used, the exact terms of reference and documents to be issued shall be agreed at the beginning of the project and shall be specified in detail in the design basis.

The application of standards other than those referenced here does not allow for a reduction of the targeted safety as described in the philosophy of IEC 61400-22 in combination with the related technical standards. DNV GL reserves the right to ask for additional requirements to cover issues essential to the certification process and not covered by the standards in question.

It is not allowed to combine safety measures from different standard systems due to the possible differences in the underlying safety philosophies of the different standard systems.

In case standards are combined, caution shall be exercised and the choice of standards is subject to acceptance by DNV GL.

Guidance note:

Within a particular standard, aspects such as requirements for partial safety factors for calculations of design loads and design resistance are generally mutually balanced to give an overall acceptable safety level. In another standard with the same overall acceptable safety level, the requirements for the safety factors may have been balanced differently. Picking requirements for load factors from one standard and material factors from another can therefore easily result in unpredictable, and possibly too low or too high, safety levels.

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1.6.6 Surveillance requirements

The customer, or other entity having legal responsibility for the premises where DNV GL personnel will work, shall inform DNV GL of any safety and health hazards related to the work and/or any safety measures required for the work, prior to starting the work, or if such information is not available at that time, during the performance of the work.

Whenever DNV GL undertakes to work on site, the customer shall provide all adequate safety measures to ensure a working environment that is safe and in accordance with all relevant legislation.

If at any time during the execution of work on site a DNV GL employee judges that the work situation is unsafe then work shall be suspended until such situation has been made safe.

For on- and offshore projects the transport and installation surveillance starts from loading at the manufacturers' production sites and ends at the wind farm site.

In offshore projects the transport surveillance can be combined with the marine warranty surveillance, if both are carried out by DNV GL or other acknowledged marine warranty surveyor and agreed at the beginning of the project. Caution should be taken as the scope of the transport surveyor and marine warranty surveyor differ significantly in respect to the project certification purpose. Briefings and written approvals for consent between the parties in respect to availability and instructions of the marine warranty surveyor for the success of the transport surveillance are required.

SECTION 2 SERVICE OVERVIEW - PROCEDURE AND CONTENT OF PROJECT CERTIFICATION

2.1 Overview

Project certification of wind farms in accordance with this service specification is carried out according to the IEC 61400-22 project certification system.

Project certificates can be issued for single or more assets of the wind farm:

- wind turbines and their support structures
- substations including, if applicable, topsides or transformer stations with equipment and support structures
- power cables

or

- the complete wind farm.

The project certificate for the wind farm includes all three mentioned assets ensuring the evaluation of the interfaces considering the wind farm system as a whole.

The DNV GL project certification system in accordance with IEC 61400-22 consists of six phases, see [Figure 2-1](#). The phases refer to the project certification from site condition, design basis, design, manufacturing, transport, installation and commissioning to the maintenance of the certificate during the in-service phase. These phases cover the modules defined by IEC 61400-22 (see [Figure 2-1](#)).

Conformity statements will be issued after successful completion of each phase. Conformity statements for single modules according to IEC 61400-22 such as site conditions (see [Figure 2-1](#)) can be issued on request.

The project certificate for a specific asset will be issued after successful completion of all phases for one asset (see [Figure 2-1](#), column wind turbines, substations or power cables).

The project certificate for the wind farm will be issued after successful completion of all phases for all assets of the wind farm (see [Figure 2-1](#), column project certificate wind farm).

In case of outstanding issues provisional conformity statements and project certificates can be issued on request. An outstanding issue shall be non-safety relevant and implies that the outstanding issue regarding compliance with specified or agreed standards have not been resolved (see [\[2.4\]](#)). A provisional project certificate is valid for maximum one year (see [\[2.5\]](#)).

The project certificate(s) may be maintained throughout the in-service phase. For maintenance of the certificate throughout the in-service phase, reference is made to [\[2.5\]](#).



Mandatory
 Optional

Modules in IEC 61400-22	Phases in DNV-GL-SE-0073	Project Certificate Wind Farm			Deliverables
		Wind Turbines	Substations	Power Cables	
Site Conditions Evaluation	I ↓	Design Basis	Design Basis	Design Basis	Conformity Statements
Design Basis Evaluation					
Integrated Load Analysis	II ↓	Design	Design	Design	
Design Evaluation					
Manuf. Surveillance	III ↓	Manufacturing	Manufacturing	Manufacturing	
Transport. & Install. Surveillance	IV ↓	Transport & Installation	Transport & Installation	Transport & Installation	
Commissioning Surveillance	V ↓	Commissioning	Commissioning	Commissioning	
Project Charact. Measurements					
Final Evaluation	↓	Final Evaluation Report	Final Evaluation Report	Final Evaluation Report	Final Evaluation Report
Project Certificate	↓	Project Certificate Wind Turbines ⊕	Project Certificate Substations ⊕	Project Certificate Power Cables ⊕	Project Certificate Wind Farm - Wind turbines - Substations - Power Cables =
Operations & Maint. Surveillance	VI	In-Service Ⓞ	In-Service Ⓞ	In-Service Ⓞ	Conformity Statement

Figure 2-1 DNV GL project certification system in accordance with IEC 61400-22

The verification of single asset components or power cable sections as described in [1.3] can be offered optionally to enable issuing conformity statements after successful completion of the respective activities.

On request, complementary services to DNV GL project certification may be performed and will be documented separately (see [3.6]).

2.2 Project certification phases

The following project certification phases are shown in Figure 2-1:

- Phase I: Design basis covers the site conditions and the basis for design.
- Phase II: Design covers the steps necessary to achieve final design verification. This verification includes a site-specific design approval of the integrated structural system consisting of wind turbine and support structure or substation topside and support structure or power cables.
- Phase III: Manufacturing covers the surveillance during manufacturing of the project related assets.
- Phase IV: Transport and installation covers the surveillance during transport and installation of the project related assets.
- Phase V: Commissioning involves all follow-up verification and on-site inspections during the implementation of the project.
- Phase VI: In-service involves follow-up verification and periodic on-site inspections after start of

operation and during the subsequent in-service period.

Each phase will be completed with the issue of a conformity statement.

After completion of phases I through V for each asset and prior to the issue of the project certificate wind farm, a final evaluation shall be performed. During the final evaluation DNV GL shall check all parts of the certification (evaluation reports and conformity statements, type certificate) for consistency and completeness with regard to the phases and assets described in this service specification. A DNV GL Project certificate wind farm will be issued after successful completion of the final evaluation. The certificate documents compliance at the date of issue of the project certificate for a certain project with standards specified and agreed in the design basis.

The verification activities associated with the various certification phases and distinguished between the different wind farm assets are presented in more detail in [Sec.3](#).

The following table provides an overview of the asset relevant sections of this document.

Table 2-1 Project certification of wind farms – document section references

Phases		Assets		
		wind turbines [3.3]	substations [3.4]	power cables [3.5]
I	design basis	[3.3.2]	[3.4.2]	[3.5.2]
II	design	[3.3.3]	[3.4.3]	[3.5.3]
III	manufacturing	[3.3.4]	[3.4.4]	[3.5.4]
IV	transport and installation	[3.3.5]	[3.4.5]	[3.5.5]
V	commissioning	[3.3.6]	[3.4.6]	[3.5.6]
		project certificate wind turbines	project certificate substation	project certificate power cables
		project certificate wind farm		
VI	in-service	[3.3.7]	[3.4.7]	[3.5.7]

2.3 Technical requirements

This service specification provides the key references to the technical requirements to be fulfilled for the assets subject to the project certification and serves as DNV GL's interpretation of the requirements of IEC 61400-22 for wind farms.

2.4 Deliverables

A DNV GL project certificate can be issued for an onshore or offshore wind farm or its individual assets as defined in this service specification (see [\[2.1\]](#)).

A project certificate wind farm contains the following:

- project certificate wind turbines
- project certificate substation(s)
- project certificate power cables
- final evaluation report.

Each project certificate is supported by at least the following:

- conformity statement design basis
- conformity statement design
- conformity statement manufacturing
- conformity statement transport and installation
- conformity statement commissioning
- final evaluation report
- conformity statement in-service (for maintenance of project certificate).

Each conformity statement is supported by a subject related evaluation report.

The project certificate of the wind farm can be obtained based on the three asset related project certificates or by fulfilling the mandatory phases (see [Figure 2-1](#)) for the three assets as described in this service specification.

For surveillance during manufacturing, transportation, installation and commissioning as well as in-service, DNV GL shall report critical findings to the customer immediately after the surveillance. DNV GL shall issue surveillance reports to the customer and the frequency of these shall be agreed with the customer (for example daily, weekly or monthly). The report shall describe the extent of the surveillance including findings, non-conformities and possible recommendations. The reports will be issued in electronic form and sent by e-mail to the customer.

In the event that full compliance is not obtained during the project certification, the deliverables will depend on the nature of the lack of compliance. Three deliverable outcomes are available in this regard and described in the following:

- *No outstanding issue.* Conformity statements with the accompanying DNV GL evaluation reports will be issued. A DNV GL project certificate will be issued based on the conformity statements for the asset verified.
- *Non-safety critical outstanding issues.* One or more provisional conformity statement(s) will be issued with the outstanding issue(s) listed in the conformity statement(s). A provisional project certificate can be issued on request, which points out the outstanding issues. The outstanding issues listed on the conformity statement(s) will be repeated in the project certificate. Specific description of the outstanding issues will be given in the accompanying DNV GL evaluation reports. As outstanding issues become closed, an updated conformity statement and finally a project certificate with no outstanding issues can be issued.
- *Safety critical outstanding issues.* (A) conformity statement(s) and the project certificate will not be issued. DNV GL will deliver the DNV GL evaluation report(s) that would normally accompany the conformity statement for the relevant phase. The DNV GL evaluation report(s) will list the outstanding issues whose rectification is required before (a) conformity statement(s) can be issued.

2.5 Certificate validity and maintenance

The DNV GL project certificate refers to conformity statements issued for the completed phases of the project certification.

The validity of the project certificate is limited to the design life-time of the installation stated in the project certificate.

Maintenance of the project certificate is conditional on periodic in-service verification by DNV GL and requires the following information:

- annual reporting by the customer covering the certified wind farm project (or asset project) and including information about:
 - installed turbines, substations and cables as installed on the site
 - abnormal or deviant operating experience or operating failures as well as minor modifications
- reporting by the customer of planned major modifications without delay and in sufficient time to allow for evaluation by DNV GL before implementation and to enable updating of the design phase and others, if relevant
- the wind farm and the assets of which it is comprised are maintained to a standard complying with the requirements of applicable codes and relevant manuals
- periodic inspections by DNV GL or other acknowledged in-service inspectors during the validity period of the certificate to check that the wind farms corresponds to the certified design.

The project certificate should be confirmed one year after the date of first issuance by a conformity statement in-service. When a periodic in-service agreement for the wind farm is in place between DNV GL and the customer, the interval of confirmation of the project certificate is set to the duration of the service

agreement plus one year; however, five years is the maximum period of confirmation.

Following a successful completion of an in-service verification, a conformity statement in-service that validates the project certificate will be issued.

Guidance note:

In-service is optional according to IEC 61400-22. However, it becomes mandatory according to IEC 61400-22, if maintenance of project certificate is chosen. It is strongly recommended to perform the maintenance of the certificate from issuing date over the life-time. The resuming of certificate maintenance of an suspended or invalid project certificate can be difficult or even impossible.

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Re-certification may be necessary, if additional requirements for maintenance of the project certificate are set by national authorities or by the applicable design code or standard during the validity period of the certificate.

Safety relevant incidents shall be reported to DNV GL without delay. DNV GL shall evaluate the incidents. In case of a serious defect of the asset in question, DNV GL shall suspend the certificate until elimination of the cause. The certificate shall be reaffirmed after successful verification of the rectifying measure.

Provisional statements or provisional certificates have a maximum validity of one year. During this period the customer shall document the closing of the outstanding issues and they shall be evaluated by DNV GL.

2.6 Accredited services

DNV GL is accredited according ISO/IEC 17065 for project certification of wind farms, among others, according to the following systems:

- BSH no. 7005, *Standard Design of Offshore Wind Turbines, Federal Maritime and Hydrographic Agency (BSH)*, edition 2007
- DNV GL Project Certification System according to IEC 61400-22
- GL Project Certification System according to GL-IV-1, edition 2010
- GL Project Certification System according to GL-IV-2, edition 2012
- IEC Project Certification System according to IEC 61400-22
- Offshore and Onshore Wind Turbine Parks according to Executive Order from the Danish Ministry for Climate, Energy and Buildings No. 73 dated 2013-01-25: *Bekendtgørelse om teknisk certificeringsordning for vindmøller* (Executive order on the technical certification scheme for wind turbines).

SECTION 3 SERVICE DESCRIPTION

3.1 General - Objective

The objective of the DNV GL system described in this service specification is to detail and clarify the verification activities and facilitate achieving compliance with the IEC 61400-22 system, in particular with respect to the topics listed in [Sec.3](#).

Mandatory and optional certification modules in the IEC system are outlined in [Figure 2-1](#) (see "Modules in IEC 61400-22"), in which the certification phases according to the DNV GL system (see "Phases in DNV GL" in [Figure 2-1](#)) are included for comparison. The DNV GL system complies with the IEC 61400-22 system with the main difference that some DNV GL phases comprise multiple IEC modules. The number of conformity statements issued when the IEC system is followed for the certification will therefore be larger than the number of conformity statements issued when the DNV GL system is applied. Another difference between the two documents is due to the fact that the IEC requirements are relatively openly formulated, the corresponding DNV GL requirements have been rephrased for clarity. However, as the IEC system and the DNV GL system are mutually compliant, the IEC system is fulfilled when the DNV GL system is followed for the certification, and vice versa.

3.2 Project certificate wind farm

3.2.1 General

The project certificate for the onshore or offshore wind farm comprises the project specific certification of the three assets ensuring the verification of the integrative needs.

A project certificate wind farm consists of the following assets with the respective conformity statements and evaluation reports:

- wind turbines with their support structures, see [\[3.3\]](#)
- substation with its topside, support structure(s) and equipment, see [\[3.4\]](#)
- power cables, see [\[3.5\]](#).

3.2.2 Phases for the wind farm

The project certification of the wind farm can be obtained performing the asset related project certifications in parallel or separately and unifying the three asset project certificates at a later stage. In both cases the following DNV GL project certification phases shall successfully be completed for all three assets:

- i) design basis
- ii) design
- iii) manufacturing
- iv) transport and installation
- v) commissioning.
for the maintenance of the project certificate
- vi) in-service.

In the case of performing the certification of different assets in parallel the number of conformity statements can be reduced, including all assets in the conformity statements of each phase.

The asset related certifications (see [\[3.3\]](#) to [\[3.5\]](#)) are available to cover projects' individual needs and the logical subsequence of wind farm project realisation.

The unification of separately achieved asset-related certifications requires in addition the verification of the interfaces between the assets to ensure a safe and integrated wind farm certification.

The details of the asset-related certifications are given in [\[3.3\]](#) to [\[3.5\]](#).

Once the verifications of design basis, design, manufacturing, transport, installation, and commissioning for all assets have been successfully completed and the final evaluation has been performed, DNV GL will issue

a project certificate wind farm.

3.3 Project certificate wind turbines

3.3.1 General

This section provides the details of DNV GL's verification activities for each of the phases of the DNV GL project certification system according to IEC 61400-22 for the asset that consists of the wind turbines and their support structures.

Once the verification of design basis, design, manufacturing, transport, installation, commissioning for the asset wind turbines and their support structures has been successfully completed and the final evaluation has been performed, DNV GL will issue a project certificate wind turbines.

3.3.2 Phase I: Design basis

The purpose of the verification of the design basis is to evaluate if the site conditions and the basis for design are properly established and documented. This includes general specifications, criteria, parameters, design approach, manufacturing, basic quality requirements, suppliers' qualification and other assumptions relevant for design. The design basis shall document a safe design and adequate implementation of the turbines and their support structures in the specific project.

The standards, codes and additional requirements shall be agreed within the design basis (see [1.6.4]).

A design basis shall be provided to DNV GL. This design basis shall include documentation of the following:

- a) site conditions
- b) standards, codes and additional requirements
- c) design criteria
- d) manufacturing, transport, installation and commissioning requirements
- e) operation and maintenance requirements
- f) wind turbine type(s).

The design basis identifies the basic assumptions, specification, methods and requirements for the project design. In case of the project being implemented as a multi-contract project, the design of assets, such as the wind turbines and the support structures, may be carried out by different parties. In such cases the design basis forms an essential tool with a view to ensure, document and verify the safety of the total system and consistency between the different project parts. It is strongly recommended that the design basis is developed as an integrated document to be applied for all parts. If the development of the design basis is divided between suppliers of parts of the project, the design basis for each part shall contain all information of relevance for the design of that part.

In case of multi-contracting, the design basis may comprise three parts that together form the design basis for the project:

- A site conditions and general requirements relating to (a) through (e)
- B wind turbine specific requirements relating to (b) through (f), including definition of design load cases and design wind parameters, load factors and turbine design methodology
- C structure-specific requirements relating to (b) through (e), including interpretation of geotechnical and environmental (e.g. met-ocean) data for design, specification of design methodology including principles, procedure, materials and requirements for installation and commissioning and for operation and maintenance.

Typically, but not necessarily, DNV GL carries out the verification work for Part A for the project owner, for Part B for the wind turbine supplier and for Part C for the support structure contractor.

In respect to the wind turbine type the design basis of the type certificate is used for comparison and implementation into the project specific design basis. The wind turbine type certificate is not needed in the design basis phase, but in the design phase, for which reason the customer's obligations and DNV GL's

services related to the wind turbine type are given in [3.3.3.2] for the design phase. For integration of type certificates reference is made to [3.7].

DNV GL shall verify the design basis for compliance with IEC 61400-22 and standards, codes and additional requirements listed in the design basis.

Once the verification of the design basis has been successfully completed, DNV GL will issue a conformity statement for Phase I: Design basis wind turbines.

For onshore sites where only a confirmation of the site conditions and wake analysis is desired, please refer to [3.6.2].

3.3.2.1 Site conditions

DNV GL shall evaluate the establishment of site conditions detailed in IEC 61400-22 in accordance with, respectively, IEC 61400-1 for onshore or IEC 61400-3 for offshore applications, based on reported data and/or applicable standards or methods valid for the site.

The following site conditions shall be addressed and will be subject to verification:

- wind conditions
- geotechnical conditions
- earthquake conditions
- other environmental conditions (e.g. ice, high temperatures, lightning)
- electrical power network conditions.

Additionally for offshore sites:

- wave conditions
- marine conditions, and
- weather windows and weather downtime.

Additionally for onshore sites:

- terrain and topographical conditions.

For measured data DNV GL shall assess principles and methods for:

- data acquisition
- statistical methods applied
- establishment of design parameters.

Independent analysis for selected parameters may be carried out by DNV GL, based on the environmental and geotechnical data provided.

Additionally for offshore sites:

- the metocean conditions provided may be derived from site-specific measurements supported by hindcasts. Site-specific measurements shall when possible be correlated with data from a nearby location for which long term measurements exist. The monitoring period for the site-specific measurements shall be sufficient to obtain reliable data for design.

The site-specific measurements shall be carried out and documented as required in IEC 61400-22 and, respectively, IEC 61400-1 or GL-IV-1 for onshore or IEC 61400-3, DNV-OS-J101 or GL-IV-2 for offshore application, unless a conservative approach is adopted. Such an approach may utilize the uniform conditions at sea together with hindcast models.

Measurements of the site conditions shall either be carried out by a testing laboratory accredited to ISO/IEC 17025 or shall be subject to approval by DNV GL on the basis of an evaluation of the quality and reliability of the measurements. Such an evaluation shall cover the following issues:

- test and calibration methods
- equipment

- measurement traceability
- assurance of the quality of test and calibration results
- reporting of the results.

The geotechnical site investigation and laboratory testing are assumed to have been carried out by companies with relevant experience of similar work. The quality of the soil investigation and the test results shall fulfil the requirements given in EN 1997-2.

Not necessarily all parts of ISO/IEC 17025 may apply to the geotechnical field and laboratory work. In all cases, a description of all test procedures and relevant standards shall be presented.

DNV GL shall verify that relevant reports properly document the site conditions.

DNV GL shall assess the interpretation of the site conditions and the identification of the design parameters describing the site conditions to be used for design of the wind turbine's, support structure and other installations. Design parameters representing the following conditions shall be included:

- wind climate
- ice
- geotechnical data
- other site conditions, such as seismicity, lightning, temperature
- electrical network conditions.

Additionally for offshore sites:

- wave climate
- correlation between relevant parameters such as wind, waves and current
- current
- water level
- water depth
- seabed topography
- other site conditions, such as salinity, spray ice, marine growth, air density, traffic, disposed matters, pipelines and cables.

Additionally for onshore sites:

- terrain topography and complexity.

The verification of the geotechnical design basis shall focus on:

- extent, quality and relevance of the soil investigations
- derivation of geotechnical design parameters from the soil investigations.

The geotechnical design basis may, in addition to site-specific soil data, include derived soil profiles and recommendations regarding calculation methods.

DNV GL shall review the electrical power network conditions to be used as the basis for the wind farm project. If the electrical power network conditions for the site differ from the normal electrical power network conditions specified in IEC 61400-1 for onshore or IEC 61400-3 for offshore, such conditions, applicable at the wind turbine terminal, shall be documented and stated.

3.3.2.2 Design criteria

The design of the integrated structure that is comprised of the wind turbine and its support structure shall be based on the specific site conditions as well as the methods and principles as given in IEC 61400-22 and, respectively, IEC 61400-1 for onshore or IEC 61400-3 or DNV-OS-J101 for offshore application.

DNV GL shall require and assess all relevant overall design aspects and parameters to be applied in the calculations.

For offshore projects these parameters comprise the wind and wave (current) conditions, air density and temperature, loads, load combinations, partial safety factors applied for loads and materials, water depth

and tide, scour protection design, corrosion allowance, marine growth and other issues of relevance. Marine growth consideration is required for offshore sites but the applied thickness is an assumption. If no further information is available values from either DNV-OS-J101 or GL-IV-2 may be assumed. However the thickness may not exceed the estimated value, otherwise the customer has to remove the marine growth.

For onshore projects the relevant design aspects and parameters to be applied in the calculations are the wind conditions, air density and temperature, terrain topography and complexity, loads, load combinations, partial safety factors applied for loads and materials, and other issues of relevance.

For all projects DNV GL shall require and assess information needed to determine the resulting conditions due to wakes from neighbouring wind turbines. This information shall comprise a detailed site layout, a description of the calculation method to be applied as well as an analysis of wake effects for all wind turbine positions in the actual wind farm layout under consideration and also wake effects from nearby wind farms within a distance of ten times the rotor diameter.

Furthermore, DNV GL shall require and assess a description of the main design methodology, including the load case descriptions and method of load calculation, and structural and geotechnical design methodologies. This is important in order to obtain early agreements regarding methodologies and to avoid discussions about overall principles and methods later in the project.

DNV GL shall verify the principles used to establish load combinations for the limit states ULS, FLS and if relevant SLS and/or ALS for compliance with IEC 61400-1 for onshore or IEC 61400-3 for offshore application.

The verification of the design basis for load calculations shall focus on:

- design values for wind conditions and other environmental conditions
- design values for soil stiffness, soil strength and soil damping (see below)
- load combinations and soil properties for assessment of cyclic degradation of soil strength
- methods and principles used for prediction of extreme design loads and fatigue design loads, and methods and principles for response analyses
- partial safety factors
- load combinations (design load cases)
- duration of simulations as well as number of simulations
- load factors and load reduction factors
- design lifetime of components, systems and structures.

Additionally for offshore sites:

- design values for combination of wind and wave conditions, in particular misalignments between wind, wave and currents
- applied wave theory and models for hydrodynamic loads
- design values for sea states, wave heights, crest elevations, directional scatter, fetch and sea level
- design values for water levels and seabed levels.

IEC 61400-3 does not describe how the damping shall be determined. Damping shall be considered with the following parameters of contribution to damping:

- soil damping (due to internal friction)
- soil radiation damping (due to pressure wave radiation)
- wave damping
- viscous damping
- aerodynamic damping
- structural damping
- slosher dampers, tuned mass dampers etc.

The consideration of accidental limit states (ALS) is optional according IEC 61400-3, however it is recommended to consider relevant ALS for the design of primary structures and DNV-OS-J101 or GL-IV-2

should be applied.

Additionally for onshore sites:

- terrain complexity
- design values for the up-flow distortion of the wind due to complex terrain.

3.3.2.3 Manufacturing, transport, installation and commissioning

The design basis shall state assumptions, specifications and requirements for structural design for loads occurring during manufacturing, transportation, installation and commissioning, such as environmental loads, lifting loads, and local loads from temporary supports. The design basis shall also state assumptions, specifications and requirements for the manufacturing, transportation, installation and commissioning programmes themselves. Manufacturing and commissioning of the rotor-nacelle-assembly and the tower is usually properly documented through the type certification. Commissioning requirements for the sub-structure and the foundation are usually very limited.

Assumptions, specifications and requirements may include, but are not necessarily limited to:

- standards, codes and additional requirements, see [1.6.4]
- specifications and tolerances
- limiting environmental conditions
- manufacturing requirements and quality assurance systems
- methods and loads of relevance for transportation and installation
- requirements for transportation, installation (incl. loading) and commissioning manuals
- quality assurance systems for the installation contractors.

The assumptions, specifications and requirements are expected to depend on owner's requirements as well as on the actual contractual arrangements for the wind farm project.

When the wind turbine has been type certified by DNV GL, only those assumptions, specifications and requirements not verified as part of the type certification may be stated.

DNV GL shall verify assumptions, specification and requirements stated in the design basis.

3.3.2.4 Operation and maintenance

The design basis shall state assumptions, specifications and requirements for structural design against loads occurring during operation and maintenance. The design basis shall also state assumptions, specifications and requirements for the operation and maintenance programmes.

Assumptions, specifications and requirements to be stated include, but are not necessarily limited to:

- inspection scope and frequency
- target lifetime of components, systems and structures
- requirements for service and maintenance manuals
- requirements for condition monitoring systems.

For the type certified wind turbine, most of these assumptions, specifications and requirements are covered by manuals approved in the type certification process.

When the wind turbine has been type certified by DNV GL, only assumptions, specifications and requirements not verified as part of the type certification may be stated.

DNV GL shall verify assumptions, specification and requirements stated in the design basis.

3.3.3 Phase II: Design

DNV GL shall verify the final design for compliance with design criteria selected according to [3.3.2.2], and other standards and requirements identified in Phase I: Design basis (see [3.3.2]).

The concretisation of appliance of the design basis shall be submitted at the beginning of the design phase, at latest. As an optional intermediate step the design principles given in design briefs may be verified before the final design documentation is delivered to DNV GL. Details of the verification activities in this phase are

given in the following sections.

Once the verification of the final design has been successfully completed, DNV GL will issue a conformity statement for Phase II: Design wind turbines

For onshore sites and further optional services, reference is made to [3.6].

3.3.3.1 Integrated load analysis

The loads and responses shall be verified based on the documentation review and independent analysis for compliance with the approved design basis. The design report for integrated load analysis shall as a minimum document the following:

- the wind turbine together with its support structure shall be analysed for the relevant load cases
- the wake effects from neighbouring wind turbines shall be taken into account using the method described in the approved design basis
- where relevant the load cases shall be selected such that load cases are included that represent situations with low aerodynamic damping. Such cases may include misaligned wind directions, yaw error due to grid loss or malfunction of the control system
- the loads and responses in the design reports shall be presented in a form that allows for design checks and verification
- as part of the documentation the calculated time histories shall be supplied to DNV GL in a readable format.

Additionally for offshore sites:

- in general the loads (including blade-tip-tower clearance) for offshore application shall fulfil the requirements of IEC 61400-3
- the wave and wind loads should preferably be combined and applied to the calculation model to enable simulation in the time domain. The expected foundation stiffness variations due to soil and structural properties as well as water depth variations shall be considered in the calculations
- the load cases shall be selected such that load cases are included that represent situations with low aerodynamic damping. Such cases may include misaligned wind and wave directions, yaw errors due to grid loss or malfunctions of the control system
- IEC 61400-3 does not contain any control and safety system faults. Therefore IEC 61400-1 or GL-IV-2 shall be used in this regard.

To verify the site-specific loads for the turbines in question DNV GL shall perform an independent load analysis analysing a selected sub-set of load cases for fatigue and extreme loads if relevant. The DNV GL independent load analysis report can be made available to the customer on request.

Such an independent analysis will be carried out based on a full dynamic load modelling of the integrated systems consisting of wind turbines and support structures, including soil modelling of offshore sites and using an aero-hydro-elastic computer programme.

For onshore sites where the installed wind turbines are in compliance with the corresponding type certificate and only the site conditions exceed the design limits, site-specific loads are verified by DNV GL.

Guidance note:

The integrated load analysis is preferably performed by a single computer program. It should consider the simultaneous dynamic impacts of all relevant environmental forces such as wind, waves, current, etc. on the complete system. The model on the complete system shall comprise rotor-nacelle-assembly, support structure, foundation and soil properties. This enables an analysis of the dynamic system response taking the correlation of all acting environmental impacts into account.

In the event that parts of the offshore wind turbine are modelled with a separate computer programme, e.g. with a specific wind turbine code or a specific offshore code, it has to be shown that each sub system represents the relevant dynamic properties of the complete system by equivalent elements. The transfers of loads between the various sub-systems have to be aligned at defined interfaces. The load alignment at the sub-system interfaces can be achieved by an iterative process.

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Critical load cases and load combinations shall be analysed by DNV GL in order to verify loads.

In offshore wind farms the designer of the support structure and the wind turbine supplier normally complete integrated analyses for one or a few locations only. The loads on the remaining locations are then

determined under certain assumptions; the chosen approach is normally setup depending on variations in water depth, soil conditions, natural frequencies and damping. DNV GL will check that loads determined on the remaining locations are representative. If the representativeness cannot be proven for the entire wind farm, conservative assumptions shall be applied.

3.3.3.2 Wind turbine type

The wind turbine type shall be verified for project certification. This shall be documented by a type certificate or the mandatory modules of the type certificate of IEC 61400-22 shall be fulfilled (see [3.7]). This will be verified with respect to the specific project and site-specific conditions in project certification. In the following reference is made to the term type certification only, even when the fulfilment of the mandatory modules of type certification is possible, too. The certificates shall be valid at the date of issue of the conformity statement for the design phase and project certificate. The certification system applied for the wind turbine type certificate shall be stated in the design basis.

DNV GL shall verify that a valid type certificate is in place for the wind turbine. In addition, the following conditions, requirements and specifications shall be presented to DNV GL and shall be verified by DNV GL:

- external conditions assumed for the wind turbine design including the grid conditions
- requirements for transportation and installation
- requirements for operation and maintenance
- specification for the interfaces between wind turbine and support structure, e.g. tower–sub-structure geometry, stiffness of support structure, and stiffness of soil support.

Guidance note:

Adequate implementation and site-specific adaptations of the type certified turbine for the project are part of the project certification process. Potential synergies from type certification can be used where identified and possible. Permissions required by suppliers shall be provided to DNV GL by the developer or contractor.

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A methodology for how to handle deviations from the conditions of the type certificate, such as reinforcement of the blades, reinforcement of the tower top and yaw system, and modification of the electrical systems, shall be outlined.

Guidance note:

Major deviations from the wind turbine design including the controller, covered by the type certificate may require an update of the type certificate; see [3.7.3].

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The wind turbine specification shall uniquely define the wind turbine type. If the wind turbine has been type certified by DNV GL, the wind turbine specification may be limited to a reference to the type certificate and specifications of possible deviations from the certified wind turbine type, such as a site-specific tower, additional corrosion protection or other site-specific configurations, see [3.6.2.3].

For the use of information from the type certification, such as the independent load analysis of the integrated wind turbine and support structure, DNV GL shall be given permission to use specifications and wind turbine models from the DNV GL wind turbine type certification. The control system applied in the project shall be the same as for the type certified wind turbine. If this is not the case the new control system release (hardware and software) shall be included in the type certification or a site-specific design evaluation should be performed as part of the project certification.

If the wind turbine has been type certified by a certification body other than DNV GL and this body is recognized by DNV GL (see [3.7.7]), DNV GL shall require documentation of the wind turbine type in accordance to the IEC clarification sheet (see [3.7]).

Guidance note:

Documentation of the wind turbine type for evaluation and independent calculation of the loads and response of the integrated wind turbine and support structure may include turbine specifications and a software model of the wind turbine and the load conditions and loads, which form the basis for the type certificate. In that way DNV GL should assess the adequacy of the model before performing an independent load analysis of the wind turbine and the site-specific support structure.

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3.3.3.3 Wind turbine

DNV GL shall verify that the wind turbine design basis is in compliance with the wind farm verified design

basis. The type certificate for the wind turbine will be evaluated with respect to the site-specific loads and responses.

DNV GL shall review the wind turbine type certificate conditions and limitations as compared to the actual site conditions. The action taken by designers with respect to these conditions shall be stated in the design documentation. In addition this comparison will cover metocean conditions, if applicable, including other relevant conditions such as:

- temperature
- humidity
- solar radiation
- rain, hail, snow and ice
- chemically active substances
- mechanically active particles
- salinity
- electrical conditions
- lightning
- earthquake.

Due account shall be taken of the generally more aggressive offshore environment. Environmental conditions other than wind and marine conditions can affect the integrity and safety of the offshore wind turbine by thermal, photochemical, corrosive, mechanical, electrical and other physical actions.

Moreover, combinations of the environmental parameters given may increase their effects. Hence, the documentation for utilization ratios used will be subject to special considerations.

In particular, electrical components like generator, converter, transformer, switch gear and enclosures shall be designed for the appropriate site conditions. The corrosion protection systems shall be able to withstand the site-specific marine environment.

DNV GL shall review the submitted design report of the site-specific loads with respect to the loads assumed for the type certificate. The objective is to verify that the loads do not exceed the verified capacity. Any increases in load level as well as any changes in modes shapes and natural frequencies shall be stated in the design report and will be evaluated.

The evaluation of the site-specific loads shall consider the relevance and validity of load measurements, safety and functional testing and component tests such as blade test. Furthermore, the evaluation shall also identify components that will require reinforcement or modifications.

Design documentation shall be provided for new, modified or reinforced components and systems, such as corrosion protection systems, which are not fully covered by the type certificate for the wind turbine. The documentation shall be prepared according to the design basis and, if relevant, according to the requirements for the type certification system applied.

DNV GL shall verify that the wind turbine electrical system including the wind turbine terminals meets the requirements in the approved design basis with respect to the following:

- the design of the electrical system shall ensure minimal hazards to people as well as minimal potential damage to the wind turbine and external electrical system during operation and maintenance of the wind turbine under all normal and extreme conditions
- the electrical system, including all electrical equipment and components, shall comply with the relevant IEC standards
- the design of the electrical system shall take into account the fluctuating nature of the power generation from wind turbines
- provisions shall be made to ensure adequate protection of all electrical components and systems against the effects of corrosion and humidity.

3.3.3.4 Primary support structure

The support structure comprises the tower, the sub-structure connecting the tower to the foundation, J-

tubes and the foundation, which transfers the loads into the soil. Distinction is made between primary and secondary structures for the support structure. Primary structures transfer permanent loads and environmental loads, acting on the support structure, to the soil. Secondary structures covered by the DNV GL scope comprise access ladders, main structural elements in external access platforms or boat landings. The primary support structure forms the subject of this sub-section. Secondary structures attached to the primary support structure are covered in [3.3.3.5].

Guidance note:

Certain elements of the primary structure such as cans of tubular nodes, ring flanges of tubular towers, thick-walled deck-to-leg and column connections can be classified as special structures. Special structures are part of the primary structures. The reasoning for introducing this terminology is to distinguish these structures due to their special loading and stress conditions, and therefore additional quality demands. The IEC series does not consider this differentiation, which in practice is used. Same terminology as used in the DNV-OS-J101.

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DNV GL shall verify that the design of the support structure is in compliance with the design basis. The verification of the structural design will include design review and independent design analyses, if deemed necessary.

The design evaluation shall be carried out to an extent sufficient to enable DNV GL to state that the support structure complies with the approved design basis and IEC 61400-22. However, the customer shall document that the resulting safety level complies with the intended level of IEC 61400-22 and respectively, IEC 61400-1 for onshore or IEC 61400-3 for offshore application.

Fatigue design documents should be based on DNV-OS-J101 considering DNVGL-RP-0005.

The following verification activities are conducted:

- review of detailed design calculation reports, design drawings and manufacturing specifications for detailed structural design of the support structure
- relevant independent analyses of loads and structural strength, see [3.3.3.1].

The verification may include independent analyses of the support structure using appropriate methods, such as FEM analyses, and covers:

- structural strength (stress levels, buckling and joint check) in both in-situ scenarios and transitional stages
- soil stiffness and soil capacity
- fatigue life (incl. consideration of fatigue accumulated during phases of installation and commissioning)
- dynamic behaviour/natural frequency checks
- vibrations induced by vortex shedding
- serviceability (if applicable).

If the design includes highly utilized structural connections, such as grouted connections of steel structures and tubular joints, detailed independent FEM calculations of the connections may have to be carried out by DNV GL.

For grouted connections DNV-OS-J101 or GL *TN Grouted Connections* shall be applied.

Environmental loads from wind, if relevant, waves and current, acting on the support structure, shall be based on a load analysis of the integrated system of wind turbine and support structure, and documentation in a form suitable for verification shall be submitted to DNV GL. The verification may include an independent analysis according to [3.3.3.1].

The verification of the structural design shall focus on:

- review of design calculations for ULS, SLS, FLS and, if relevant, ALS
- review of design implementation of manufacturing and installation requirements, however only with respect to the structural integrity of the final installed (permanent) support structure
- evaluation of proposed corrosion protection system(s) against design requirements with a view to required design life, standards and codes, operation and maintenance
- review of design drawings and manufacturing specifications with respect to requirements in standards,

codes and with respect to assumptions in calculations regarding dimensions, materials, tolerances and testing.

For geotechnical design of foundations reference is made to DNV-OS-J101 and CN No. 30.4. The purpose of a soil investigation is to provide a range of strength and deformation parameters with sufficient accuracy. Additionally the investigations shall supply information to evaluate deterioration from dynamic loads in sufficient detail. The investigations should be targeted on the actual phase of the project with respect to extent, details and accuracy.

The verification of the geotechnical design shall focus on:

- evaluation of calculation methods, stability and failure modes
- review of geotechnical design calculations for ULS, FLS, SLS and, if relevant, ALS
- review of design documentation regarding soil preparation, tolerances and scour protection
- the expected stiffness and damping of the support structure will be checked against assumptions made in calculations of wind turbine loads.

The following design documentation shall be submitted for verification of the final structural and geotechnical design:

- design documentation for the structural and geotechnical design calculations, for ULS, SLS, FLS and ALS. The documentation should include description of the assumptions made for the calculations, for example regarding manufacturing and installation methods.
- design report containing design calculations for the corrosion protection system(s)
- design report for the driveability study, if applicable
- design drawings including general note drawing(s)
- design documentation regarding scour and scour protection design, if relevant.

3.3.3.5 Secondary structures

The secondary structures covered in the project certification consist of access ladders, main structural elements in external access platforms and boat landings, if relevant.

The verification of the structural design of secondary structures in the support structure shall be verified with focus on:

- design methodology
- materials
- corrosion protection system(s) with respect to issues such as design life and maintenance as required in codes and standards
- design drawings and manufacturing specifications with respect to requirements in standards and codes.

The secondary structures to be covered by the project certification shall as a minimum comprise the effect of those secondary structures that have an influence on the structural integrity of the primary structure, for example in terms of welds, load distributions, stiffness and corrosion.

3.3.3.6 Electrical design

Installations other than primary and secondary structures comprise installations such as cables and electrical installations.

The design of electrical systems to be covered by the design verification comprises electrical design not covered by the wind turbine type certification, i.e. it comprises electrical systems beyond the wind turbine terminals. The design shall be verified for compliance with the appropriate standards focusing on the safety of the installations as defined in the approved design basis. The verification will be carried out on the basis of diagrams, specifications and calculations of the distribution system. Design documentation of the following items shall be submitted for review by DNV GL, if relevant:

- cabling
- semiconductor devices
- switchboards

- transformers
- converters
- other equipment (e.g. diesel generators for emergency power supply).

The wind turbine external and wind farm array power cable is the subject of [3.5] of this service specification.

3.3.3.7 Manufacturing, transport, installation and commissioning plan

The manufacturing, transportation, installation (incl. loading and unloading, such as lifting loads) and commissioning processes for the wind turbines, the support structure and other installations shall be reviewed by DNV GL for compliance with the agreed requirements stated in the approved design basis.

The overall DNV GL aim is to verify that the final structure in-situ has not been exposed to unforeseen loading during manufacturing, transportation, installation and commissioning. Exposure to fatigue loading during transportation may be of relevance.

DNV GL shall review the manuals for the wind turbine and support structure and verify their compliance with the wind turbine's type certification system and the approved design basis. The review and verification shall cover the following:

- manufacturing and goods handling processes
- transport procedures considering loading
- installation procedures
- commissioning procedures including check lists describing function test of protection system, initial energisation of the electrical system, testing after installation to confirm proper, safe and functional operation of all devices, controls and equipment safe start-up
- procedures for safe shutdown; safe emergency shutdown
- environmental conditions, e.g. required weather window
- interface points, e.g. connection to foundation and to the electrical system
- quality control, measurements and inspections
- personnel safety.

The following verification activities shall be conducted by DNV GL in order to verify compliance of the transportation and installation procedures with the approved design basis:

- review of transportation and installation requirements (transportation, lifting)
- review of structural design subjected to transportation and installation loads.

For the wind turbine, DNV GL will require the preparation of transportation and installation manuals, which as a minimum shall consist of the transportation and installation procedures and the emergency procedures specified by the wind turbine manufacturer. The manuals should also include contingency procedures. The manual may be based on the transportation and installation manuals for the type-certified wind turbine, duly updated with a view to the site-specific application.

Normally the different manuals will not all be finalised at the design stage. However, at the design phase the design influencing assumptions shall be documented by the respective manuals, at least. The final site-specific wind turbine manuals and manuals for the support structure will be reviewed during the transport, installation and commissioning phase, see [3.3.5] and [3.3.6].

3.3.3.8 In-service plan

For the wind turbine, DNV GL shall require preparation of a user's manual and an in-service and maintenance manual(s), which as a minimum shall consist of the service and maintenance requirements and emergency procedures specified by the wind turbine manufacturer. The manuals shall also provide for unscheduled maintenance. The manuals may be based on the user's manual and the service and maintenance manual(s) for the type-certified wind turbine, duly updated with a view to the site-specific application.

DNV GL shall review the user's manual and the service and maintenance manual(s) for the wind turbine and will verify that these manuals are in compliance with the wind turbine's type certification system and the

approved design basis. The review and verification shall cover the following:

- scheduled maintenance actions including inspection intervals and routine actions
- condition monitoring systems
- safety related operational procedures or maintenance activities
- quality recording and record keeping processes.

For the support structure and other installations, DNV GL shall require that relevant input to the inspection and maintenance plan shall be prepared. The input to the inspection plan and the maintenance manual shall be seen as a help to the operations and maintenance organization that normally will be established later. Examples of issues to be covered are inspections and checks of the corrosion protection system and inspections for fatigue cracks, the scour protection system and assumed service vessel(s), if relevant.

In general the manuals shall consider the site-specific circumstances and applications. In particular the assumptions from the design work shall be the basis for the in-service plan. Therefore it is strongly recommended that the designer during his design work prepares a report that states all assumptions made in design and that this report is used as input to the development of the inspection and maintenance plan.

The above mentioned documentation may not be finalised during the design phase and the verification of this documentation will therefore be covered in the transport and installation phase. However, at the design phase the design influencing assumptions shall be documented, at least.

3.3.4 Phase III: Manufacturing

3.3.4.1 General

DNV GL shall conduct manufacturing surveillance in order to verify compliance between the approved design and the product. The surveillance shall be conducted at the manufacturer's premises for production of main components as well as in the rotor-nacelle-assembly shop and shall involve:

- evaluation of manufacturing
- evaluation of quality management system, if ISO 9001 certificate is not available
- product related quality audits
- surveillance of contractor's quality assurance activities.

Manufacturing surveillance consists of (initial) audits and inspections of project related components. The surveillance activities comprise both on-site inspections and document review.

The purpose of the (initial) audit is to check the qualification (ability to perform the production of relevant components according to the assumed quality and to document this ability) of the manufacturing company prior to commencement of production and to check the documentation forming the basis for production.

The detailed scope of the inspections will be developed based on the results of the audits, which may result in a reduction of inspections to be performed. Complementary to the inspection the manufacturing records are reviewed.

Guidance note:

The (initial) audit can be omitted, if a workshop approval for the production purpose is available.

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The scope of the manufacturing surveillance of the wind turbine and support structure is detailed in [3.3.4.2] and [3.3.4.3].

The customer shall assure that DNV GL gets access to the relevant construction, manufacturing and assembly sites. Permissions required by suppliers shall be provided to DNV GL by the developer or contractor.

The extent of the inspections and the number of occasions when surveillance has to be carried out for project certification shall be evaluated by DNV GL for each specific project and will depend on DNV GL's experience with the manufacturer.

For component manufacturers producing on a large scale (no pre-series production) with a good track record, the number of inspections may be reduced to a minimum but generally some inspection will be

performed. In other cases more detailed inspections shall be performed.

Initially three inspections will be assumed, at start, mid, and end of production at each manufacturer. Alternatively a time-based approach should be elaborated. However, the extent and quantity of inspections will be evaluated after each inspection performed using a risk based approach. The evaluation will be based on both the actual inspection results by DNV GL and the past records of the component manufacturer for the actual type of production. Examples of the extent of inspection of a component for a project with wind turbines are shown in Figure 3-1 and Figure 3-2. Figure 3-1 shows a reduction of surveillances after the first inspections and Figure 3-2 shows an increase of surveillances due to possible severe non-conformities observed during the first and second term of inspections.

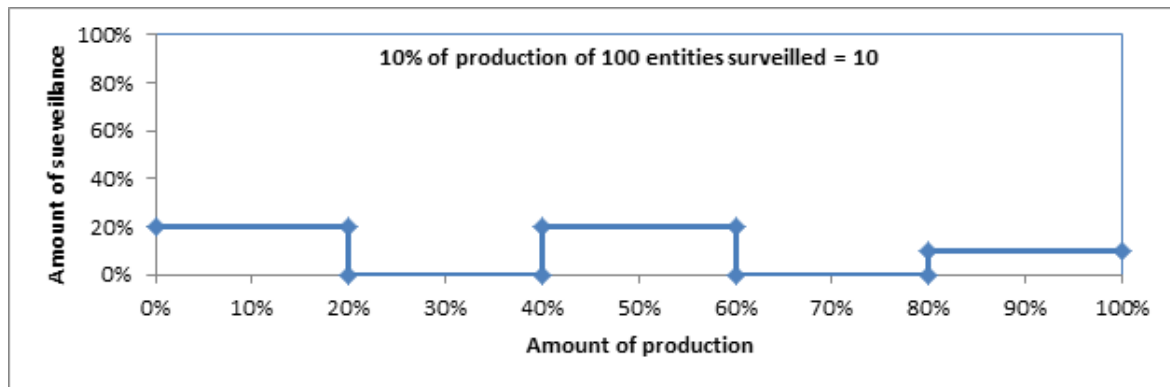


Figure 3-1 Example showing a reduction in surveillance activities

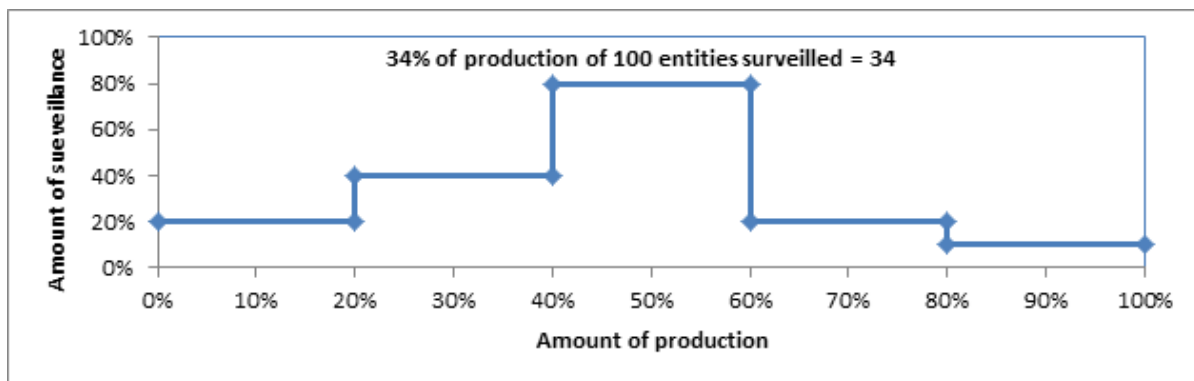


Figure 3-2 Example showing an increase in surveillance activities

DNV GL will initially assume that the average amount of inspection corresponds to inspection of the processes according to the inspection and test plan of 10% of the parts, as shown in the first example, see Figure 3-1. The amount of items to inspect for each part will depend on the inspection and test plan and the individual project.

It is assumed that a serial production is running in all manufacturing workshops subject to inspection such that all witness points in the Inspection and Test Plan for one component can be seen in one visit.

The surveillance shall be based on relevant standards together with design documentation previously submitted to DNV GL as input for the design verification, such as documentation of:

- critical items
- test programs
- inspection and test plan
- approved design drawings and specifications
- qualification of personnel.

Each surveillance is to be completed at the manufacturing premises and the following documentation shall be made available to DNV GL for the surveillance:

- workshop qualification (e.g. workshop approval)
- general arrangement drawings and specifications
- manufacturing drawings, specifications and instructions
- welding procedure specifications and related welding procedure qualification records
- work procedures for NDT and corrosion protection
- inspection check sheets, NDT reports, and measurements reports
- certificates of personnel qualifications (e.g. for NDT testing).

Each surveillance shall be documented in a detailed surveillance report including photo documentation whenever deemed necessary. Permissions required by suppliers shall be provided to DNV GL.

Once the surveillance has been satisfactorily completed, DNV GL will issue a conformity statement for Phase III: Manufacturing wind turbines.

3.3.4.2 Surveillance of wind turbines' components

The type certification of the wind turbine is based on design verification, manufacturing evaluation, evaluation of quality control, testing and measurements. As suppliers for the wind farm project the wind turbine manufacturer and its suppliers of the main components shall operate a quality management system, at least the workshops for casting, welding, and other key processes.

If the quality management system in conformity with ISO 9001 is not available, DNV GL shall evaluate the system. The DNV GL project certification will in addition to this, and in accordance with the IEC 61400-22 requirements, include inspection and audit activities in order to verify that the manufacturing of wind turbines, support structures and foundations for the specific project are carried out according to the approved design and with the intended quality.

The surveillance of the assembly of hub and nacelle shall be completed in the wind turbine manufacturing assembly workshop. The surveillance will be carried out on a random basis and shall be focused on:

- compliance with quality plan requirements
- visual inspection of units under assembly
- visual inspection of electrical installation
- documentation review (components certificates, production worksheets and final documentation).

The following components of a standard wind turbine and the described processes shall in general be subject to manufacturing surveillance in connection with project certification. The list of components and processes to be inspected shall be evaluated for each project under consideration of the wind turbine specific design, e.g. gear box design. If the results of a manufacturing process can be inspected sufficiently in a subsequent process, inspection at the manufacturer for this process is not necessary, e.g. inspection of machined areas for a cast or welded component may be inspected during incoming goods inspection at the assembly workshop. Therefore the list below should be reduced or extended. This shall be agreed at the beginning of the project.

- rotor blades
- rotor hub
- rotor shaft and axle journal
- main bearing
- main bearing housing(s)
- gearbox
- generator
- transformer
- frequency converter
- high-voltage switchgear
- generator structures (direct drive only)

- main and generator frame
- hub assembly
- nacelle assembly.

The manufacturing surveillance will be carried out on a random basis. The extent of surveillance shall be based on a documentation review at the manufacturers' premises, covering the following items:

- compliance with quality plan requirements
- visual inspection of on-going jobs in order to check compliance with documented manufacturing procedures
- test documentation review
- final documentation review.

Guidance note:

Focuses during manufacturing surveillance are the project specific adaptations of a type certified turbine and its components. The manufacturing surveillance is a project specific inspection of a representative quantity of the project ordered components. The availability of a quality management system at the workshop is a prerequisite. Quantities of inspection are adjustable, if reasonable and still representative. The manufacturing sites in projects are often not limited to nor the same as in the type certification. If they are synergies identified, these can be used to reduce efforts, upon agreement and permissions.

In general the sub-sub-suppliers of the wind farm developer will not be inspected, if the documentation is complete and processes at the sub-supplier compliant. However, in practice it happens that the inspection at the sub-supplier is not successful and therefore it could be that an inspection at the sub-sub-supplier can help to sort out the discrepancies.

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Secondary steel (ladders, boat landings, etc.) is not part of the manufacturing surveillance and needs to be agreed in advance.

3.3.4.3 Surveillance of support structure

The support structure for the wind turbine consists of the following components:

- tower
- sub-structure
- foundation.

Separate surveillance of these components will be carried out as outlined in the following.

A tower section manufacturing surveillance shall be carried out for conical or tubular steel towers. The surveillance shall be completed at the manufacturer's shop and will be focused, on a random basis, on:

- compliance with quality plan requirements
- incoming goods inspection
- welding procedures specification
- welders qualification
- construction drawings (shop drawings) versus reviewed drawings (design drawings)
- visual inspection of on-going jobs
- witnessing of non-destructive testing and its documentation
- visual inspection of finished sections before shipping
- documentation review.

Surveillance of monopiles and jacket structures shall be completed at the manufacturers' shops or in the fabrication yard and will be focused, on a random basis, on:

- compliance with quality plan requirements
- incoming goods inspection
- welding procedures specification
- welder qualifications
- construction drawings versus reviewed drawings
- visual inspection of on-going jobs

- corrosion protection systems
- witnessing of non-destructive testing
- visual inspection of finished monopiles before shipping
- documentation review.

Surveillance of concrete structures and foundations shall be completed at the fabrication shop or on the construction site and will be focused, on a random basis, on:

- construction and shop drawings for compliance with design drawings and specifications
- surveillance of measuring and testing equipment
- compliance with the specifications, standards and procedures
- formwork, reinforcing steel, embedment prior to concrete casting
- preparations for casting, use of correct materials, construction joints, grouting of ducts, curing conditions etc.
- material tests
- corrosion protection systems
- repair work
- documentation review.

For other types of support structures, such as suction buckets or lattice towers, a detailed manufacturing surveillance programme will be tailor made for each specific project.

Agreed surveillance of secondary structures shall be completed at the fabrication shop or at the manufacturers' premises. The surveillance will be carried out on a random basis and shall be focused on:

- compliance with quality plan requirements
- welding procedures specification and welding procedures qualification
- welder qualifications
- construction drawings versus reviewed drawings
- visual inspection of on-going jobs
- witnessing of non-destructive testing
- visual inspection of finished structures before shipment
- documentation review.

3.3.5 Phase IV: Transport and installation

3.3.5.1 General

Transportation and installation is a crucial temporary phase in a wind farm project. DNV GL shall perform transportation and installation surveillance as part of the project certification process.

The transportation and installation surveillance shall be followed up by a detailed surveillance report. This surveillance report will include photo documentation whenever deemed necessary. Permissions required by suppliers shall be provided to DNV GL by the developer or contractor.

Prior to the transportation of the first support structure and wind turbine to the wind farm, method statements for transportation and installation manuals including loading and unloading shall be issued for DNV GL review.

Once the transportation and installation surveillance has been satisfactorily completed, DNV GL will issue a conformity statement for Phase IV: Transport and installation wind turbines.

3.3.5.2 Transportation surveillance

The transportation surveillance covers the surveillance of the handling of the goods including laying and fastening.

A DNV GL project certification surveyor shall be present during the first transportation and during one other transportation randomly chosen among the remaining support structures and wind turbines within the wind farm. Further surveillance to be carried out for project certification shall be evaluated by DNV GL for each

specific project.

The surveyor shall focus on the following:

- surveillance of lifting, skidding operations during loading and unloading
- surveillance of welding of fastening to structure.

The surveyor shall perform the tasks deemed necessary to verify compliance with the verification basis, verified design, drawings, specifications and procedures as far as safety is concerned. The surveyor shall ascertain that non-conformities and deviations from the verified design, drawings and procedures are identified, recorded and acted upon.

For offshore projects it has to be considered that marine operations, i.e. operations associated with moving or transporting an offshore structure or parts for the construction, installation or abandonment process, can have a decisive influence on the overall design and on the dimensioning of the offshore wind turbines or their components. The sea transport manual shall cover all relevant procedures and limiting conditions, and shall be approved by DNV GL.

During the surveillance, the surveyor shall focus on the following, if applicable:

- surveillance of structure for damage prior to cutting of fastening
- witnessing of upending and lifting operations.

When welding is performed for transportation, the following shall be subject to inspection:

- surveillance of preparation for welding including correct use of materials, fit up, weather protection
- surveillance of welding performance including adherence to welding procedures, preheating, tack welding, welding, post weld heat treatment, weld repairs
- surveillance of NDT activities including performance of NDT, evaluation of results and of the extent of the NDT.

For bolted connections the focus during the surveillance shall be on:

- surveillance of fit-up
- bolt pre-tensioning.

3.3.5.3 Installation surveillance

A DNV GL surveyor shall be present during installation of the first support structure and wind turbine. Further surveillance to be carried out for project certification shall be evaluated by DNV GL for each specific project. The surveyor shall focus on the following:

- surveillance of lifting, skidding operations during installation
- surveillance of installation and testing of concrete system, if relevant
- surveillance of installation and testing of grouting system, if relevant
- surveillance of other offshore related items such as scour protection, if applicable.

The surveyor shall perform the tasks deemed necessary to verify compliance with the verification basis, verified design, drawings, specifications and procedures as far as safety is concerned. The surveyor shall ascertain that non-conformities and deviations from the verified design, drawings and procedures are identified, recorded and acted upon.

During the surveillance, the surveyor shall focus on the following, if applicable:

- surveillance of the structure for damage during or after the cutting of the sea-fastening
- witnessing of upending and lifting operations for installations
- surveillance of grouting operations and sample taking.

When welding is performed, the following shall be subject to inspection:

- preparation for welding including correct use of materials, fit up, weather protection
- welding performance including adherence to welding procedures, preheating, tack welding, welding,

- post weld heat treatment, weld repairs
- NDT activities including performance of NDT, evaluation of results and of the extent of the NDT.

For bolted connections the focus during the surveillance shall be on:

- surveillance of fit-up
- bolt pre-tensioning.

The final as-built documentation shall be issued for DNV GL review. The review shall focus on items such as the following in order to verify that the design is still sufficient:

- pile driving records
- 28 days grout strength
- general deviations from approved design.

The DNV GL project certification surveyor shall be present during the first installation and during one other installation randomly chosen among the remaining support structures and wind turbines within the wind farm. However, the final number of installations to be attended by the DNV GL project certification surveyor may be larger depending on the project details and the number and types of wind turbines.

Even when DNV GL performs a marine warranty survey, the DNV GL surveyor for project certification shall be present during the loading and installation.

3.3.6 Phase V: Commissioning

3.3.6.1 General

DNV GL shall perform a commissioning surveillance as part of the project certification with the purpose to verify that the wind turbines with their support structures installed on site are commissioned according to the requirements of the manufacturer and in compliance with relevant documentation provided in the design phase.

DNV GL shall attend the commissioning of the first two wind turbines and at least at one wind turbine every 50 wind turbines being installed in the wind farm. The rest of the turbines are to be covered by review of as-built documentation unless identified non-conformities or deviations identified in the initial surveys or in the review of the as-built documentation lead to the conclusion that more surveys need to be performed. However, the final number of wind turbines to be witnessed in commissioning may be larger depending on the project details and the number and types of wind turbines. A larger number can also be agreed, on customer's demand or if it is required by national legislation.

The following documentation shall be made available to the DNV GL surveyors prior to the commencement of the surveillances:

- commissioning procedures
- commissioning checklists.

The commissioning surveillance shall be followed up by a detailed surveillance report. The surveillance report will include photo documentation whenever deemed necessary.

Once the commissioning surveillance has been satisfactorily completed, DNV GL will issue a conformity statement for Phase V: Commissioning wind turbines.

3.3.6.2 Commissioning surveillance

The wind turbine commissioning shall be carried out in accordance with the submitted procedures reviewed and approved by DNV GL in advance of the commissioning.

During commissioning, main systems and equipment shall be checked for compliance with approved documentation and commissioning procedures.

The relevant systems shall be functionally tested, as far as is practicable, in accordance with approved procedures, to confirm proper, safe and functional operation of all devices, controls' and equipment's safe start-up.

The following procedures are to be witnessed by DNV GL or tested in presence of the attending surveyor:

- commissioning procedures supplied by the manufacturer
- starting and stopping routines of the wind turbine in automatic and manual mode
- checking of the control system software version and settings
- function test of all components of the protection system
- safe shutdown
- safe emergency shutdown
- safe shutdown from over-speed or a representative simulation of such shutdown
- automatic start-up and operation of wind turbine.

The final commissioning reports for all wind turbines or a representative no., which will be selected on random basis or project specific needs, shall be complete and submitted to DNV GL.

3.3.7 Phase VI: In-service

3.3.7.1 General

The in-service phase implies an activity by which the wind turbines, the support structures and other installations are monitored regularly during their entire operational life. DNV GL or other acknowledged in-service inspectors shall conduct periodic in-service surveillance. The in-service surveillance results shall be evaluated to verify that the required standards are observed and maintained. The in-service phase serves to confirm the validity of the project certificate, see [2.5].

Prior to the initiation of surveillance activities, a maintenance, repair and inspection programme shall be developed and submitted to DNV GL for approval. The programme shall serve as a reference for parties involved in maintenance and repair carried out at the wind turbines and their support structures. The maintenance, repair and inspection programme shall be updated as required based on findings and deviations. Any update of the programme shall be subject to DNV GL approval.

In general the inspection and maintenance plan(s) required during the design phase (see [3.3.3.8]) shall be taken into consideration.

Once the verification of the in-service surveillance has been successfully completed, DNV GL will issue a conformity statement for Phase VI: In-service wind turbines that confirms validity of the project certificate.

3.3.7.2 In-service surveillance

The scope of work shall include a detailed project-specific plan that identifies the surveillance activities required, the surveillance intervals, the number of wind turbines to be monitored and the reporting requirements. The interval between surveillance will depend on the wind turbine type and on the knowledge built up during the previous phases of the certification process. The first surveillance after commissioning of the wind turbines will usually take place after one year. The scope will include assessment of the status regarding any outstanding issues from the previous surveillance. DNV-OS-J101 provides some guidance regarding inspection plans of wind turbine structures to be inspected during periodic surveillance.

The surveillance report shall highlight any findings or deviations reported during the periodic in-service surveillance. Major findings and deviations shall be reported to the customer in terms of recommendations.

The DNV GL periodic in-service phase shall be carried out to provide evidence as to whether the surveyed installation or parts thereof continue to comply with the approved design. Prior to the surveillance the status of outstanding issues as well as information on all revisions made to the maintenance procedure within the latest year shall be submitted to DNV GL.

As a part of the periodic in-service surveillance, records of maintenance and repairs carried out since the previous surveillance will be reviewed and verified against the program. The company responsible for the maintenance and repairs shall be subject to audits in order to verify the documentation for work carried out. The review shall include:

- follow-up of outstanding issues from the previous surveillance and status regarding recommendations
- review of revised procedures
- review of maintenance documentation

- review of maintenance history in the file or any digital registration.

The surveillance conducted offshore may in general include:

- preparation of the offshore program, based on findings from the onshore part and systems, if applicable
- verification that installed hardware and software components are in compliance with type certification requirements
- verification that repair and maintenance according to approved programme and manufacturer's recommendations were conducted
- general surveillance and test of selected systems and components
- subsea inspections of structures and cables.

3.3.7.3 Wind turbines

Periodic surveillances of a number of wind turbines and those parts of their support structures that are located above water are required in order to verify compliance with the approved design. The surveillance shall comprise relevant systems of the wind turbines' installations such as:

- rotor including blades and hub assembly
- mechanical transmission including gear boxes
- nacelle structure and connections
- generators, converters and transformers
- control and protection systems
- electrical systems
- lifting applications
- personnel safety installations.

The surveillance of the systems listed above shall focus on the following items:

- fatigue cracks
- dents and deformation(s)
- bolt pre-tension
- status on outstanding points from previous surveillance
- settings and parameters used by the control system
- cooling media for transformer and generator if applicable
- lubrication where applicable
- test of the control and protection system (witness tests carried out by the operator)
- condition monitoring system
- additional surveillance identified based on findings and deviations, e.g. witnessing of tests and inspections in order to distinguish between random and systematic failures.

3.3.7.4 Submerged structures

The support structure below water shall be subject to periodic surveillances in order to verify compliance with approved design. The subsea inspections shall be initiated by the owner, operator or assigned contractors, and they will be performed by a remotely operated vehicle and/or by divers in accordance with the approved maintenance, repair and inspection programme. A DNV GL expert or other acknowledged in-service inspectors shall witness these inspections.

The subsea inspection shall as a part of the surveillance be monitored by a DNV GL or other acknowledged in-service surveyor in order to monitor the condition of:

- support structure below water including foundation
- access platforms
- J-tubes
- ladders
- fenders

- corrosion protection systems

with a view to the following issues:

- marine growth
- cracks and deformations
- scour protection
- dents
- bolt pretension
- status of outstanding issues from previous surveillance.

Before the inspection the structure shall be cleaned if the marine growth limits that have been assumed in the load calculations are exceeded or likely to be exceeded. Inspection intervals of submerged parts should not exceed 5 years. It is recommended to make more frequent inspections during the first five years or if the design limits are likely to be exceeded.

3.4 Project certificate substation

3.4.1 General

The certification requirements in IEC 61400-22 consider substations as “other installations”, for which a general recommendation is made. The substations consist of the topside including equipment and the support structure.

This section provides DNV GL’s verification activities for each of the phases of the DNV GL project certification system according to IEC 61400-22 for the asset that consists of the substations. The following types of substations and their support structures are covered:

- high voltage AC (transformer) platforms
- high voltage DC (converter) platforms
- associated accommodation platforms.

Wherever the service for substations is identical to the service for wind turbines and their support structures, reference is made to the service descriptions in the relevant parts of [3.3].

The following standards are applicable, and in compliance with IEC 61400-22 for substations:

- DNV-OS-J201: *Offshore Substations for Wind Farms*
- GL-IV-7: *Rules for the Certification and Construction - Industrial Services - Offshore Substations.*

A combination of both codes is not acceptable without further detailed analysis.

In general this section of this service specification and the references made above focus on offshore substations, however, the procedural principle and safety philosophy is applicable to onshore installations as well, and shall be agreed with DNV GL in advance. As example IEC 61936-1 for the power installation is applicable for both. The structural verification may be dependent on further or other local codes.

Once the verification of the design basis, design, manufacturing, transport and installation and commissioning for the asset substation and its support structure has been successfully completed and the final evaluation has been performed, DNV GL will issue a project certificate Substation.

3.4.2 Phase I: Design basis

The purpose of the design basis verification is to evaluate if the site conditions and the basis for design, including general specifications, criteria, parameters, design approach and other assumptions relevant for design are properly established and documented and that this design basis is sufficient for a safe design of the substation (see [1.6.4]).

DNV GL’s verification activities are based on the formerly agreed standard DNV-OS-J201 or GL-IV-7.

A design basis shall be provided to DNV GL that includes documentation of the following:

- a) site conditions
- b) standards, codes and requirements
- c) design criteria
- d) transport, installation and commissioning requirements
- e) operation and maintenance requirements.

DNV GL shall verify the design basis for compliance with DNV-OS-J201 or GL-IV-7 and other standards and codes identified in the design basis.

Once the verification of the design basis has been successfully completed, DNV GL will issue a conformity statement for Phase I: Design basis substation.

3.4.2.1 Site conditions

DNV GL shall evaluate the establishment of site conditions detailed in IEC 61400-22 and, respectively, IEC 61400-1 for onshore and IEC 61400-3, DNV-OS-J201 or GL-IV-7 for offshore application, based on reported data and/or applicable standards or methods valid for the site.

[3.3.2.1] specifies which site conditions shall be addressed in the design basis and provides details about DNV GL's services for verification of the site conditions.

In addition to verification of the external site conditions addressed in [3.3.2.1], the operating conditions for components and equipment operated in an "air-conditioned" environment shall be addressed and will be subject to verification.

3.4.2.2 Design criteria

The design of the integrated structure of the substation shall be based on the specific site conditions as well as the methods and principles given in DNV-OS-J201 or GL-IV-7.

Design criteria shall be specified in accordance with DNV-OS-J201 or GL-IV-7. This applies to the different engineering disciplines including:

- structural design
- electrical design
- fire and explosion protection
- access and transfer design
- emergency response
- construction
- in-service inspections and maintenance.

The documentation for the individual engineering disciplines shall include the following:

- safety philosophy
- main design methodology
- design aspects and design parameters.

For verification of the design basis, DNV GL shall adhere to the specifications given in [3.3.2.2] as applicable.

3.4.2.3 Manufacturing, transport, installation and commissioning

The design basis shall state assumptions, specifications and requirements for structural design against loads occurring during manufacturing, transportation, installation and commissioning, such as environmental loads, loading, unloading and lifting loads, and local loads from temporary supports. The design basis shall also state assumptions, specifications and requirements for the manufacturing, transportation, installation and commissioning programmes themselves.

Assumptions, specifications and requirements may include, but are not necessarily limited to:

- standards, codes and additional requirements, see [1.6.4]
- specifications and tolerances
- limiting environmental conditions

- manufacturing requirements and quality management systems
- methods and loads of relevance for transportation and installation
- requirements for transportation, installation (incl. loading and unloading) and commissioning manuals
- quality management systems for the installation contractors.

DNV GL shall verify assumptions, specification and requirements stated in the design basis.

3.4.2.4 Operation and maintenance

The design basis shall state assumptions, specifications and requirements for structural design against loads occurring during operation and maintenance. The design basis shall also state assumptions, specifications and requirements for the operation and maintenance programmes.

Assumptions, specifications and requirements to be stated include, but are not necessarily limited to:

- inspection scope and frequency
- target lifetime of components, systems and structures
- requirements for service and maintenance manuals
- requirements for condition monitoring systems.

DNV GL shall verify assumptions, specification and requirements stated in the design basis.

3.4.3 Phase II: Design

3.4.3.1 General

DNV GL shall verify the final design for compliance with DNV-OS-J201 or GL-IV-7 and other standards and codes identified in the design basis. Details of the verification activities in this phase are given in the following sub-sections.

Once the verification of the final design has been successfully completed, DNV GL will issue a conformity statement for Phase II: Design Substation.

3.4.3.2 Structural design and geotechnical design

The verification of the design of the substation topside and the support structure shall be based on loads, capacities, design methods and principles specified in the approved design basis and in relevant DNV GL standards, e.g. DNV-OS-J201, DNV-OS-C101, DNV-OS-C502 and GL-IV-7. For areas where the approved design basis or the DNV GL standards do not apply, reference to a recognized standard or design method may be accepted by DNV GL.

The structural design verification shall include:

- loads and load combinations
- geotechnical design
- design of primary structure
- design of secondary structures
- topside arrangement
- transportation, installation, operation and maintenance
- grout design, if applicable
- connections.

For geotechnical design of foundations reference is made to DNV-OS-C101 and CN No. 30.4. Guidance for prediction of scour and for means to prevent scour is given in DNV-OS-J101. The purpose of a soil investigation is to provide a range of strength and deformation parameters with sufficient accuracy. Additionally the investigations shall supply information to evaluate deterioration from dynamic loads in sufficient detail. The investigations should be focused on the actual phase of the project with respect to extent, details and accuracy.

The following design reports and drawings shall be submitted to DNV GL for verification of the final structural and geotechnical design of the substation topside and the support structure:

- design documentation for the structural and geotechnical design calculations for ULS, SLS, FLS and ALS
- design calculation shall cover transportation and installation as well as operational conditions
- assumptions made for the calculations, for example regarding manufacturing and installation methods
- design report(s) containing design calculations for corrosion protection system(s)
- design report for the driveability study (if applicable)
- design drawings including general note drawing(s)
- design documentation regarding scour and scour protection design.

The loads on the substation topside and the support structure may comprise the following loads and load combinations:

- dead weight of structures and appurtenances
- dead weight and variable loads from equipment
- live loads
- environmental loads, for example from wind, waves and ice
- accidental loads, for example from ship collisions and dropped objects.

The principles used to establish load combinations for SLS, ULS, FLS and ALS shall be reviewed for compliance with the relevant DNV GL standards. The load combinations for the substation topside and the support structure shall be reviewed with a focus on:

- selection of load combinations
- selection of load factors and load reduction factors
- calculation results.

The verification of the geotechnical design for the substation shall focus on:

- evaluation of calculation methods, stability and failure modes
- review of geotechnical design calculations for ULS, SLS and ALS
- review of design documentation regarding soil preparation, tolerances and scour protection
- stiffness and damping of the support structure.

The consideration of accidental limit state (ALS) is optional according IEC 61400-3, however it is recommended to consider relevant ALS for the design of primary structures and DNV-OS-J201 or GL-IV-2 should be applied.

3.4.3.3 Primary structures

The verification of the structural design of the primary structures (see [3.3.3.4]) in topside and support structure shall focus on:

- design methodology, safety level and materials
- review of design calculations for ULS, SLS, FLS and ALS
- eigenfrequency and vortex shedding analyses
- manufacturing and installation methods, with respect to the structural integrity of the final installed (permanent) structure
- corrosion protection system(s) with respect to issues such as design life and maintenance as required in codes and standards
- design drawings and manufacturing specifications with respect to requirements in codes and standards as well as assumptions in calculations with respect to issues such as dimensions, materials, tolerances and testing.

Fatigue design documents shall be based on DNV-OS-J201 or GL-IV-7 considering ISO 19902. A combination of these standards with regard to design fatigue factors and S/N-curves is not acceptable.

The following verification activities are conducted:

- review of detailed design calculation reports, design drawings and manufacturing specifications for

- detailed structural design of the support structure
- relevant independent analyses of loads and structural strength, see [3.3.3.1].

The verification may include independent analyses of the structure using appropriate methods, such as FEM analyses, and covers:

- structural strength (stress levels, buckling and joint check)
- soil stiffness and soil capacity
- fatigue life.

If the design includes highly utilized structural connections (e.g. grouted connections of steel structures and tubular joints), detailed independent finite element calculations of the connections shall have to be carried out by DNV GL. Such analysis will be described in an independent scope of work.

3.4.3.4 Secondary structures

The verification of the structural design of secondary structures (see [3.3.3.5]) in the topside and the support structure shall be verified with focus on:

- design methodology and safety level
- materials
- review of design calculations for ULS, SLS and ALS
- corrosion protection system(s) with respect to issues such as design life and maintenance as required in codes and standards
- design drawings and manufacturing specifications with respect to requirements in codes and standards.

3.4.3.5 Electrical design

The electrical design shall be assessed for compliance with the DNV-OS-J201 or GL-IV-7 and further standards, codes and requirements specified in the design basis. The focus of the verification shall be on the safety of the installations as defined in the approved design basis. The verification will be carried out by spot checks of the documentation in the form of diagrams, specifications and calculations of distribution system.

The electrical design review shall include:

- main components design (main transformer, switchgear, cables and, if applicable, semiconductor converter)
- arrangement of components, with regard to safety
- electrical protection
- earthing and equipotential bonding
- cabling and termination
- station and emergency power supply.

The following documentation for the electrical system shall be submitted for verification:

- operational philosophy
- essential design studies (e.g. insulation coordination, short-circuit calculations)
- single line diagrams including identification of components
- data sheets and test records for major electrical equipment
- lightning protection, system earthing and bonding principles.

The following documentation for cabling shall be submitted for verification:

- cable rating and selection
- cable routing sketch
- cable data sheets or type lists, including information on fire properties and certificate references
- cable schedules.

Specific studies for which documentation shall be made available may include:

- short-circuit studies
- discrimination study
- load schedule on emergency power systems
- protection coordination and setting.

The verification activities shall include review of the following:

- high-voltage / power equipment safety
- control and protection system design
- main components (main transformer, converter, switchgear) utilization and protection
- emergency generation capabilities
- platform marking, identification, lighting and instrumentation
- heating/ventilation/air conditioning, as well as corrosion protection measures.

Optionally the electrical performance of the substation connected to wind farm and grid can be reviewed by analysis, see [3.6.3].

3.4.3.6 Fire and explosion protection design

Verification of the fire and explosion protection design shall be based on applicable standards, i.e. DNV-OS-J201 or GL-IV-7 and country-specific regulations.

The following documentation shall be submitted to DNV GL for verification as applicable:

- fire protection philosophy and specification
- fire zone layout
- general arrangement of all rooms showing fire insulation and draught stops
- fire integrity of walls and decks; insulation material specification and position; deck and surface coverings material specification and positions
- penetrations of cables and pipes through fire walls, details of fire dampers
- ventilation system layout including dimensions and penetrations of ducts through fire divisions
- fire pumps, fire mains, hydrants and hoses, deluge, sprinkler and spray systems, and other active fire protection systems
- fixed fire detection and alarm systems in accommodation spaces, machinery spaces, and product storage spaces; specification and location of detectors, equipment alarms and call points; wiring diagrams.

The documentation submitted to DNV GL for verification shall in addition address the following topics:

- nature and risks of potential fires and explosions
- quantities of fluids, flammable and combustible materials handled, processed and stored on the substation
- manning philosophy and human factors.

In the context of fires and explosions, the results of the evaluation process and the decisions taken with respect to the need for, and role of, any risk reduction measures (the “fire and explosion strategy”) shall be reviewed for verification.

Guidance note:

Complex substations are likely to require detailed studies to address hazardous fire and explosion events. Simple substations may rely on application of recognized codes and standards. The fire and explosion strategy should describe the role and functional requirements for each of the systems used to manage possible hazardous events on the substation.

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---

As for functional requirements, the following shall be reviewed for verification:

- purpose and duty of a particular system
- integrity, reliability and availability of the system

- survivability of the system and dependency on other systems.

Deck layout and firefighting measures shall be checked for compliance with applicable regulations.

For substations featuring an accommodation module, specific verifications to assure compliance with applicable regulations shall be carried out.

3.4.3.7 Access and transfer design

Verification of the access and transfer design shall be based on applicable standards such as DNV-OS-J201 or GL-IV-7, and country-specific state regulations.

The following documentation shall be submitted for verification:

- boat landing documentation
- helicopter deck documentation (if applicable)
- helicopter winching area documentation (if applicable)
- details of area and deck-to-deck access.

The design of the boat fender system shall be verified as part of the structural design review.

Verification of the design of the helicopter deck is optional. A specific scope shall be agreed.

Layout of stairs and ladders shall be verified as part of the emergency response design.

3.4.3.8 Emergency response design

Verification of the emergency response design shall be based on applicable standards as specified in the design basis, e.g. DNV-OS-J201, GL-IV-7 and country-specific regulations.

The following documentation shall be submitted for verification:

- safety philosophy and design principles
- platform arrangement
- orientation, fire and safety plans.

The documentation submitted to DNV GL for verification shall in addition address the following topics:

- environmental conditions
- distance to the nearest installation, to shore and to coastal facilities
- number and distribution of personnel
- effect of time of day on emergency response
- immediate effects of an incident on the installation and people
- development of heat and smoke in the event of fire
- capacity for treatment at available medical facilities.

The verification of the emergency response design shall include an assessment of the proposed emergency response measures, comprising an analysis of performance of the measures and a judgement of their adequacy. Platform layout and safety systems shall be evaluated with regard to hazard identification and safety for humans, the environment and the asset considering:

- alarms and communications
- shutdown
- escape routes and muster areas
- evacuation, rescue and recovery.

For the assessment of the selection of emergency response equipment, the following issues shall be considered:

- location
- type
- number

- capacity
- accessibility and survivability under emergency conditions
- reliability and/or availability
- maintenance, usability and training requirements.

Changes on the installation or changes of the external situation that may affect the emergency response procedures shall also be part of the assessment. Such changes in particular include:

- potential emergency scenarios
- emergency response equipment
- emergency response organization
- emergency response procedures
- staff experience
- research results and new knowledge
- changes in statutory legislation.

3.4.3.9 Manufacturing, transport, installation and commissioning plan

Verification of the manufacturing, transportation, installation (incl. loading and unloading, such as lifting loads) and commissioning processes shall be based on applicable standards, e.g. DNV-OS-J201, GL-IV-7 and country-specific regulations.

The overall DNV GL aim is to verify that the final structure in-situ has not been exposed to unforeseen loading during manufacturing, transportation, installation and commissioning. Exposure to fatigue loading during transportation may be of relevance.

The following documentation shall be submitted for verification:

- description of concepts and procedures
- method statements for transfer operations (i.e. loading and unloading, float-out, lift-off and mating)
- installation and commissioning manual including emergency procedures.

The documentation shall be evaluated and verified for compliance with the approved design basis including:

- manufacturing and goods handling processes
- review of transportation and installation requirements (goods loading, loadout, sea transportation, offshore lifting and installation)
- essential installation procedures
- essential commissioning procedures
- procedures for safe shutdown
- personnel safety.

Normally the different manuals will not all be finalised at the design stage. However, at the design phase the design influencing assumptions shall be documented by the respective manuals, at least. The final site-specific substation manuals will be reviewed during the transport, installation and commissioning phase, see [3.4.5] and [3.4.6]. However, the relevant temporary situations shall be considered in the design phase.

3.4.3.10 In-service plan

DNV GL shall require that relevant input to the inspection and maintenance plans shall be prepared. The input to the inspection plan and the maintenance manual shall be seen as a help to the operations and maintenance organization that normally will be established later. Examples of issues to be covered are inspections and checks of the scour protection system and the corrosion protection system, assumed service vessel(s), and inspections for fatigue cracks if relevant.

Verification of the operation and maintenance programme shall be based on applicable standards such as DNV-OS-J201 or GL-IV-7 and industry best practice.

The following documentation shall be submitted for verification:

- description of risk based inspection and maintenance programmes, covering inspection, scheduled maintenance and unscheduled maintenance
- service and maintenance manual for key components.

The documentation shall be evaluated and verified for compliance with the approved design basis regarding scope and intervals of the following:

- operational monitoring and condition monitoring
- safety related inspection and maintenance
- scheduled maintenance
- unscheduled maintenance provisions
- record keeping and quality control.

It is strongly recommended that the designer during his design work prepares a report that states all assumptions made in design and that this report is used as input to the development of the operation and maintenance plan.

The above mentioned documentation may not be finalised during the design phase and the verification of this documentation will therefore be covered in the installation phase. However, at the design phase the design influencing assumptions shall be documented, at least.

3.4.4 Phase III: Manufacturing

3.4.4.1 General

The aim of the manufacturing surveillance is to check the compliance with the applicable rules and standards, verify compliance with approved drawings and check that the substation is being built to the intended quality.

The manufacturing surveillance shall be conducted at the fabrication yard and will include:

- evaluation of manufacturing
- evaluation of quality management system, if an ISO 9001 certificate is not available
- product related quality audits
- surveillance of contractor's quality assurance activities
- periodical surveillances.

Manufacturing surveillance consists of (initial) audits and component inspections related to the particular project. The surveillance activities comprise both on-site inspections and document review.

The purpose of the (initial) audit is to check the qualification (ability to perform the production of relevant components according to the assumed quality and to document this ability) of the manufacturing company prior to commencement of production and to check the documentation forming the basis for production.

The detailed scope of the inspections will be developed based on the results of the audits, which may result in a reduction of inspections to be performed. Complementary to the inspection the manufacturing records are reviewed.

The scope of the manufacturing surveillance of the topside structure, topside equipment and support structure is detailed in [3.4.4.2] to [3.4.4.4].

The extent of the inspections and the number of occasions when surveillance has to be carried out for project certification shall be evaluated by DNV GL for each specific project. In the event that the manufacturer does not hold a valid ISO 9001 certificate, the audits to be completed by DNV GL may be increased to evaluate the quality management system. The minimum requirement for surveillance is detailed in [3.4.4.2] to [3.4.4.4].

The surveillance shall be based on relevant standards, such as DNV-OS-J201, GL-IV-7 and DNV-OS-C401, and on design documentation previously submitted to DNV GL as input for the design verifications, such as documentation of:

- critical items

- test programs
- inspection and test plan
- approved design drawings and specifications
- qualification of personnel.

The surveillance shall be completed at the fabrication yard(s) or the manufacturers' premises and the following documentation shall be made available to the DNV GL surveyor:

- general arrangement drawings and specifications
- manufacturing drawings, specifications and instructions
- welding procedure specifications and related welding procedure qualification records
- work procedures for NDT and corrosion protection
- inspection check sheets, NDT reports, and measurements reports
- certificates of personnel qualifications (e.g for NDT testing).

Each surveillance shall be followed by a detailed surveillance report including photo documentation whenever deemed necessary. Permissions required by suppliers shall be provided to DNV GL by the developer or contractor.

Once the surveillance has been satisfactorily completed, DNV GL will issue a conformity statement for Phase III: Manufacturing substation.

3.4.4.2 Topside structure

Depending on the number of manufacturing sites five to ten surveillance visits to the manufacturer's workshop or shipyard are considered as the minimum number of surveillances to be completed by DNV GL. The surveillance shall be focused on:

- compliance with quality plan requirements
- welding procedures specification and welding procedures qualification
- welder qualifications
- construction drawings versus reviewed drawings
- visual inspection of on-going jobs
- witnessing of non-destructive testing
- visual inspection of finished sections before shipping
- documentation review.

3.4.4.3 Topside equipment

Electrical equipment is part of the project certification substation and therefore manufacturing surveillance of such topside equipment is necessary for certification of the substation.

For topside equipment, the following documentation shall be submitted to DNV GL for the verification of the manufacturing activities:

- general arrangement drawings and specifications
- manufacturing drawings, specifications and instructions.

For other topside equipment, the following documentation, in addition to the above mentioned shall be submitted to DNV GL for the verification of the manufacturing activities:

- fire-fighting, life-saving and escape-route general drawings
- layout and arrangement of the topside equipment and systems.

Three surveillance visits to the topside assembly workshop or shipyard are considered as the minimum number of surveillances to be completed by DNV GL. Two additional surveillance visits may be necessary for testing purposes. Surveillance shall be focused on:

- fire insulation
- fire-fighting appliances

- fire detection
- escape routes
- life-saving arrangement and equipment
- electrical systems with voltage up to 440V.

3.4.4.4 Support structure

The surveillance shall be completed in accordance with specifications given in relevant parts of [3.3.4.3].

Depending on the number of manufacturing sites five to ten surveillance visits are considered as the minimum number to be completed by DNV GL, but a specific agreement shall be established in each case. For support structure concepts and manufacturers that DNV GL is familiar with, this minimum number of surveillance visits may apply. For other types of support structures, such as concrete structures, and for manufacturers that DNV GL is unfamiliar with, the number of surveillance visits shall be agreed for each project on a case-by-case basis.

3.4.5 Phase IV: Transport and installation

3.4.5.1 General

Transportation and installation is a crucial temporary phase in a wind farm project. DNV GL shall perform transportation and installation surveillance as part of the project certification process.

The transportation and installation surveillance shall be followed up by a detailed surveillance report. This surveillance report will include photo documentation whenever deemed necessary. Permissions required by suppliers shall be provided to DNV GL by the developer or contractor.

Prior to the transportation of the first support structure and topside or substation to the wind farm, method statements for transportation and installation manuals including loading and unloading shall be issued for DNV GL review.

Once the transportation and installation surveillance has been satisfactorily completed, DNV GL will issue a conformity statement for Phase IV: Transport and installation substation.

3.4.5.2 Transportation surveillance

The transportation surveillance covers the surveillance of the handling of the goods including laying and fastening.

A DNV GL surveyor shall be present during handling of the substation and support structure.

The surveyor shall focus on the following:

- surveillance of lifting, skidding operations during loading and unloading
- surveillance of welding of fastening to structure.

The surveyor shall perform the tasks deemed necessary to verify compliance with the verification basis, verified design, drawings, specifications and procedures as far as safety is concerned. The surveyor shall ascertain that non-conformities and deviations from the verified design, drawings and procedures are identified, recorded and acted upon.

For offshore projects it has to be considered that marine operations, i.e. operations associated with moving or transporting an offshore structure or parts for construction, installation or abandonment process, can have decisive influence on the overall design and on the dimensioning of the offshore sub-station or its components. The sea transport manual shall cover all relevant procedures and limiting conditions and shall be approved by DNV GL.

During the surveillance, the surveyor shall focus on the following, if applicable:

- surveillance of structure for damage prior to cutting of fastening
- witnessing of upending and lifting operations.

When welding is performed, the following shall be subject to inspection:

- surveillance of preparation for welding including correct use of materials, fit up, weather protection

- surveillance of welding performance including adherence to welding procedures, preheating, tack welding, welding, post weld heat treatment, weld repairs
- surveillance of NDT activities including performance of NDT, evaluation of results and of the extent of the NDT.

For bolted connections the focus during the surveillance shall be on:

- surveillance of fit-up
- bolt pre-tensioning.

3.4.5.3 Installation surveillance

Prior to the installation of the substation and its support structure, installation manuals (incl. loading and unloading) shall be issued for DNV GL review.

A DNV GL surveyor shall be present during installation of the substation and support structure. The surveyor shall focus on the following:

- surveillance of lifting, skidding operations during installation
- surveillance of installation and testing of grouting system, if relevant
- surveillance of other offshore related items such as scour protection, if applicable.

The surveyor shall perform the tasks deemed necessary to verify compliance with the verification basis, verified design, drawings, specifications and procedures as far as safety is concerned. The surveyor shall ascertain that non-conformities and deviations from the verified design, drawings and procedures are identified, recorded and acted upon.

During the surveillance, the surveyor shall focus on the following (if applicable):

- surveillance of the structure for damage during or after cutting of sea-fastening
- witnessing of upending and lifting operations for installations
- surveillance of grouting operations and sample taking.

When welding is performed, the following shall be subject to inspection:

- preparation for welding including correct use of materials, fit up, weather protection
- welding performance including adherence to welding procedures, preheating, tack welding, welding, post weld heat treatment, weld repairs
- NDT activities including performance of NDT, evaluation of results and of the extent of the NDT.

For bolted connections the focus during the surveillance shall be on:

- fit-up
- bolt pre-tensioning.

The final as-built documentation shall be issued for DNV GL review. The review shall focus on items such as

- pile driving records
- 28 days grout strength
- general deviations from approved design

in order to verify that the design is still sufficient.

The DNV GL project certification surveyor shall be present during the installation of the substation and its support structure. The extent of the surveillance depends on the project details and complexity of the substation and support structure.

Even when DNV GL performs a marine warranty survey, the DNV GL surveyor for project certification shall be present during the loading and installation.

3.4.6 Phase V: Commissioning

3.4.6.1 General

DNV GL shall perform a commissioning surveillance as part of the project certification with the purpose to verify that the substation with the support structure installed on site are commissioned according to the requirements of the manufacturer and in compliance with relevant documentation provided in the design phase.

DNV GL shall attend the commissioning of the substation. The following documentation shall be made available to the DNV GL surveyors prior to the commencement of the surveillance:

- commissioning procedures
- commissioning checklist.

The commissioning surveillance shall be followed up by a detailed surveillance report. The surveillance report will include photo documentation whenever deemed necessary. Permissions required by suppliers shall be provided to DNV GL by the developer or contractor.

Once the commissioning surveillance has been satisfactorily completed, DNV GL will issue a conformity statement for Phase V: Commissioning Substation.

3.4.6.2 Commissioning surveillance

Commissioning of the topside equipment shall be in accordance with the submitted procedures reviewed and approved by DNV GL in advance of the commissioning.

Most of the commissioning and testing review shall be performed at the manufacturer's workshop or in the yard, see [3.4.4.2]. To the extent that this review is supplemented by a commissioning surveillance during commissioning, main systems and equipment shall be checked for compliance with approved documentation and commissioning procedures. The relevant systems shall be functionally tested in presence of DNV GL's attending surveyor, to the extent practicable and in accordance with approved procedures, to confirm proper, safe and functional operation of all devices, controls and equipment safe start-up.

When a commissioning surveillance is carried out, the following items shall be witnessed by DNV GL or shall be tested in the presence of the attending surveyor:

- checking of the control system settings
- function test of protection system
- safe shutdown
- running tests of relevant systems
- review of remedial work on structure and equipment.

The final commissioning reports shall be complete and submitted to DNV GL.

3.4.7 Phase VI: In-service

3.4.7.1 General

The in-service phase implies an activity by which the substation, support structure, J-tubes and cables are surveyed regularly during their entire operational life. DNV GL or other acknowledged in-service inspectors shall conduct periodic in-service surveillance. The in-service surveillance results shall be evaluated to verify that the required standards are observed and maintained. The in-service phase serves to confirm the validity of the project certificate, see [2.5].

Prior to the initiation of surveillance, a maintenance, repair and inspection programme shall be developed and submitted to DNV GL for approval. The programme shall serve as a reference for parties involved in maintenance and repair carried out at the substation(s). The maintenance, repair and inspection programme shall be updated as required based on findings and deviations. Any update of the programme shall be subject to DNV GL approval.

In general the operation and maintenance plan required during the design phase (see [3.4.2.4]) shall be taken into consideration.

Once the verification of the in-service surveillance has been successfully completed, DNV GL will issue a conformity statement for Phase VI: In-service substation that confirms validity of the project certificate.

3.4.7.2 In-service surveillance

The scope of work shall include a detailed project-specific plan that identifies the surveillance activities required, the surveillance intervals and the reporting requirements. The surveillance interval will depend on the knowledge built up during the previous phases of the certification process. The first surveillance after commissioning will usually take place after one year. The scope will include assessment of the status regarding any outstanding issues from the previous surveillance. DNV-OS-J201 provides guidance regarding in-service inspection and maintenance of substations to be inspected during periodic surveillance.

The surveillance reports shall highlight any findings or deviations reported during the periodic in-service surveillance. Major findings and deviations shall be reported to the customer in terms of recommendations.

The DNV GL periodic in-service phase shall be carried out to provide evidence as to whether the surveyed installation or parts thereof continue to comply with the approved design. Prior to the surveillance the status of outstanding issues as well as information on all revisions made to the maintenance procedure within the latest year shall be submitted to DNV GL.

As a part of the periodic surveillance, records of maintenance and repairs carried out since the previous surveillance shall be reviewed and verified against the program. The company responsible for the maintenance and repairs shall be subject to audits in order to verify the documentation for work carried out. The review shall include:

- follow-up of outstanding issues from the previous surveillance and status regarding recommendations
- review of revised procedures
- review of maintenance documentation
- review of maintenance history in the file or any digital registration.

The surveillance conducted offshore may in general include:

- preparation of the offshore program, based on findings from the onshore part and systems, if applicable
- verification that installed components are in compliance with certification requirements
- verification that repair and maintenance according to approved programme and manufacturer's recommendations are conducted
- general surveillance and test of selected systems and components
- subsea inspections of structures and cables.

Components recommended for consideration during in-service surveillance of the substation and its support structures, equipment and cables are given in the following sub-sections.

3.4.7.3 Substation

Periodic surveillance of the substation and the part of its support structure above water are required in order to verify compliance with the approved design. The surveillance of the substations' installation shall involve such as:

- general surveillance of the topside and support structures
- fire-fighting equipment and systems by visual inspection and test
- life-saving appliances by visual inspection and test
- electrical systems such as generators, converters and transformers
- control and protection systems
- lifting applications
- personnel safety installations
- selected systems and components by general inspection and test.

The surveillance of the systems listed above shall focus on the following items:

- fatigue cracks

- dents and deformation(s)
- bolt pre-tension
- status of outstanding points from previous surveillance
- settings and parameters used by the control system
- cooling media for transformer and generator if applicable
- test of the control and protection system (witness tests carried out by the operator)
- additional surveillance identified based on findings and deviations, e.g. witnessing of tests and inspections in order to distinguish between random and systematic failures.

3.4.7.4 Submerged structures

The support structure below water shall be subject to periodic surveillance in order to verify compliance with approved design. The subsea inspections shall be initiated by the owner, operator or assigned contractors, and they will be performed by a remotely operated vehicle and/or by divers in accordance with the approved maintenance, repair and inspection programme. A DNV GL expert or other acknowledged in-service inspectors shall witness these inspections.

The subsea inspection shall, as a part of the surveillance, be witnessed on a spot check basis by a DNV GL or other acknowledged in-service surveyor in order to monitor the condition of the following structural components:

- support structure below water including foundation
- access platforms
- J-tubes
- ladders
- fenders
- corrosion protection systems.

with a view to the following issues:

- marine growth
- cracks and deformations
- scour protection
- dents
- bolt pretension
- status regarding outstanding issues from previous surveillance.

Before the inspection the structure shall be cleaned if the marine growth limits that have been assumed in the load calculations are exceeded or likely to be exceeded. Inspection intervals of the submerged parts should not exceed 5 years. It is recommended to make more frequent inspections during the first five years, or if the design limits are likely to be exceeded.

3.5 Project certificate power cables

3.5.1 General

This section provides the details of DNV GL's verification activities for each of the phases of the DNV GL Project Certification System according to IEC 61400-22 for the asset power cables.

The power cables comprise cables between the wind turbines and substation and between the substation and the main grid. The export power cable (between the substation and the main grid) can be included in the scope of work optionally which needs to be agreed at the beginning of the project.

The requirements for power cables within IEC 61400-1 for onshore and IEC 61400-3 for offshore are of a general nature and top level electrical standards are referred to.

The certification requirements in IEC 61400-22 consider cables installed outside of wind turbines as "other installations", for which a general recommendation to evaluate the design is made. IEC 61400-1 makes

reference to IEC 60204-1 (low voltage) and IEC 60204-11 (high voltage). Additionally, IEC 61400-3 emphasises adequate electrical protection, e.g. by selection of correct cable rating or class. DNV GL Project Certification for power cables will in addition to this, and in accordance with IEC 61400-22 requirements, include requirements which constitute good practice. Therefore, certification of power cables shall be carried out on the basis of GL-IV-2 (Edition 2012, Section 8.10) in consideration of recommendations given in DNV-RP-J301 and CIGRÉ guidelines. For onshore wind farms and their power cables these standards are transferrable or GL-IV-1 (Edition 2010, Section 8.8) should be applied. Once the verification of the design basis, design, manufacturing, transport and installation and commissioning for the asset power cables has been successfully completed and the final evaluation has been performed, DNV GL will issue a project certificate power cables.

3.5.2 Phase I: Design basis

The purpose of the verification of the design basis is to evaluate if the site conditions and the basis for design including general specifications, criteria, parameters, design approach and other assumptions relevant for design are properly established and documented and that this design basis is sufficient for a safe design and implementation of the power cables in the specific wind farm (see [1.6.4]).

A design basis shall be provided to DNV GL. This design basis shall include documentation of the following and shall be subject to verification:

- standards and requirements for cables and cable route(s)
- site conditions:
 - relevant for offshore subsea power cables and the interface at the turbines (top layer of the seabed), incl. soil types and potential burial requirements, sediment mobility, thermal conductivity, boulders, etc.
 - relevant for onshore / near shore conditions, landfall area, the interface at the turbines (top layer of the soil), incl. soil types and potential burial requirements, thermal conductivity, boulders, etc.
- design criteria
- transport, installation and commissioning requirements
- operation and maintenance requirements
- power cable type(s).

Once the verification of the design basis has been successfully completed, DNV GL will issue a conformity statement for Phase I: Design basis power cables.

3.5.3 Phase II: Design

DNV GL shall verify the final design for compliance with IEC 61400-22 and other standards and requirements identified in the design basis.

For the design the GL-IV-1 (Edition 2010, Section 8.8) or GL-IV-2, (Edition 2012 for submarine cables, see Section 8.10) in consideration of recommendations given in DNV-RP-J301 and CIGRÉ guidelines shall be taken as a basis.

The design documentation for power cabling shall include documentation of the following and shall be subject to verification:

- cable selection philosophy
- cable sizing and specifications, including fire properties – where relevant - and certificate reference, if applicable
- cable specifications, design and testing programme
- cable interface at wind turbine or substation (including J-tubes or similar, if relevant), e.g. arrangements, layout, sizing, forces
- landfall design, if applicable
- cable routing sketch
- cable route risks and burial assessment, including immediate vicinity of the turbine sub-structure, if

relevant

- cable schedules
- cable installation and fixing
- operations and maintenance.

The focus is on the power cable installation parts such as:

- power cores and fibre optic elements
- cable joints
- cable route and protection (includes landfall)
- cable termination systems (interface at turbine / substation)
- hang-off and cable protection
- risers and fixation components.

Guidance note:

DNV GL shall require that relevant input to the inspection and maintenance plan shall be prepared. The input to the inspection plan and the maintenance manual shall be seen as a help to the operations and maintenance organization that normally will be established later. Examples of issues to be covered are inspections and checks of the scour protection system and assumed service vessel, and inspections for cracks if relevant. This documentation may not be available during the design phase and the verification of this documentation will therefore be covered in the installation phase. However, the relevant temporary situations shall be considered in the design phase.

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The designer shall prepare a report that states all assumptions made in design during the design work. This report should be used as input to the development of the inspection and maintenance plan.

Once the verification of the final design has been successfully completed, DNV GL will issue a conformity statement for Phase II: Design power cables.

3.5.4 Phase III: Manufacturing

DNV GL shall conduct manufacturing surveillance in order to verify compliance between the approved design and the product. The surveillance shall be conducted at the manufacturer's facilities and will involve:

- evaluation of critical production steps
- evaluation of quality system
- product related quality audits
- surveillance of contractor's quality assurance activities
- periodic surveillance.

Manufacturing surveillance consists of (initial) audits and project related component inspections. The surveillance activities comprise both on-site inspections and document review.

The purpose of the (initial) audit is to check the qualification (ability to perform the production relevant components according to the assumed quality and to document this ability) of the manufacturing company prior to commencement of production and to check the documentation forming the basis for production.

The detailed scope of the inspections will be developed based on the results of the audits, which may result in a reduction of inspections to be performed. Complementary to the inspection the manufacturing records are reviewed.

The customer shall ensure that DNV GL obtains access to the relevant manufacturing and assembly sites. Permissions required by suppliers shall be provided to DNV GL by the developer or contractor.

The extent of the inspections and the number of occasions when surveillance visits have to be carried out for project certification shall be evaluated by DNV GL for each specific project and will depend on DNV GL's experience with the manufacturer. The aim is to complete the surveillance of 10 to 25% of produced cable lengths during a factory acceptance test (FAT), typically including high voltage withstand and partial discharge tests. In the event that the manufacturer does not hold a valid ISO 9001 certificate, the number of surveillance visits to be completed by DNV GL may be increased to evaluate the quality management system.

Guidance note:

Prior to witnessing routine and sample testing activities, DNV GL will require evidence of valid type test records or type approval for the chosen cable design.

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The surveillance shall be based on relevant standards together with design documentation previously submitted to DNV GL as input for the design verification, such as documentation of:

- critical items
- test programs
- approved details
- qualification of personnel, if applicable.

Each surveillance is to be completed at the manufacturing premises and the following documentation shall be made available to DNV GL for the surveillance:

- general arrangement drawings and specifications
- manufacturing drawings, specifications and instructions
- inspection check sheets, test reports, and measurements reports
- certificates of personnel qualifications, if applicable.

Each surveillance shall be documented in a detailed surveillance report including photo documentation whenever deemed necessary. Permissions required by suppliers shall be provided to DNV GL by the developer or contractor.

Once the surveillance has been satisfactorily completed, DNV GL will issue a conformity statement for Phase III: Manufacturing power cables.

3.5.5 Phase IV: Transport and installation

3.5.5.1 General

Transportation and installation is a crucial temporary phase in a wind farm project. DNV GL shall perform transportation and installation surveillance as part of the project certification process.

Prior to the transportation and installation of the first power cable to the wind farm, method statements for transportation and installation manuals including loading and unloading shall be issued for DNV GL review.

Once the transportation surveillance has been satisfactorily completed, DNV GL will issue a conformity statement for Phase IV: Transport and installation power cables.

3.5.5.2 Transportation surveillance

The transportation shall include documentation of the following and shall be subject to verification and surveillance:

- general cable transport method review including loading and fastening
- surveillance of transportation, e.g. 10%.

The transportation surveillance shall be followed up by a detailed surveillance report. This surveillance report will include photo documentation whenever deemed necessary. Permissions required by suppliers shall be provided to DNV GL by the developer or contractor.

3.5.5.3 Installation surveillance

The installation shall include documentation of the following and shall be subject to verification and surveillance:

- general cable installation method review, including loading, laying, pull-in and burial
- surveillance of cable pull-in, laying, burial, e.g. 10%.

The DNV GL project certification surveyor shall be present during the first installation and during one other installation randomly chosen from the remaining cable lengths. However, the final number of installations to be attended by the DNV GL project certification surveyor may be larger depending on the project details

and the number and types of power cable.

The final as-built documentation shall be issued for DNV GL review. The review shall focus on items such as-built documentation and records.

The installation surveillance shall be followed up by a detailed surveillance report. This survey report will include photo documentation whenever deemed necessary. Permissions required by suppliers shall be provided to DNV GL by the developer or contractor.

3.5.6 Phase V: Commissioning

DNV GL shall perform a commissioning surveillance as part of the project certification with the purpose to verify that the power cables installed on site are commissioned according to the requirements of the manufacturer and in compliance with relevant documentation provided in the design phase.

DNV GL shall attend the commissioning of the first power cables; however, the final number of commissioning stages to be attended may be larger depending on the project details and the number and power cable types.

The following documentation shall be made available to the DNV GL surveyor prior to the commencement of the surveillance:

- commissioning procedures
- commissioning checklist.

The power cable commissioning shall be carried out in accordance with the submitted procedures reviewed and approved by DNV GL in advance of the commissioning.

During commissioning, systems and equipment shall be checked for compliance with approved documentation and commissioning procedures.

The relevant systems shall be functionally tested, as far as is practicable, in accordance with approved procedures to confirm proper, safe and functional operation of all devices, controls and equipment safe start-up.

The following procedures are to be witnessed by DNV GL or tested in presence of the attending surveyor:

- witnessing of cable hang-off, termination, e.g. 10%
- witnessing of testing.

The commissioning surveillance shall be followed up by a detailed surveillance report. The surveillance report will include photo documentation whenever deemed necessary. Permissions required by suppliers shall be provided to DNV GL by the developer or contractor.

Once the commissioning surveillance has been satisfactorily completed, DNV GL will issue a conformity statement for Phase V: Commissioning power cables.

3.5.7 Phase VI: In-service

3.5.7.1 General

The in-service phase implies an activity, by which the power cables are monitored regularly during their entire operational life. DNV GL or other acknowledged in-service inspectors shall conduct periodic in-service surveillance. The in-service surveillance results shall be evaluated to verify that the required standards are observed and maintained. The in-service phase serves to confirm the validity of the project certificate, see [2.5].

Prior to the initiation of surveillance, a maintenance, repair and inspection programme shall be developed and submitted to DNV GL for approval. The programme shall serve as a reference for parties involved in maintenance and repair carried out on the cables or a wind farm. The maintenance, repair and inspection programme shall be updated as required based on findings and deviations. Any update of the programme shall be subject to DNV GL approval.

In general the inspection and maintenance plan required during the design phase (see [3.5.3]) shall be taken into consideration.

Once the verification of the in-service surveillance has been successfully completed, DNV GL will issue a conformity statement for Phase VI: In-service power cables that confirms the validity of the project certification.

3.5.7.2 In-service surveillance

The scope of work shall include a detailed project-specific plan that identifies the surveillance activities required, the surveillance intervals, the lengths of cables to be monitored and the reporting requirements. The interval between surveillance visits will depend on the cable type(s) and on the knowledge built up during the previous phases of the certification process. The first surveillance after commissioning of the power cables will usually take place after one year. The scope shall include assessment of the status regarding any outstanding issues from the previous surveillance.

The surveillance report shall highlight any findings or deviations reported during the periodic in-service surveillance. Major findings and deviations shall be reported to the customer in terms of recommendations.

A DNV GL in-service phase shall be carried out to provide evidence as to whether the monitored installation or parts thereof continues to comply with the approved design. Prior to the surveillance the status of outstanding issues as well as information about all revisions made to the maintenance procedure within the latest year shall be submitted to DNV GL.

As a part of the surveillance, records of maintenance and repairs carried out since the previous surveillance shall be reviewed and verified against the program. The company responsible for the maintenance and repairs shall be subject to audits in order to verify the documentation for work carried out. The review shall include:

- follow-up of outstanding issues from the previous surveillance and status regarding recommendations
- review of revised procedures
- review of maintenance documentation
- review of maintenance history in the file or any digital registration

The surveillance conducted offshore may in general include:

- verification that repair and maintenance are undertaken
- according to the approved program and that manufacturer's recommendations are followed subsea inspections of cables.

Periodic surveillance of a selection of operating power cables are required in order to verify compliance with the approved design. The surveillance of the systems listed above shall focus on the following items:

- damage to outer sheath or armour
- dents and deformation(s)
- status on outstanding points from previous surveillance visits
- additional surveillance identified based on findings and deviations, e.g. witnessing of tests and inspections in order to distinguish between random and systematic failures
- review of electrical cable loading history, if necessary.

Additionally for offshore installations:

- transition into J-tubes
- scour protection
- marine growth
- cable protection and burial.

3.6 Project certification related services

3.6.1 General

This section provides a description of typical project certification related services. They are optional with regard to the above described project certificates and can be provided as stand-alone. These optional

services are available on request, based on the individual needs. Such services may include pre-certification services, for example verification of project planning and pre-design evaluation.

In addition further project certification systems are available as alternatives and recognized by DNV GL:

- BSH under German jurisdiction
- Danish Project Certification System
- GL-IV-1: Guideline for the Certification of Wind Turbines
- GL-IV-2: Guideline for the Certification of Offshore Wind Turbines.

DNV GL also offers project certification of wind farms as certified verification agent (CVA) according to US legislation under BOEM.

3.6.2 Site specific design services for onshore wind farms

3.6.2.1 General

Especially for onshore projects a full project certification is not always required or desired and it may not always be necessary for such projects to be based on an existing type certificate but depending on the local market requirements, projects may be realised on the basis of conformity statements for the design verification of a wind turbine as a minimum.

Depending on the defined scope of work between the customer and DNV GL, DNV GL can offer various levels of approval for such projects, which cover parts of the scope of a full project certification and which may be, implemented subsequently in a project certificate. The site design conditions (SDC) and the site specific design assessment (SSDA) are common site specific design services for onshore wind farms. Here the assessment mainly concentrates on full or partial completion of Phases I and II according to the project certification of wind turbines.

Once the verifications of SDC and SSDA have been successfully completed in accordance with chapter [3.6.2.2] and [3.6.2.3] and with the scope of work defined between the customer and DNV GL, DNV GL will issue a conformity statement for each module. Since the SDC conformity statement is a reduced version of the design basis and the SSDA is a reduced version of the design, additional verification will be necessary, if the SDC and SSDA shall be integrated in a full onshore project certification.

3.6.2.2 Site design conditions

The verification of the site design conditions (SDC) is performed according to [3.3.2], and results in an SDC conformity statement according to IEC 61400-22.

The SDC statement of compliance usually addresses all site parameters according to [3.3.2.1], but can also address only certain aspects such as the wind and terrain conditions only. Furthermore, the SDC conformity statement may include the wake verification according to [3.3.2.1].

Which aspects have been considered and which items have been excluded from the assessment will be stated in the SDC conformity statement.

3.6.2.3 Site specific design assessment

The verification of the site specific design assessment (SSDA) is performed according to [3.3.2], and results in a SSDA conformity statement according to IEC 61400-22.

The SSDA usually addresses the integrated load analysis according to [3.3.3.1], as well as the wind turbine / RNA design evaluation according to [3.3.3.2] and [3.3.3.3], and a reduced support structure design evaluation (including tower and optionally the foundation) according to [3.3.3.4].

In order to verify the site suitability of the wind turbines for a specific wind farm their structural integrity has to be assessed, either by reference to wind data and site conditions, or by load calculations with reference to site specific conditions according to IEC 61400-1 and [3.3.3.1] of the present document.

Unless already covered in the SDC conformity statement or design basis conformity statements within the project certification, the integrated load analysis shall be extended such that load cases, a plausibility check of wind conditions and wake analysis as well as seismic requirements and information regarding the electrical network are included in this module – this will be explicitly mentioned in the conformity statement. In the event that the site specific wind turbine design deviates from the design evaluation conformity

statement or from its type certificate or, where the inclusion of specific elements is required and/or desired, whereas these were not part of the type certificate (e.g. foundation), the site suitability study will be extended by the relevant elements mentioned in the design phase (see [3.3.3]).

After successful completion of the relevant tasks of design phase stated in Chapter [3.3.3] a SSDA conformity statement can be issued which specifies which aspects of the design phase have been considered and which parts have been excluded due to the pre-defined scope and requirements.

Guidance note:

The SDC and SSDA verification can be performed independently from each other, neither one of them requires the other to be performed first or in parallel.

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3.6.3 Project characteristics measurements

Optionally the project characteristics measurements can be performed for the specific wind farm. The measurements comprise one or more of the following items:

- grid connection compatibility (GCC) according to grid codes
- verification of power performance
- verification of acoustic noise emission.

The electrical performance of the substation connected to wind farm and grid can be reviewed by analysing:

- wind farm electrical layout
- active and reactive power flows
- influence on existing electrical power grid (harmonics, flickers, lines overload, compensation)
- critical details.

The applicant may select the assessment of power quality measurements. In this case the measurements shall be conform with IEC 61400-21 and corresponding grid codes.

DNV GL shall evaluate the test reports. The GL TN GCC provides further guidance in regard to application of grid codes and fulfilment of compliance.

In general reference is made to [1.6.2] regarding reporting of measurements and test laboratories.

Once the verification of the project characteristics measurements have been successfully completed, DNV GL will issue a conformity statement for Project Characteristics Measurements.

3.6.4 Meteorological masts

The meteorological (met) mast located close to the wind farm can be considered as “other installations” according to IEC 61400-22 and be certified.

The structural design of the sub-structure and the met mast tower shall be verified according to [3.3.3].

For dynamically sensitive offshore met masts both the wind and waves contribute to the tower and sub-structure loading, if necessary, the customer has to determine the loading by a fully coupled analysis.

Once the verification of the met mast design has been successfully completed, DNV GL will issue a conformity statement design for meteorological mast.

A project certificate for met mast can be issued, if all phases are fulfilled as described in this service specification.

Additionally the measurement equipment can be included in the scope.

The commissioning surveillance comprises witnessing on a random basis of the equipment calibration and running test of the wind measurement equipment once installation has been completed. Surveys shall review the as-built systems and assess their compliance with recommendations in IEC 61400-12-1, customer specifications, and typical industry practice. Installation documentation shall be reviewed for adequacy and completeness. The surveys shall be conducted twice:

- review commissioning calibration and commissioning of wind measurement equipment, onshore

- review commissioning of wind measurement equipment, offshore.

3.7 Integration of certificates

3.7.1 General

Within the project certification of onshore and offshore wind farms according to this service specification, there may be occasions when it is intended to integrate an existing wind turbine type certificate or a component certificate of the rotor nacelle assembly. In this section possibilities are described.

It shall be considered that the integration of any type certificate shall be agreed with DNV GL in advance for every individual project as not all possible options can be foreseen nor are shown within this service specification.

As a project certificate attests compliance to a certain standard, it has to be ensured that the type and other certificates used as a basis support this. Ideally, the type certificate is in compliance with the same standard used for project certification. If this is not the case, additional items have to be assessed within the project certification procedure. In general it is possible to integrate a type certificate or component certificate issued in accordance with IEC 61400-22 or DNVGL-SE-0074.

The integration of the type certificates or conformity statements in the project certification shall be reported in the final evaluation report of the respective phase and accordingly in the project certificate.

3.7.2 Type certificate according to same edition of standard

The site-specific adaptations of the wind turbine type are considered within project certification as follows:

- verification of the site-specific loads shall be performed
- a comparison of the site-specific loads to those used for the design assessment for the type certificate shall be provided by the manufacturer
- the verification of the site-specific turbine adaptations in comparison to formerly certified turbine shall be performed, if necessary
- the verification of the site-specific foundation or support structure shall be performed by DNV GL separately
- further documentation needed e.g. for manufacturing, transportation and installation surveillance, manuals, grid connection parameters relevant for project certification.

See also [3.3.3.2].

3.7.3 Onshore type certificate in offshore project certification

An onshore type certificate(s) in an offshore project certification or vice versa requires additional actions.

In the event that a DNV GL type certificate based on the DNV GL service specification DNVGL-SE-0074 for the onshore version of the turbine is available this can be used for offshore project certification. The adaptation shall be agreed in advance for every project individually.

For fixed offshore wind turbines the steps listed below have to be considered.

- 1) The turbine (rotor-nacelle-assembly) in question may need to be modified to comply with the offshore environment and the changed operation and maintenance requirements. All modifications made shall be reported by the manufacturer in a separate, consistent report. Extra attention shall be paid e.g. to the following issues:
 - atmospheric control and corrosion protection of the machinery
 - if the type certified tower is to be included a corrosion protection according to offshore requirements shall be considered
 - for structures in the splash zone material selection according to offshore guidelines
 - safety system remote control options
 - requirements regarding offshore grid connection and electrical equipment

- adaptation of machinery materials (e.g. elastomers) and auxiliary materials (e.g. lubricants) to the offshore conditions
 - adaptation of fastenings, pad-eyes etc. to the requirements of marine operations
 - adaptation of manuals for transport, installation, operation and maintenance to the offshore environment and the requirements of the offshore guidelines
 - document explaining why onshore type testing is acceptable for the offshore version of the turbine.
- 2) DNV GL verifies if the type certificate fulfils the requirements of the offshore application. Outstanding issues and questions arising during this verification shall be resolved. After evaluation DNV GL issues Evaluation Reports for the above mentioned topics.
- 3) Site-specific adaptations of the wind turbine are considered within the site-specific design evaluation and subsequent manufacturing, transportation and installation surveillance performed during project certification:
- within the project certification a verification of the site-specific loads shall be performed
 - a comparison of the site-specific loads to those used for the design assessment for type certification shall be provided by the manufacturer
 - the verification of the site-specific support structure is performed by DNV GL separately. The support structure includes the sub-structure, the foundation and, if not considered within the certification, the tower as shown in [Figure 1-2](#).

3.7.4 Offshore type certificate in onshore project certification

In general the items listed in [\[3.7.3\]](#) shall be considered accordingly for the application of an offshore type certified wind turbine to be used in an onshore wind farm. The adaptation shall be agreed in advance for every project individually.

3.7.5 Type certificates according to former editions of standards

In case the type certificate is based on standards earlier than the valid editions, an upgrade of the type certificate is required. In general the type certificate shall be valid on the date of issue of the conformity statement for the design phase and project certificate (see [\[3.3.3.2\]](#)).

3.7.6 Type certificate or component certificate according to a standard different from IEC 61400-22

If the type certification or component certification is performed in accordance with standards other than IEC 61400-22 or this service specification, additional actions have to be taken to achieve acceptance.

If the wind turbine manufacturer holds a type certificate or component certificate according to GL-IV-2 the documents listed in [\[3.7.1\]](#) of this service specification shall be supplied. In addition the documents of the certification module "Design Basis Evaluation" (IEC 61400-22, Edition 1.0, 2010-05, Section 8.2) shall be submitted. They shall give a clear understanding of the design basis and show which standards and codes were used during the type certification process and under which conditions they were applied. These documents shall list all standards and codes applied and shall be given for all main components.

It should be noted that for integration of type certificates in offshore project certification the same requirements as mentioned in [\[3.7.2\]](#) are to be considered.

DNV GL shall analyse these documents and decide which parts of the type certificate will be accepted and which parts shall be amended. This analysis is done with a view on fulfilment in principle of the IEC standard in question and a special view on the project certification process according to this service specification, and does not include any verification of strength calculation.

Further documentation on request, if found required for the project certification (e.g. manuals, grid connection parameters) may be necessary.

After assessment of the relevant documentation (including possible strength calculations) and under consideration of the information provided by the type certificate issuing certification body, DNV GL shall inform the project certificate applicant regarding acceptance of the type certificate and of any conditions or



additional verifications which may be needed to integrate the type certificate in the project certificate.

3.7.7 Acceptance of certificates not issued by DNV GL

The acceptance of wind turbine type certificates and rotor-nacelle-assembly certificates originating from certification bodies different to DNV GL shall be agreed in advance for every project individually. In general IEC CS CBC 6A applies. In line with IEC CBC 6A, DNV GL shall not take responsibility for other certification bodies' work, which shall be stated in the project certificate.

The quantity of certificates and statements to be integrated shall be limited to a feasible number to ensure the quality of the project certificate to be delivered. DNV GL shall evaluate the possibilities on project individual basis.



DNV GL

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