

# SERVICE SPECIFICATION

DNVGL-SE-0163

Edition October 2015

## **Certification of tidal turbines and arrays**

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## 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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Any comments may be sent by e-mail to [rules@dnvgl.com](mailto:rules@dnvgl.com)

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## CHANGES – CURRENT

### General

This is a new document.

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## SECTION 1 INTRODUCTION

### 1.1 General

Certification according to this service specification is a procedure by which DNV GL gives written assurance that a product design, manufacturing, commissioning, operation and maintenance processes or services, conform to requirements specified in this service specification.

This service specification has been developed for the diverse range of technical concepts and business models in the tidal industry. The procedures, requirements and deliverables defined have been formulated to align different stakeholders expectations and clearly communicate the achievement of objectives. The risk-based approach embedded in the Service Specification, as part of the Technology Qualification process, provides a robust and transparent system to deal with uncertainties and novelties without limiting innovation. The process will help manage risk and develop trust and confidence between different stakeholders.

The document provides:

- certification requirements from concept to project consisting of array(s) of multiple devices providing means for control of risk
- common platform for describing the scope and extent of verification activities for certification of tidal turbines, components and arrays
- reference document for defining the scope of work and defining the certification plan.

### 1.2 Organisation

DNVGL-SE-0163 is divided into three main sections.

- [Sec.1](#) Introduction and description of tidal turbines and arrays
- [Sec.2](#) provides the overview and main principles for certification
- [Sec.3](#) describes the specific requirements for the different certification modules. The certification modules in this document are:
  - technology qualification, describes activities for the assessment of novelty and risk leading to statement of feasibility for a concept ([\[3.2\]](#))
  - prototype certification, proving technical and performance characteristics of a prototype ([\[3.3\]](#))
  - type certification, for the serial production of turbines ([\[3.4\]](#))
  - component certification, for components to be integrated within in a certified tidal turbine or certified project ([\[3.5\]](#))
  - project certification, for site specific conditions and requirements for tidal turbines and array infrastructure ([\[3.6\]](#)).

The scope of certification for each certification module is summarised in [App.B Table B-1](#).

### 1.3 Objectives

This service specification presents the principles and procedures for DNV GL services with respect to certification of tidal turbines and arrays. Both bottom-fixed and floating tidal turbines are covered. This document refers primarily to offshore and near shore concepts, but it may also be used for energy converters operating in rivers or converting energy from ocean currents. They may be constructed from metallic materials, concrete or composite.

### 1.4 Scope of application

This specification applies to prototype, type, project and component certification of tidal turbines or tidal turbine arrays.

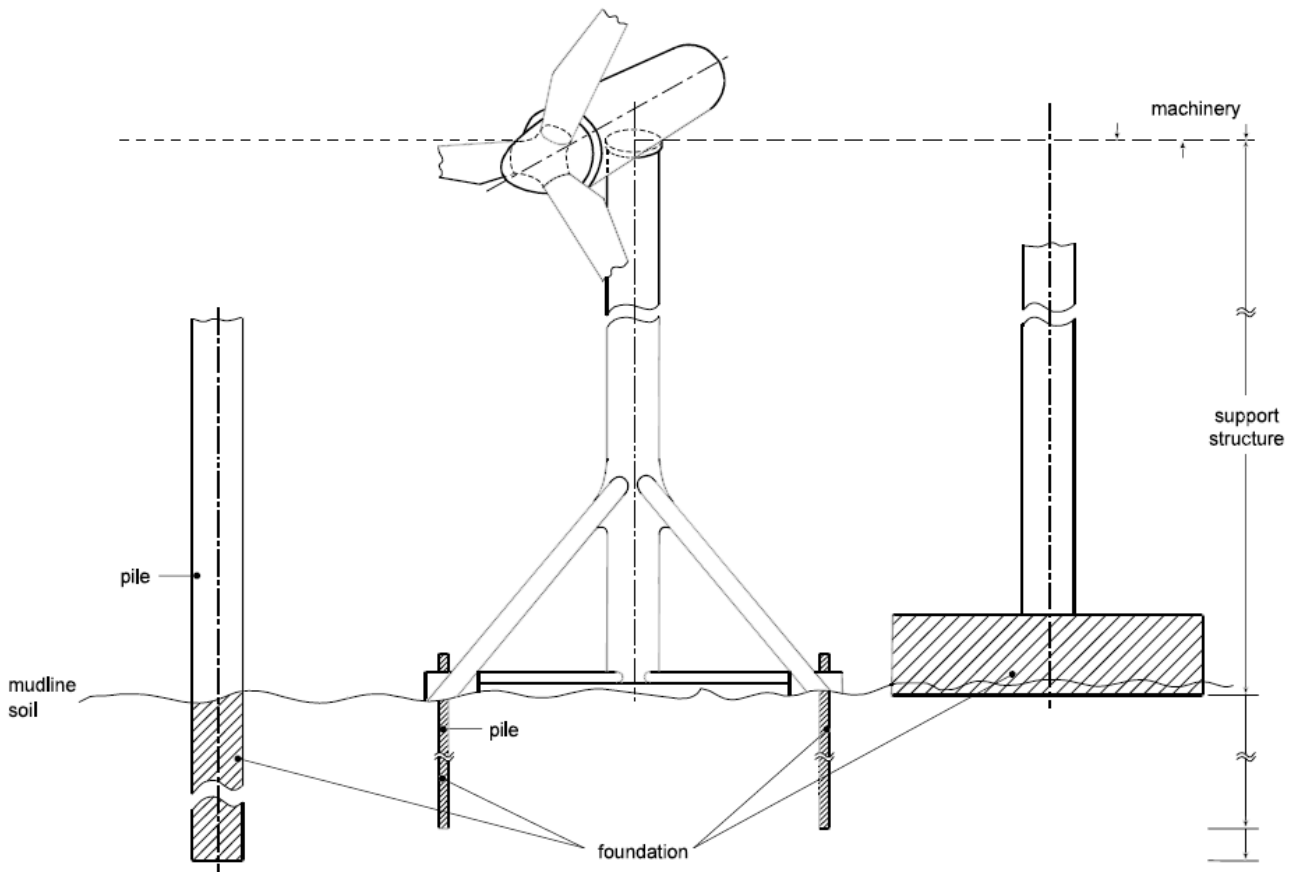
This service specification replaces the following service specification and guideline, on the tidal subject:

- DNV-OSS-312 *Certification of tidal and wave energy converters*

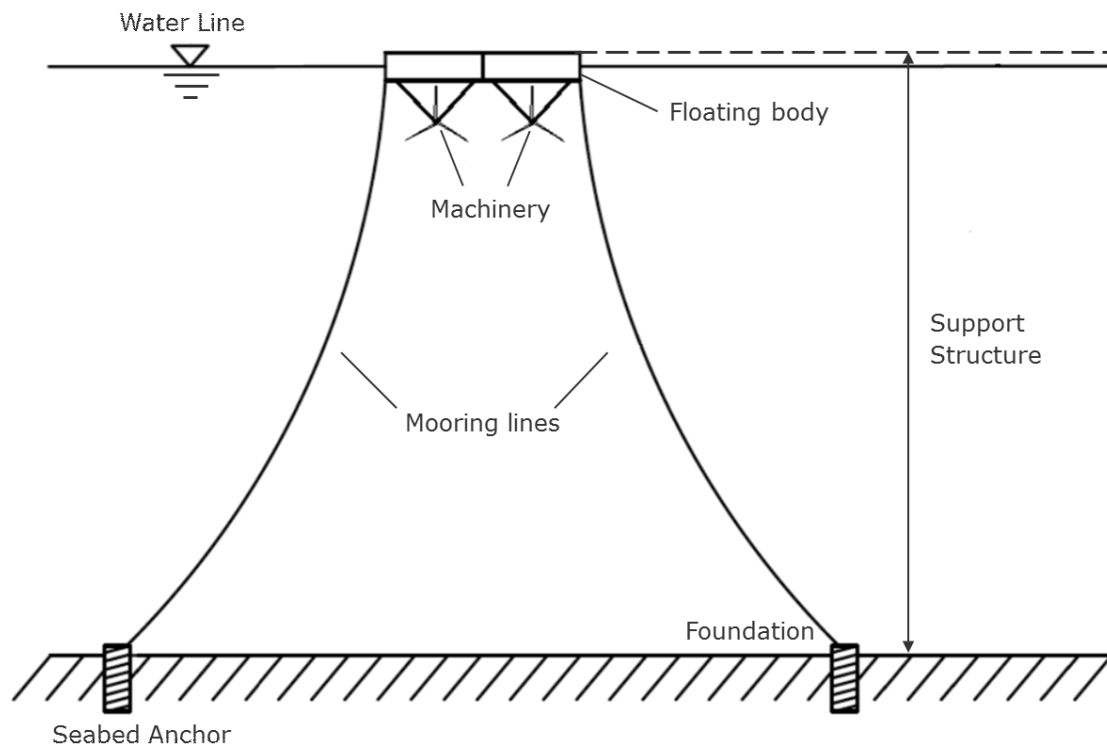
– GL IV-14 *Guideline for the Certification of Ocean Energy Converters, Part 1: Ocean Current Turbines.*

This service specification is applicable to all types of turbines and their support structures, fixed or floating, and all types of substation(s) including support structure(s), power cables and subsea connectors.

A description of the terms and definitions for a tidal turbine can be found in [Figure 1-1](#) and [Figure 1-2](#). The tidal turbine consists of the turbine itself (rotor, nacelle and machinery), foundation with support structure (either a rigid structure connected to the seabed through foundation or a floating structure, mooring and anchors). These definitions will be used in this service specification.



**Figure 1-1 Definition of a fixed tidal turbine**



**Figure 1-2 Definition of a floating tidal turbine**

The project certification of an array of tidal turbines is covered in this service specification. The project certification covers the following:

Components of a tidal turbine:

- rotor and nacelle
- machinery
- support structure and foundation
- subsea connectors.

Components of a substation are:

- transformer housing including installations and equipment
- support structure and foundation.

Cable sections of power cable route:

- asset-power-cable (e.g. turbine power cable, substation power cable)
- array-power-cable
- export-power-cable
- subsea connectors.

Onshore balance of plant:

- control station for remote operation of array
- onshore grid connection.

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



## 1.5 Definitions

The terms *shall*, *should* and *may* are used when referring to actions and activities.

**Table 1-1 Verbal forms**

<i>Term</i>	<i>Definition</i>
shall	verbal form used to indicate requirements strictly to be followed in order to conform to the document
should	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
may	verbal form used to indicate a course of action permissible within the limits of the document

**Table 1-2 Terms**

<i>Term</i>	<i>Definition</i>
accreditation	accreditation is a formal, third party recognition of competence to perform specific tasks It provides a means to identify a proven, competent evaluator so that the selection of a laboratory, inspection or certification body is an informed choice.
array infrastructure	installed equipment required for the operation of the tidal turbine array including but not limited to turbines, support structures, cables and substations
certificate	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)
certification basis	requirements for the product's, component's, assembly's or system's specifications, operating conditions, performance targets and reliability targets The basis to which the product, component, assembly or system will be assessed during certification.
certification module	a certification phase is subdivided into certification modules
certification phase	main certification task during the design, manufacturing and testing
certification plan	the certification plan is a deliverable from technology qualification and defines the certification requirements for the turbine or array
degrees of novelty	the level of novelty and maturity are normally classified as proven, limited history and new or unproven The degree of technology novelty combined with where/how the technology is applied (Application Area) will be classified in categories to be used as input to a risk assessment.
manufacturer	an organization situated at a stated location or stated locations that carries out or controls such stages in the manufacture, testing, handling and storage of a product and provides documentation for assessment
new technology	technology that is not proven nor has no track record The failure modes and mechanisms of failure are not known or there is limited understanding on how the technology can fail and the safety margins to failures. The technology has large uncertainties.
operator	entity with prime responsibility for operating the tidal turbine or array
power plant	energy producing facility, comprising all its main assets to produce power and transfer it into the power grid In this service specification the term power plant is associated with the main assets tidal turbines and substation(s) including their support structures, power cables and the control station.
project certificate	a certificate issued by DNV GL and affirming that, at the time of assessment, the asset referred to in the certificate complies with the applicable requirements
prototype	prototype is defined as one or a limited number of turbines deployed at a specified position where the objective is to demonstrate technology and performance
proven technology	in the field, proven technology has a documented track record for a defined environment Such documentation shall provide confidence in the technology from practical operations, with respect to the ability of the technology to meet the specified requirements. Technology has been used in the industry for many years with modes of failure and failure mechanisms identified and controlled by design, fabrication, testing and maintenance requirements provided in standards or industry practice.
qualification methods	actions identified during the technology qualification phase to deal with uncertainties and significant risks
risk	the qualitative or quantitative likelihood of an accident or unplanned event occurring, considered in conjunction with the potential consequences of such a failure In quantitative terms, risk is the quantified probability of a defined failure mode multiplied by its quantified consequences.

**Table 1-2 Terms (Continued)**

<i>Term</i>	<i>Definition</i>
site conditions	site conditions consist of all natural phenomena which may influence the design of a tidal turbine by governing its loading, its capacity or both, including but not limited to meteorological conditions, oceanographic conditions, water depth, geotechnical conditions, bathymetry, seismicity, biology, and various human activities
statement of compliance	a statement issued by DNV GL affirming that, at the time of assessment, a product or a service meets specified requirements
statement of feasibility	the statement of feasibility is a document issued by DNV GL affirming that, at the time of assessment, the technology is considered conceptually feasible and suited for further development and qualification according to criteria agreed at the commencement of certification
survey reports	survey reports issued by a surveyor appointed by DNV GL addressing the issues related to survey activities that shall cover different stages such as manufacturing, testing (during manufacturing), marine transportation, commissioning, installation and decommissioning
technology developer	entity with prime responsibility for the design and construction of the tidal turbine
technology qualification	the process of providing the evidence that technology will function within specified limits with an acceptable level of confidence  Technology qualification can be seen as the process of substantiating a claim about the provision of a function, which is not already covered by validated requirements.
technology with limited field history	technology that has been used to a limited range of applications and conditions  The technology has limited statistical basis and track record to clearly conclude that there are no new technical uncertainties to be identified. It is unlikely that standards and procedures have already been developed or are available to address the technology.
type certificate	a certificate issued by DNV GL, when it has been demonstrated that a product type in question, here a tidal turbine type, complies with the applicable requirements  The type certificate will allow the customer to manufacture certified tidal turbines during the period of validity of the certificate.

Abbreviations used in this Service Specification:

**Table 1-3 Abbreviations**

<i>Reference</i>	<i>Title</i>
ALS	accidental limit state
CIGRÉ	Conseil International des Grands Réseaux Électriques
CMS	condition monitoring system
EN	European norm
FEM	finite element method
FMECA	failure mode effects and criticality analysis
FMIRR	failure mode identification and risk ranking
FLS	fatigue limit state
IAC	Internal Arc Classification
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
LVRT	low voltage ride through
MSA	manufacturing survey arrangement
NAVAID	navigation aid
RNA	rotor-nacelle-assembly include rotor blades, hub, PTO
PTO	power take-off  Mechanism that converts the motion of the prime mover into a useful form of energy such as electricity, e.g. drive train including shaft, gear, coupling, generator, but excluding the rotor.
QM	quality management
SLS	serviceability limit state
SoC	statement of compliance
ULS	ultimate limit state

## 1.6 References

This service specification makes reference to relevant DNV GL, DNV and GL standards and guidelines and to international codes and standards as well as other international publications. Unless otherwise specified in this service specification, the latest valid revision of each referenced document applies.

**Table 1-4 References**

<i>Reference</i>	<i>Title</i>
BS 5760, Part 5	Guide to failure modes, effects and criticality analysis and IEC-60300-9, Part 3: Application guide - Section 9: Risk analysis of technological systems.
DNV-OS-F201	Dynamic Risers
DNVGL-RP-0360	Subsea power cables in shallow water (planned published December 2015)
DNVGL-ST-0076	Design of electrical installations for wind turbines
DNVGL-ST-0164	Tidal turbines
DNVGL-ST-0359	Subsea power cables (planned published December 2015)
DNV-OS-J201	Offshore Substations for Wind Farms
IEC TS 62600-200	Marine energy – Wave, tidal and other water current converters – Part 200: Electricity producing tidal energy converters – Power performance assessment
IEC TS 62600-201	Marine energy - Wave; tidal and other water current converters Part 201: Tidal energy resource assessment and characterization
IEC-60300-9, Part 3	Application guide - Section 9: Risk analysis of technological systems.
ISO 9000	Quality management systems - Fundamentals and vocabulary
ISO 9001	Quality Management Systems - Requirements
ISO 9004	Managing for the sustained success of an organization - A quality management approach
ISO/IEC 17020	Conformity assessment - Requirements for the operation of various types of bodies performing inspection
ISO/IEC 17025	General requirements for the competence of testing and calibration laboratories
ISO/IEC 17065	Conformity assessment – requirements for bodies certifying products processes and services.

## SECTION 2 SERVICE OVERVIEW

### 2.1 General certification process

The DNV GL certification process consists of the certification phases shown in Figure 2-1 which refer to the main certification tasks during the design, manufacturing and testing of the Tidal Turbine. The tasks will follow the development of the tidal energy converter from concept development to complete project. The entry point and modules required to reach a certification level will depend on the technology maturity. For example a new concept may start at technology qualification and target prototype certification, whereas a proven concept which has already achieved prototype certification may target type certification.

The phases of the overall certification process are discussed in Sec.3 in detail.

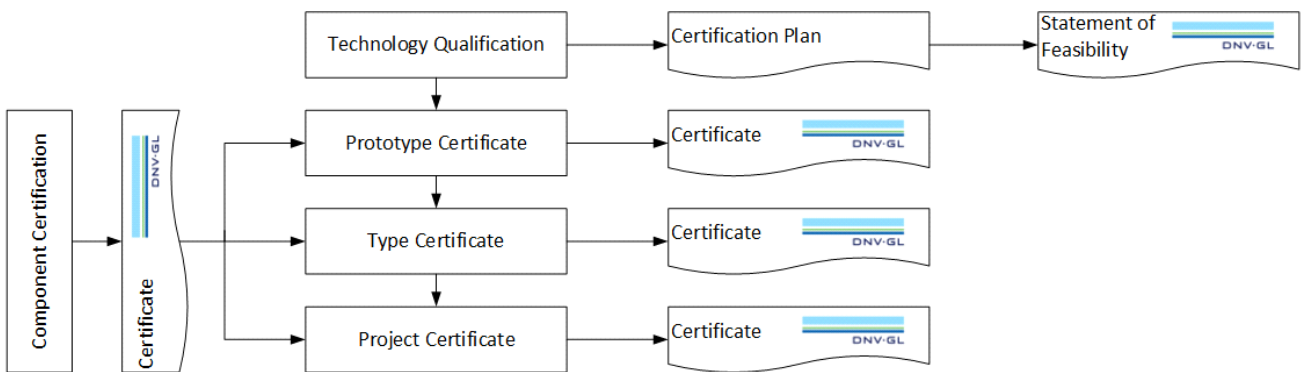


Figure 2-1 Certification phases

### 2.2 Certification scope for the technology qualification

The technology qualification process is performed by the technology developer completing the modules as shown in Figure 2-2 and described in detail in [3.2]. On successful completion of the process up to and including the failure mode identification and risk ranking (FMIRR) a certification plan and statement of feasibility will be issued by DNV GL.

The certification basis, technology assessment and failure mode identification and risk ranking should be reviewed through the development of the technology to assess the impact of any design changes. DNV GL shall be kept informed of any design changes and if required the certification plan should be updated.

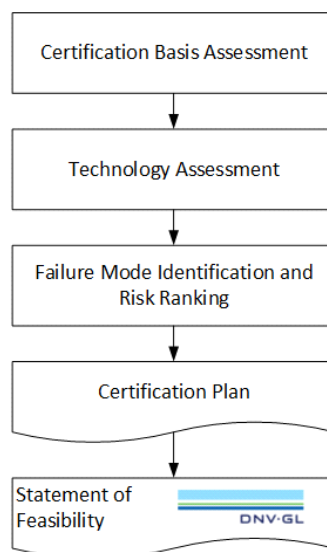


Figure 2-2 Certification modules for the technology qualification

## 2.3 Certification scope for prototype, type and project certification

### 2.3.1 General

The prototype, type and project certification phases are performed by completing all certification modules as shown in Figure 2-3 and described in detail in [3.3] to [3.6]. For each successfully completed certification module DNV GL will issue a statement of compliance (SoC) and a certification report. After successful completion of all modules DNV GL will issue a certificate.

The involvement of DNV GL for certification will depend on the phase of the turbine development. The focus of prototype certification is to provide a level of assurance for a demonstration device that is to collect data and validate design methodologies. Type certification is for series production of tidal turbines. In this case the level of DNV GL involvement will be to confirm the technology developer demonstrates full compliance with the technical requirements for the design life of the turbine. Project certification shall confirm, for a specific site, that the tidal turbine or array of turbines meets requirements governed by site-specific external conditions.

Maintenance of the certification shall require periodic in-service inspection.

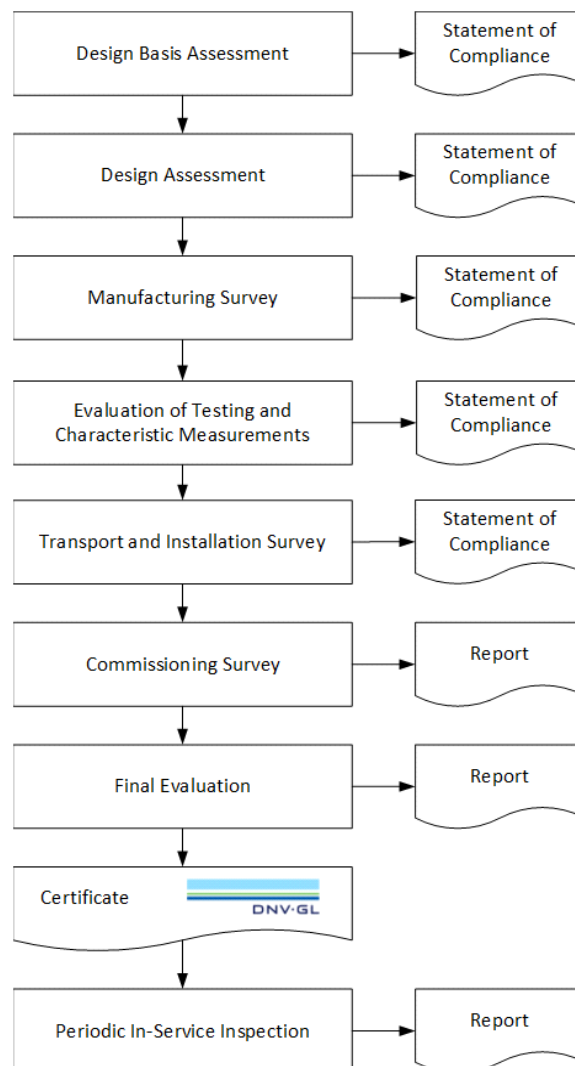


Figure 2-3 Certification modules for prototype, type and project certification

## 2.3.2 Design basis assessment

The design basis will be reviewed by DNV GL and shall provide the key information related to the design, parameters for operation and survival conditions (including accidental scenarios and abnormal conditions), installation and maintenance.

The design basis assessment covers the following items including but not limited to:

- general system description
- operating limitations
- design parameters
- standards and codes applied for design
- provisions for authority requirements
- main principles for manufacturing, transportation, installation, commissioning, operation and maintenance as well as abandonment
- materials selection
- environment (internal and external)
- definition of turbine operational modes and limits
- variable functional loads
- main principles for quality assurance
- reliability targets.

## 2.3.3 Design assessment

### 2.3.3.1 General

Design assessment technical requirements are given in the standard for design and construction of tidal turbines DNVGL-ST-0164. For novel technology additional qualification methods are defined in the certification plan issued at the statement of feasibility phase.

Its purpose is a complete examination of the tidal turbine design including verification of the assumptions through material and component tests. In case that components like support structure and foundation are not included in the assessment, the dynamic influence of the virtual support as well as the loads acting on a virtual support structure are to be considered in the load assumptions.

For the assessment of the design the manufacturer shall submit a full set of documents in the form of specifications, calculations, drawings, descriptions and parts lists. The documents for control and safety system concepts, load case definitions and load assumptions will be assessed first. Please refer also to Appendix [A.1].

DNV GL will verify the design for compliance with DNVGL-ST-0164 and other requirements specified in the certification plan that has been issued by DNV GL.

The design evaluation will address the following topics where applicable:

- environmental conditions
- load cases
- load analysis
- control and safety system
- blade design and material selection
- structural components, including the support structure and foundation
- machinery systems and components
- watertight integrity
- stability for floating turbines
- electrical components
- hydraulic components
- transportation, installation, maintenance and operations
- test plan

- personnel safety (depending on international and national requirements)
- measures of quality management in the design phase
- cables and infrastructure for arrays
- offshore and onshore substation.

### **2.3.3.2 Control and safety system**

DNV GL will evaluate the documentation of the control and safety system. The evaluation for control and safety system will comprise the following documentation:

- description of the applied system version control (including control software)
- description of modes of operation
- design of functionality of all elements
- fail-safe/safe-life design of the safety system
- system logic and hardware implementation
- authentication of reliability of all safety critical sensors
- braking system(s) analysis if available
- quality control for the controller development process
- test program for safety and function test.

Documentation shall also be provided demonstrating that the controller used for the load calculations has the same functionality and algorithms as for the actual tidal turbine.

A failure analysis such as failure mode and effect and criticality analysis (FMECA) for the control and safety system including safety critical braking systems shall be executed and documented by the manufacturer.

In some cases work shop testing may be necessary to verify the controller.

### **2.3.3.3 Load assessment**

DNV GL will verify the loads and the load cases considered and the load effects. The extent of the verification will depend on the certification phase, the tidal turbine concept and on the size and rated power of the tidal turbine. Load assessment shall be carried out in line with DNVGL-ST-0164.

As part of the verification of loads and load cases, DNV GL will carry out independent load analyses. The focus of the independent analyses will be on fatigue load cases and selected critical extreme load cases. Load validation can also be carried out through review of the technology developer's documentation or data from full scale testing.

The following aspects are to be considered:

- ULS loads
- FLS loads
- ALS loads.

The assessment of loads is performed considering the following:

- methodology for the derivation of loading
- verification of functional and metocean limitations considered in the loading derivation
- verification of parameters used for load derivation (including control parameters)
- verification of structure, foundations and blade representation
- verification of loading derivation
- confirmation of critical load cases for extreme condition
- checking of the loads at the blades, rotor, structural components as well as machinery systems and components
- methodology used for validation of analytical model focused on the global forces.

In general the DNV GL independent load analysis will include a time domain load simulation using a special-purpose code.

The independent load analysis will serve as an independent check of applied input and will be used for the verification of the manufacturer's load analysis report with respect to load level and dynamic behaviour.

The load assessment may also be based on experience from the assessment of tidal turbines with similar dimensions and design. This is possible if the extreme loads and fatigue loads can be compared with those of other tidal converters of similar size.

If a tidal converter of a larger type is submitted for assessment the pertinent values shall be extrapolated with due consideration for the physical circumstances.

#### **2.3.3.4 Blades**

The design documentation of the blades should include descriptions, specifications, drawings and part lists together with design calculations, analysis and test reports. DNV GL requires that the documentation clearly identifies the loads and relevant external conditions.

DNV GL will evaluate the rotor blade design for compliance with the requirements of DNVGL-ST-0164.

The design documentation shall comprise:

- design calculations
- drawings and specifications including layup and tolerances
- material properties shall be taken from recognised standards or shall be verified by testing for the final component/type certificate
- design evaluation may be carried using conservative material properties prior to verification by testing
- if possible, the manufacturing instructions should be reviewed in connection with design evaluation. Otherwise the correspondence between design and manufacturing will have to be checked in connection with the manufacturing survey.

For blades, the material properties must be documented as follows:

For blades made of composite material, the material properties have to be determined by testing at an accredited testing laboratory or the tests witnessed by DNV GL. The extent of witnessing has to be agreed between the manufacturer/designer and DNV GL. The following tests are mandatory for fibre reinforced plastics and adhesives:

- tensile test on FRP (strength, modulus, failure strain)
- compression test on FRP (strength, modulus, failure strain)
- shear test on FRP and adhesives (strength, modulus)
- single lap shear test on adhesives (strength)
- fatigue single lap shear test at  $R=-1$  on adhesives (strength)
- pull-out test on metallic inserts, if any (strength)
- fatigue pull-out test at  $R=-1$  on metallic inserts, if any (strength).

For blades made of metallic materials the material parameters shall be taken from the relevant European or equivalent international standards in consultation with DNV GL.

The DNV GL assessment consists of reviewing the documentation and analysis provided by the designer. If the blade design documentation includes advanced analyses, such as FEM analyses of highly utilized parts, DNV GL may carry out independent analyses for verification of the design.

The blade manufacturer/designer shall address the types of repairs (which have influence on the strength and/or stiffness of the blade) that can be foreseen for the blade type. The repairs shall be validated by testing, preferably in connection with the full scale blade testing or representative sub-component testing. The validation may also be based on testing of a similar blade type. The planned testing for validation of repairs shall be addressed in the blade test specification.

The detailed specification for testing of the blades shall be agreed upon with DNV GL as part of the design assessment.



### 2.3.3.5 Structural components

The design documentation relating to structural components normally consists of descriptions, specifications, drawings and part lists together with design calculations and test reports if applicable. DNV GL requires that the documentation clearly identifies the basis for the design, i.e. codes and standards, as well as loads and relevant external conditions.

The DNV GL assessment consists of documentation reviews and independent analyses for compliance with the requirements of DNVGL-ST-0164.

For structural components whose design documentation includes advanced analyses, such as FEM analyses of highly utilised members, DNV GL may carry out independent analyses for verification of the design.

For structural components subject to component tests, the results may be used as full or partial documentation of the structural capacity. In this case, the test plan is subject to approval by DNV GL. Tests are to be performed and documented by an accredited test laboratory or to be witnessed by DNV GL.

In case that components of the support structure are not included in the assessment, the dynamic influence of a virtual support as well as the loads acting on a virtual support structure are to be considered in the load assumptions.

DNV GL will assess the design requirements for the foundation. The characteristic loads and the design loads will be assessed, and the permissible range for foundation flexibility at the foundation–support structure interface will be assessed. The assessment will be carried out by a review of documentation.

For moorings, DNV GL may carry out independent analyses for verification of the design.

### 2.3.3.6 Machinery components and systems

DNV GL will evaluate the designs of machinery components for compliance with the requirements of DNVGL-ST-0164.

The design documentation relating to components normally consists of descriptions, specifications, drawings, part lists and schematics together with design calculations, which may be combined with measurement reports, test reports, drawings and part lists. DNV GL requires that the documentation clearly identifies the basis for the design, i.e. codes and standards, as well as loads and relevant external conditions.

The DNV GL assessment consists of reviewing the documentation and analysis provided by the technology developer. For advanced analyses, such as FEM analyses, DNV GL may carry out independent analyses for verification of the design.

For mechanical components subject to component tests, the results of the component tests may be used as full or partial documentation of the structural capacity. In this case, the test plan is subject to approval by DNV GL. Tests are to be performed and documented by an accredited test laboratory or to be witnessed by DNV GL.

### 2.3.3.7 Electrical components and systems

DNV GL will evaluate the design of electrical components and systems for compliance with the requirements of DNVGL-ST-0164 and DNVGL-ST-0076.

The design documentation related to electrical components and systems normally consists of descriptions, specifications, diagrams, schematics, drawings and part lists together with design calculations and if applicable also test reports. DNV GL requires that the documentation clearly identifies the basis for the design, i.e. codes and standards, as well as relevant external conditions.

For the DNV GL evaluation of the design of electrical components and systems the following shall be documented by the manufacturer/designer:

- assumptions made for the dimensions and the installation layouts
- major electrical components including generator, main converter, high-voltage switchgear, transformer and cables
- safety relevant electrical systems and components such as low-voltage gear, control-gear,
- protection system (overspeed, short-circuit, overpower, vibration, emergency stop)
- protection against electrical hazards (direct and indirect contact, arcing)

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- 
- 
- electrical interfaces to mechanical appliances like e.g. hydraulics and brakes
  - if relevant lightning protection, earthing and equipotential bonding (limitation of step and touch voltages; over voltage protection)
  - a set of electrical wiring diagrams.

Specific requirements and issues that are relevant for design and testing of the major electrical components are listed below.

Generators:

- IEC type and routine tests
- heat-run test (converter operated, if applicable)
- bearing life-time calculation.

Frequency converter:

- protective earthing and bonding (EMC)
- environmental categories
- testing such as protective bonding impedance test, impulse withstand voltage test and touch current measurement, etc.

Power Transformers:

- design and testing
- ventilation and installation
- protection (internal faults, temperature, etc.).

High voltage switchgear:

- design and testing
- internal fault testing and corresponding installation.

Cables:

- for design and testing refer to DNVGL-ST-0076 and CIGRÉ guidelines.

Dynamic umbilical:

- refer to DNV-OS-F201 Dynamic risers' adapted for use with cable properties.

#### **2.3.3.8 Array infrastructure**

The equipment and extent of an array infrastructure will vary significantly between projects however the approach to achieving project certification should be the same. The level of involvement of DNV GL and the certification scope should be selected using the same risk based approach as for the tidal turbines to ensure high risks are identified and mitigated early in the process.

The design assessment of the array infrastructure should follow the activities identified during the technology qualification module ([3.2]) and recorded in the certification plan ([3.2.5]).

In general the following design requirements should be followed:-

- Subsea cable:
  - DNVGL-ST-0359 *Subsea power cables*
  - DNVGL-RP-0360 *Subsea power cables in shallow water*
- Substations onshore – Grid compliance according to local grid requirements
- Substation offshore structure DNV-OS-J201 *Offshore Substations for Wind Farms*
- Other equipment according to standards and requirements identified on a case by case basis.

### 2.3.3.9 Transportation, installation, maintenance and operations

The purpose of this part of the design assessment is to verify that the tidal turbine can be manufactured, transported, installed, maintained and operated according to any requirements identified in the design documentation.

The DNV GL assessment consists of a document review. The documents to be reviewed consist of specifications, instructions, manuals and other documents that DNV GL may require. Manuals including up to date information and any modifications will be reviewed as part of the final evaluation.

For transportation, installation and retrieval, a site plan showing the location of the tidal converter(s) shall be submitted, together with plans of the electrical installation showing how the power plant will be connected to the public grid.

### 2.3.3.10 Personnel safety

DNV GL will evaluate personnel safety aspects in the design documentation. The evaluation will comprise documentation of the following aspects according to applicability of the design concept:

- safety instructions
- climbing facilities
- access ways and passages
- standing places, platforms and floors
- hand rails and fixing points
- lighting (for surface piercing devices)
- electrical system and earthing system
- fire resistance
- emergency stop buttons where necessary.

The DNV GL assessment consists of a documentation review. The documentation to be reviewed normally consists of specifications, instructions, layout drawings and manuals. Final manuals will be reviewed as part of the final evaluation.

Where local safety regulations have been identified and form part of the certification scope these shall also be considered in the review.

### 2.3.3.11 Quality management for design

For the design assessment there will be a check on the technology developer's quality management (QM) system. The designer shall be certified according to ISO 9001, otherwise the relevant parts of the designer's QM system will be assessed by DNV GL.

## 2.3.4 Manufacturing survey

Manufacturing survey requirements shall be defined in the certification plan issued at the statement of feasibility phase. During the manufacturing survey phase the applicable activities in the certification plan shall be closed out.

The objective of the manufacturing surveys are to verify whether the manufactured parts, components and products are in compliance with:

- technical specifications agreed upon in the specific project.
- Codes and standards as defined in the certification plan
- documents certified by DNV GL (calculations, drawings, procedures etc.).

During the manufacturing surveys there will be a check on the manufacturer's quality management (QM) system. The manufacturer shall be certified according to ISO 9001, otherwise the relevant parts of the manufacturer's QM system will be assessed by DNV GL.

The extent and amount of the manufacturing surveys are to be agreed with DNV GL. Survey levels depend on the standard of the manufacturer's experience and component quality, the requirements of DNVGL-ST-

0164 and any actions in the certification plan. In general (but not limited to), the following actions and approvals will be carried out by DNV GL:

- inspection and testing of materials and components
- scrutiny of QM records, such as test certificates, tracers, reports
- review of competency records of manufacturing personnel
- review or witness of qualification testing
- survey by random sampling of manufacturing, including storage conditions and handling
- inspection of the corrosion protection system
- supervise inspection of coating for damage, spot check of thickness at critical areas
- inspection of the electrical power system
- witnessing of the final test
- incoming check of sub-supplied components.

When the manufacturer has in operation a quality system certified by an accredited certification body to ISO 9001, or equivalent, a manufacturing survey arrangement (MSA) may be established with the manufacturer for serial production. This is to reduce the level of manufacturing surveys of individual tidal turbines and depend on the results of initial survey visits to approve the facilities.

The MSA shall be described in a document stating the requirements, scope, acceptance criteria, documentation and the roles of DNV GL and the manufacturer in connection with the survey. It may be agreed through an MSA that the majority of the required surveys and tests are completed without the presence of a surveyor.

When establishing an MSA, an initial assessment of the manufacturer's ability to control product quality and to comply with the scope, requirements and criteria laid down in the MSA will be performed. The extent and frequency of periodical assessments of the manufacturer will be included in the MSA.

An MSA is normally given a validity of 4 years. When the MSA is based on a certified quality system, the MSA automatically becomes invalid if the quality system certificate no longer is valid.

Renewal of the manufacturing survey agreement may be necessary in the event of:

- design modifications to the tidal turbine or major components
- changes in the manufacturing processes, which can potentially influence the production quality or component properties
- starting manufacture at a new location
- changes to manufacturing facilities
- deviations or malfunction in the operation of the tidal converter that can be ascribed to manufacturing flaws.

The extent of manufacturing surveys depends on the standard of the quality management measures and shall be agreed with DNV GL. As a minimum, the quality management (QM) system shall meet the requirements of ISO 9001, whereby ISO 9000 defines fundamentals and vocabulary and ISO 9004 contains a QM approach for sustained success of an organization. The QM system shall be worked out in detail in writing. The QM system consists of at least a manual, procedures and work instructions in sufficient detail. For the manufacturers of products who do not pursue their own development activities, the exclusion of Clause 7.3 ("Design and development") within ISO 9001 is permissible.

The descriptions of the quality management measures in production shall be presented in a summarizing document for the corresponding component or assembly. The quality management examinations can be supported by means of drawings, specifications and specimen documents.

The manufacturers shall have at their disposal suitable facilities and equipment for faultless execution of the work. External facilities may be included for consideration only if these meet the prerequisites for competent execution and are available without restriction.

Equipment and facilities should be on a scale suitable for the manufacturing processes and include but not limited to the following:

- workshops, roofed-over working areas as required, equipment for assembly sites

- store-rooms for materials
- drying facilities (e.g. for welding fillers)
- lifting gear for assembly and transport
- processing machinery and tools
- tools and equipment for welding and cutting
- appliances for joining-up, and for welding, laminating, bonding and gluing
- air-condition monitoring instruments.

The personnel employed by the company shall be such as to ensure that the components can be competently prepared, manufactured and tested to the extent necessary. DNV GL may require proof of the technical qualifications of the staff.

It shall be decided in each individual case whether the compliance can be inspected in the component manufacturer's works or as part of the incoming inspection of the tidal converter manufacturer.

### 2.3.5 Evaluation of testing and characteristic measurements

For testing and measurement certification the requirements are given in DNVGL-ST-0164 and the certification plan issued at the statement of feasibility phase. During the evaluation of testing and characteristic measurements phase the applicable requirements in the certification plan shall be addressed.

A test plan shall be submitted for evaluation. The test plan shall specify main components to be tested during the test period and pass/fail criteria and data to be documented during the tests specifically addressing the certification requirements in DNVGL-ST-0164 and the certification plan:

- witnessing and evaluation of the safety-related tests selected by DNV GL from the documentation for commissioning
- protection and function tests
- power performance measurements shall be carried out in accordance with IEC TS 62600-200, (early discussions are to be carried out to agree on how to apply the tests and manage possible deviations)
- load measurements
- blade tests
- power quality and LVRT tests
- other tests (PTO tests).

**Guidance note:**

The test plan should consider the requirements of the test site, definition of the measurement load cases and the amount of data required for each, the quantities to be measured and changes in the tidal turbine configuration.

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

For the instrumentation the following requirements shall be fulfilled:

- test of safety critical instrumentation protection functions and safeguarding
- condition monitoring system shall be calibrated for the component failure modes
- parameters identified as critical to safety and operation of the turbine shall be monitored by instrumentation that can operate within the range to be measured
- evidence of reliability of instrumentation shall be provided and redundancy considered for safety or operationally critical measurements
- for prototype testing a measurement plan shall be submitted for review by DNV GL.
- for the verification of design assumptions the measurement plan shall list the parameters necessary for the verification of design assumptions the ranges to be detected, acceptance criteria and instrumentation installed.
- in the case of multiple identical prototypes deployed in a single array the measurement plan shall be carried out on one turbine. The measurement equipment should be on the first prototype completed and assumes there are no major changes as defined in [3.4.3.1] between prototypes.
- instrumentation functions at a frequency and duration that allows for verification of models and design assumptions.

Verification by testing and measurement is required to validate that the analysis (design calculations and modelling) accurately determines the design loads. Testing shall also confirm the behaviour of the control and safety systems being assessed and approved. Such verification is necessary to capture observable shortcomings and deviations from models used within the development of the tidal converter as well as during the design assessment. Special care shall be taken with regard to the number of sensors to be installed, the location of the sensors, their working range and accuracy.

The correlation between environmental loads on the site and reading of the sensors at the turbine and supporting structure are to be established and the precision of the instrumentation used for site characterisation should be compatible with the turbine and supporting structure.

### 2.3.6 Transport and installation survey

Transport and installation survey requirements shall be defined in the certification plan issued at the statement of feasibility phase. During the transport and installation survey phase the applicable activities in the certification plan shall be closed out.

Transport and installation procedures which, if necessary, take account of the special circumstances of the site and results of the site specific design assessment, shall be submitted for a check of the compatibility with the assessed design and with the prevailing transport and installation conditions (climate, job scheduling etc.).

A site plan showing the location of the Tidal Turbines shall be submitted, together with plans of the electrical installation showing how the power plant will be connected to the public grid.

The extent and amount of survey activities depends on the quality management measures of the companies involved in transport and installation. As a rule, DNV GL will carry out the following activities:

- inspection of seafastening arrangements
- monitoring of marine operations
- inspect the components for damage before transportation and again prior to installation
- inspection of the job schedules, sequences and timing (e.g. for welding, installation, bolting up)
- inspection of prefabricated subassemblies, and of components to be installed, for adequate quality of manufacture, insofar as this has not been done at the manufacturer's workshop
- spot-check survey of critical or high risk steps in the installation with emphasis at the start of operations and adjusting attendance to repeated operations depending on results (e.g. pile driving, grouting)
- inspection of grouted and bolted connections, survey of non-destructive tests (e.g. welded joints)
- inspection of the installation and functionality of corrosion protection
- inspection of the scour protection if applicable
- inspection of cable laying and trenching
- inspection of the electrical installation (cables pull-in, equipment earths and earthing system).

### 2.3.7 Commissioning survey

#### 2.3.7.1 General

Commissioning survey requirements shall be defined in the certification plan issued at the statement of feasibility phase. During the commissioning survey phase the applicable activities in the certification plan shall be closed out.

Prior to the final evaluation a commissioning survey plan shall be agreed with DNV GL. Successful execution of the commissioning survey is a prerequisite for issuance of the final acceptance and issuance of the certificate. The commissioning survey is integral part of the certification process having following objectives:

- visual inspection of electrical systems, hydraulic systems, mechanical systems and corrosion protection systems (will need to be carried out during onshore commissioning for equipment no longer accessible after deployment)
- witnessing and evaluation of the safety-related tests selected by DNV GL from the documentation for commissioning
- witnessing and evaluation of condition monitoring system functionality.

The planning of the commissioning survey depends on the accessibility for visual inspections and the conditions for testing the different components and systems of the tidal converter. The commissioning survey may be performed in several iterations or phases. The tidal turbine is inspected and the technical execution is compared to the design on which the Design Assessment is based.

Compliance with any restrictions and/or conditions stated in the certification reports (for reporting the assessment of the design documentation) is assessed as far as possible.

#### **2.3.7.2 Electrical systems**

The electrical components and the incorporation of the electrical installations into the tidal turbine and lightning protection system into the installation onshore shall be inspected. The inspection mainly comprises the following fields:

- installation of the electrical cabinets (earthing, connection of the incoming cables, fill factor of cable channels etc.)
- installation of generator, frequency converters and motors (earthing, check of rating plates etc.)
- installation of the medium-voltage switchgear in accordance with the IAC-Classification
- cable routing and installation (bending radius, distance between cables according to the specified installation method, installation of cable loop in the yaw section, installation and filling factor of cable trays and pipes, connection of shields, identification of cables in accordance with the wiring diagrams etc.)
- installation of the lightning protection system (where applicable)
- inspection of protection settings and their permanent marking
- inspection of the parameter set for the electrical rotor-blade pitch converter (if applicable) to be compliant with the parameters assessed during design assessment
- check the cooling air/watertemperatures are within equipment limits.

#### **2.3.7.3 Hydraulic systems**

The inspection of hydraulic systems mainly comprises the following fields:

- verification that systems and components conform to the system's specifications
- connection of components in the system complies with the circuit diagram
- verification that settings are adjusted to the system's specifications
- verification of monitoring devices (i.e. pressure switch) for proper function
- identification whether the hydraulic system, including all safety components, functions correctly
- manual valves and check valves correctly mounted according to design and in correct open/close position
- assurance that there is no measurable unintended leakage other than slight wetting insufficient to form a drop after the system is subjected to either the maximum working pressure or a pressure defined by the manufacturer.

#### **2.3.7.4 Mechanical systems**

The inspection of mechanical systems mainly comprises the following fields:

- inspection of technical execution of the mechanical structure, i.e. bolted connections
- inspect mechanical components and assemblies for correct installation
- guards and warning signs to be in place
- vibration mounting is correctly adjusted were required
- additional issues depending on the tidal turbine concept.

#### **2.3.7.5 Corrosion Protection systems**

The inspection of corrosion protection systems mainly comprises the following fields:

- validation check of the type and location of anodes to the system's specification of cathodic corrosion protection
- inspection of corrosion protection coating for damage



- check of the adjustment values to the impressed current system's specification if applicable.

#### **2.3.7.6 Safety and protection function tests**

If protection functions are realized by programmable devices, the logic of these devices shall be demonstrated by functional testing.

If a remote reset is possible after activation of a protection function then a means of determining that it is safe to reset shall be provided (e.g. feedback that fault has been cleared).

The following tests shall be performed during the commissioning survey to check the behaviour of the tidal turbine and the functional conformity of the protection functions to the design assessment:

- check of settings and limiting values for the protection functions
- test of rotor lock device, if applicable
- test of the independence of the protection functions from the control system
- test of emergency stop functions, at least once during operation
- activation of all braking procedures
- check of tidal turbine behaviour in the case of failure in the energy backup for protection- and control functions
- test of activation of the protection functions in scope of control concept
- check of tidal turbine behaviour in case of load shedding
- check of settings and limiting values of the vibration monitoring
- test of mechanical interlocking, if applicable
- test of electrical interlocking system to the sea cable, if applicable
- running tidal turbine for check of operational parameters i.e. current direction and speed, power output, rotational speed and temperatures
- additional tests depending on the tidal turbine concept.

#### **2.3.7.7 Offshore commissioning**

The following activities shall be performed or witnessed by DNV GL surveyors during the offshore commissioning of tidal turbines and arrays.

- witness or check MWS reports on foundation completion (fixed or mooring)
- cable continuity checking
- check CMS communication
- confirm remote controls and feedback signals are working
- locking/attachment of turbine to foundation
- confirmation of protection and safeguarding systems are operational.

#### **2.3.8 Final evaluation**

The final evaluation is carried out prior to the issue of the certificate. All requirements of the certification plan should have been completed and all documentation (certification reports and statements of compliance, certificates) will be checked for consistency and completeness with regard to the elements and modules described in this service specification.

Operation, safety and maintenance manuals shall be prepared by the technology owner and reviewed by DNV GL for completeness.

#### **2.3.9 Periodic in-service inspection**

The objective of periodic in-service inspections is regular inspection of the condition of the integrity of the entire tidal turbine and array with involvement of DNV GL to maintain the validity of the prototype, type or project certificate.

The operator is responsible for the overall organization of the periodic in-service inspection. The inspection shall be carried out by DNV GL.

Documentation relating to periodic in-service inspection shall be submitted to DNV GL. Inspection intervals



and components inspected shall be stated in the documentation. The documentation shall demonstrate that critical areas identified in the following have been considered:

- results of failure mode identification and risk ranking
- results of the design assessment summarized in the certification reports related to the type certification as well as to site specific design assessment
- results of survey within manufacturing, transport, installation and commissioning
- results of maintenance works
- results of previous periodic in-service inspections.

During periodic in-service inspection the complete Tidal Turbine shall be inspected thoroughly. The following components are essential for the periodic in-service inspection:

- blades
- gearbox/PTO
- nacelle and supporting components
- seals, dehumidifiers
- hydraulic system, pneumatic system
- sub-structure (support structure and foundation)
- floating structure
- moorings, anchors
- safety devices, emergency and NAVAID lighting, sensors and braking systems
- control system and electrics including transformer station and switchgear
- condition monitoring system
- corrosion protection
- scour protection
- interconnecting power cables.

The tidal turbine shall be checked by visual inspection, whereby the individual components including the blades shall be examined closely and the areas to be examined shall be cleaned or uncovered if relevant.

Visual inspections may be carried out by a remotely operated vehicle if it can be demonstrated that defects can be detected and is not impaired by factors such as accessibility, marine growth, resolution of cameras etc.

Structural integrity of the tidal turbine including machinery, and functioning of the safety and braking systems, shall be checked as well.

The scour protection, seabed level, underwater structure and splash zone shall be checked by approved experts on site.

The structure within the splash zone (if any) shall be inspected visually with regard to corrosion, condition of welds, marine growth and damage, e.g. from collision. Generally, marine growth must be removed for inspection. Where damage is found that could extend further down, diver inspections may be called for. Plate thickness measurements may be required where there is evidence of excessive corrosion. This shall be stated in the inspection report.

Concrete surfaces shall be inspected for cracks, abrasion, sprawling and any signs of corrosion of the steel reinforcement and embedments, particularly in the splash zone, in areas exposed to sea ice, and where repairs have been carried out previously. Cleaning of the surface may be necessary. The result of the inspection shall be stated in the inspection report.

The type, location and extent of corrosion control (i.e. coatings, cathodic protection system etc.) as well as its effectiveness, and repairs or renewals shall be stated in the inspection report.

Interconnecting power cables between the tidal turbines and the transformer station as well as power cables to the shore shall be inspected, unless they are buried.

## 2.4 Deliverables

### 2.4.1 General

The deliverables indicate the incremental nature of the certification process with each phase contributing to the next step. The deliverables provide for the gradual increase in detail and scope from the concept phase through to certification of a fully developed product. Typically these deliverables will be termed as follows.

### 2.4.2 Certificates

In order to account for the different certification phases in the development of the tidal energy converter DNV GL may issue the following certificates:

- statement of Feasibility
- prototype Certificate
- type Certificate
- component Certificate
- project Certificate
- a conditioned certificate with a limited validity of up to 1 year may be issued where non-safety related requirements of DNVGL-ST-0164 and the certification plan have not been demonstrated. With the agreement of DNV GL this allows deployment provided actions are taken to close out remaining comments.

### 2.4.3 Risk acceptance

Certificates are issued based on the risk based approach described in this document and the DNV GL standard DNVGL-ST-0164. A statement in the annex of each certificate will clearly state the level of risk acceptance applied to each device during the assessment and survey activities.

### 2.4.4 Statements of compliance and reports

For the different modules for each certification phase in the development of the tidal energy converter DNV GL may issue the following statements of compliance / reports:

- certification basis
- certification plan
- design Basis Assessment
- design Assessment
- type testing and characteristic measurements
- manufacturing survey
- final evaluation
- transport and installation survey
- commissioning survey
- final evaluation
- periodic inspection.

A statement of Compliance is only issued if there are no outstanding items. Where non safety-relevant items remain outstanding, a conditioned statement of compliance can be issued, with a validity period of one year from issue. Statements of compliance may be invalidated if modifications in design or manufacturing of the components subject to the design and manufacturing surveys are made without review / consent of the DNV GL.

Final evaluation is carried out prior to the issuing of the certificate and represents the check of all statements of compliance on consistency and completeness. Conditioned statement(s) of compliance shall result in issuance of a conditioned certificate with a validity period of one year from issue.

## 2.5 Validity and maintenance of certificates

Certificates are only issued if no outstanding items remain. In cases where there are outstanding items a conditioned certificate can be issued provided none of the outstanding items are safety-relevant. The conditioned certificate has a validity period of one year. During this validity period, all installed tidal converters of this type shall be reported quarterly to DNV GL.

In addition the following shall be reported annually to DNV GL:

- a list of all installed tidal converters of that type (including a precise designation of the variant, serial number, hub height and location)
- a list of all major modifications to the design (as defined in [3.4.3.1]), manufacturing procedures and storage conditions of components subject to the design assessment as well as, if applicable, documents for assessment of the modifications
- a list of all damages to components of the installed tidal converter forming a part of the design assessment.

Certification may be withdrawn before the validity period expires, if any part of the certificate becomes invalid due to unacceptable changes in design, production procedure or due to regular severe damages within production, erection or operation.

Upon expiry of the validity period, re-certification for the prolongation of the certificate validity will be performed at the request of the manufacturer. Where modifications have been made to a tidal converter, these shall be subjected to examination. The re-certification process culminates with the re-issuing of the certificate with a validity period of five years. For the re-certification, the following documents shall be submitted for assessment by the DNV GL:

- a list of valid drawings and specifications
- a list of current manufacturing facilities
- a list of all modifications to the design of components forming a part of the design assessment and, if applicable, documents for the assessment of the modifications
- a list of changes in the QM system since the last audit
- a list of all installed tidal converters of the type (including a precise designation of the variant, serial number, hub height and location)
- a list of all damages to the installed tidal converters on all components included in the design assessment.

## 2.6 Client obligations

### 2.6.1 During design and manufacturing

- All information that may influence the judgement, decisions and requirements of DNV GL for the purpose of certification, shall be made available to DNV GL.
- It is the customer's responsibility to document or demonstrate compliance. Information may be made available by submitting documents to DNV GL or by permitting surveys performed by DNV GL at the client's premises, or at the premises of the client's sub-contractors.
- The English language shall be used in documents submitted for approval, as well as in communications between customers and DNV GL. The possibility of using a local language shall be agreed upon in advance.
- The submitted documentation shall use SI-units (International System of Units) unless otherwise agreed.
- Provide the necessary facilities for safe execution of surveys.
- DNV GL reserves the right to decline to perform a requested service when inadequate access is provided or the safety of its surveyors may be compromised.
- Measuring and test equipment used by customers, the result of which may form the basis for the surveyor's decisions, shall have a calibration status to an appropriate accuracy according to applicable standards or as accepted by the surveyor.

- Suppliers providing services on behalf of the client, such as measurements, tests and maintenance of safety systems and equipment, the result of which may form the basis for the surveyor's decisions, shall be approved by DNV GL or have recognised accreditation.

## 2.6.2 During operation and in-service

The client shall take appropriate actions according to the requirements of the ISO 9001 certification scheme with respect to complaints and any deficiencies that affect compliance with the requirements for the respective certificate. The client shall keep records of all complaints relating to the compliance of the tidal turbine with the standards and requirements used for the certificate. These records as well as documentation for actions taken shall be available to DNV GL and to the certification body which have certified the manufacturer's quality system to ISO 9001. Reports of these records and actions taken as well as reports of minor modifications to the design shall be submitted to DNV GL, at least once per year.

Proposals for major modifications to the design, to procedures, and to specifications and other documents shall be reported without delay together with all documentation affected by the modification in order for the type certificate to be maintained and extended.

Surveys of randomly chosen specimens of each type of tidal converter/component will be carried out during the validity period of the type or component certificate for the purpose of verification of the manufacturer's design procedures, their maintenance and implementations in relation to the design procedures and the design parameters initially approved by DNV GL. The client shall provide access to the turbine chosen for inspection.

Once any safety-related accident or failure of the installed certified tidal converters or component comes to the client's knowledge, the client shall report this accident or failure to DNV GL. Such major accidents or failures may result in a request by DNV GL for corrective actions to be taken by the client in order to maintain the certificates. Based on an evaluation of the accident or failure and, if relevant, an evaluation of the corrective actions, DNV GL will decide if the certificate shall be suspended until a satisfactory corrective action is implemented.

A suspension implies that the tidal turbine may not be advertised, sold, manufactured or installed with reference to the suspended certificate. The certificate may be suspended up to maximum one year provided that a plan for corrective action by the client is agreed with DNV GL. If no satisfactory corrective action is taken, the certificate in question will be withdrawn. Certification documents issued by DNV shall upon withdrawal or suspension be returned to DNV GL.

## SECTION 3 SERVICE DESCRIPTION

### 3.1 Certification requirements

The certification phases shown in [Figure 2-1](#) are described in the following chapters.

Documentation submitted for assessment shall be in English.

### 3.2 Technology qualification

#### 3.2.1 General

Technology qualification takes place through a structured set of activities that takes place throughout the development of the tidal turbine. The extent of the technology qualification phase covers all modules as shown in [Figure 2-2](#) and described in detail in the subsections below.

The statement of feasibility can be issued after the certification plan has been defined and it can be shown that all risks can be satisfactorily managed. The statement of feasibility will be supported by technical reports giving the assumptions and conditions of the statement. The issue of the statement of feasibility will include the certification plan.

#### 3.2.2 Certification basis

The certification basis will be developed by DNV GL based on the information provided by the technology developer. In general, as a minimum, the documentation listed in appendix [\[A.1.1\]](#) -General Information - shall be submitted to DNV GL for technology qualification. The documents to be submitted are to be agreed upon with DNV GL.

The purpose of creating a certification basis document during technology qualification is to define the expectations of the technology in the absence of directly applicable codes and procedures. The process in [Figure 2-2](#) shall be followed with the intention of proving that the design meets the requirements listed in the certification basis. The certification basis submitted to DNV GL for evaluation shall comprise information about the functionality, safety strategy, environmental conditions, boundaries of the technology to be certified and limiting operating parameters for the device as well as other requirements such as conditions for manufacturing, transportation, installation, commissioning, operation and maintenance.

#### 3.2.3 Technology assessment

Designs of tidal energy converters typically contain subsystems or components which have no relevant service history, are not covered by current standards or have novel aspects that are not adequately addressed. Technology assessment is the process by which component novelty is evaluated through a structured methodology.

This assessment has to be performed at the level of detail necessary to separate proven from new technology.

The technology assessment process shall be carried out based on (but not limited to) the following documents.

- certification basis
- control philosophy
- layouts and general drawings of items subject to assessment
- line diagrams and specifications of control and safety systems
- material specifications
- outline fabrication procedures
- outline installation procedures
- outline test procedures
- outline inspection and maintenance procedures.

The technology assessment includes the following steps:

- division of the technology into manageable elements
- assessment of the technology elements with respect to the novelties
- identification of the main challenges and uncertainties related to the new technology aspects
- identification of relevant standards.

The technology assessment shall be carried out by dividing the technology into sub-systems and components with a clear statement regarding their function. Technology classification will then be applied to each subsystem or component according to the classification matrix shown [Table 3-1](#).

**Table 3-1 Technology classification**

<i>Application area</i>	<i>Technology status</i>		
	<i>Proven</i>	<i>Limited field history</i>	<i>Unproven</i>
Known	1	2	3
New	2	3	4

The classification matrix implies the class definitions shown in [Table 3-2](#). Proven technology is considered a technology classified as '1 - No new technical uncertainties'. All other classes reflect varying levels of technology novelty.

**Table 3-2 Technology class definition**

<i>Technology class</i>	<i>Definition</i>
1	No new technical uncertainties
2	New technical uncertainties
3	New technical challenges
4	Demanding new technical challenges

All systems and design phases (from manufacturing to decommissioning) should be considered. New technology (classes 2-4) will be subject to technology qualification in addition to traditional certification processes, and proven technology (class 1) will be subject to a criticality assessment and certification using applicable standards and guidelines.

## 3.2.4 Failure mode identification and risk ranking

### 3.2.4.1 General

The failure mode identification and risk ranking (FMIRR) is based on the failure mode and effects and criticality analysis (FMECA) methodology that is a qualitative reliability technique for systematically analysing each possible failure mode within a hardware system, and identifying the resulting effect on safety, environment, operation and asset. The risk ranking is a quantitative procedure which ranks failure modes according to their probability and consequences (i.e. the resulting effect of the failure mode on safety, environment, operation and asset). FMECA methodology is further described in BS 5760, Part 5, Guide to failure modes, effects and criticality analysis and IEC-60300-9, Part 3: Application guide - Section 9: Risk analysis of technological systems.

Recommended actions to control the risks are consolidated into a certification plan together with the standards and novelties identified from the technology assessment.

After evaluation of the results from the implementation of the certification plan, re-ranking of the risk can be performed. Where a risk remains high, further action is required to be defined and the FMIRR cycle repeated with the updated information. Data from the in-service life is to be used as a way to re-evaluate the FMIRR and its conclusions.

It is advisable that the risk assessment is performed using a failure mode identification and criticality format.

The process shall be carried out based on (but not limited to) the following documents:

- certification basis

- technology assessment
- drawings of items subject to review
- drawings and descriptions of control and safety systems
- material specifications
- outline manufacturing procedures
- outline installation procedures
- outline inspection and maintenance procedures.

In lieu of data obtained from specific application or technology, the probability of the event/failure to be used during the risk assessment can be derived from relevant data from other industries, provided that an assessment of the impact of the new application in the marine renewables sector is taken into account and agreed with DNV GL.

### 3.2.4.2 Risk matrix

For the FMIRR the probability and consequence classes are defined in [Table 3-3](#) to [Table 3-5](#). The risk matrix is defined in [Table 3-6](#).

**Table 3-3 Probability classes**

<i>Class</i>	<i>Name</i>	<i>Description</i>	<i>Indicative annual failure rate (up to)</i>	<i>Reference</i>
1	Very Low	Negligible event frequency	1.0E-04	Accidental (event not failure)
2	Low	Event unlikely to occur	1.0E-03	Strength / ULS
3	Medium	Event rarely expected to occur	1.0E-02	Fatigue / FLS
4	High	One or several events expected to occur during the lifetime	1.0E-01	Operation low frequency
5	Very high	One or several events expected to occur each year	1.0E+00	Operation high frequency

**Table 3-4 Consequence classes - turbine**

<i>Class</i>	<i>Description of consequences (impact on)</i>				
	<i>Safety</i>	<i>Environment</i>	<i>Operation</i>	<i>Assets</i>	<i>Cost (GBP)</i>
1	Negligible injury or health effects	Negligible pollution or no effect on environment	Negligible effect on production (hours)	Negligible	1k
2	Minor injuries or health effects	Minor pollution / slight effect on environment (minimum disruption on marine life)	Partial loss of performance (retrieval not required outside maintenance interval)	Repairable within maintenance interval	10k
3	Moderate injuries and/or health effects	Limited levels of pollution, manageable / moderate effect on environment	Loss of performance requiring retrieval outside maintenance interval	Repairable outside maintenance interval	100k
4	Significant injuries	Moderate pollution, with some clean-up costs / Serious effect on environment	Total loss of production up to 1 m (GBP)	Significant but repairable outside maintenance interval	1m
5	A fatality	Major pollution event, with significant clean-up costs / disastrous effects on the environment	Total loss of production greater than 1 m (GBP)	Loss of device, major repair needed by removal of device and exchange of major components	10m

**Table 3-5 Consequence classes - project**

Class	Description of consequences (impact on)				
	Safety	Environment	Operation	Assets	Cost (GBP)
1	Negligible injury or health effects	Negligible pollution or no effect on environment	Negligible effect on production (hours)	Negligible	10k
2	Minor injuries or health effects	Minor pollution / slight effect on environment (minimum disruption on marine life)	Loss of array performance (remedial activity takes place within scheduled maintenance)	Repairable within maintenance interval	100k
3	Moderate injuries and/or health effects	Limited levels of pollution, manageable / moderate effect on environment	Loss of array performance requiring retrieval outside maintenance interval	Repairable outside maintenance interval	1m
4	Significant injuries	Moderate pollution, with some clean-up costs / Serious effect on environment	Total loss of array production up	Loss of one device or associated array infrastructure	10m
5	A fatality	Major pollution event, with significant clean-up costs / disastrous effects on the environment	Total loss of production greater than 10 m (GBP)	Loss of multiple devices and/or array infrastructure	100m

**Guidance note:**

- The currency referred to in the consequence "cost" are to be adapted for different locations worldwide representing the general description of the consequences given in Table 3-4 and Table 3-5.
- The cost consequence in Table 3-4 and Table 3-5 is related to operation and assets not directly to safety and environment which are to be considered separately.

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**Table 3-6 Risk categories**

Probability	Consequence				
	1	2	3	4	5
5	Low	Med	High	High	High
4	Low	Med	Med	High	High
3	Low	Low	Med	Med	High
2	Low	Low	Low	Med	Med
1	Low	Low	Low	Low	Med

Notes:

Low            Tolerable, no action required

Medium       Mitigation and improvement required to reduce risk to Low

High           Not acceptable: mitigation and improvement required to reduce risk to Low (ALARP)

### 3.2.5 Certification plan

The certification plan defines the certification requirements for the turbine or array. The certification plan contains a breakdown of the turbine and arrays into systems and components, standards and codes used in addition to DNVGL-ST-0164, the required level of DNV GL activity for the project phases and qualification methods that adequately address the identified failure modes not covered by available standards.

The qualification methods, in most cases, include technical analyses, testing or combinations of the two where the purpose of the testing is to reduce uncertainty in the analysis model or calibrate it. They may also involve collection of available reliability data and review of procedures intended to reduce probability



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or consequence of failure. The list of qualification methods does not include proposed improvements to the concept and further design details to be defined.

The certification plan is a result of the technology qualification activities as described in [3.2.1] to [3.2.4] above resulting in a 'fit for purpose' set of requirements. The plan shall be issued by DNV GL and it is the responsibility of the technology owner to provide evidence that the requirements have been met.

### 3.2.6 Technology demonstration

The analytical approach of technology qualification may be supported and complemented by results obtained from testing to handle uncertainties and novelty in the technology. Tests as described below are used for materials, components, assemblies and sub-assemblies. Typical tests may be:

- Basic tests, such as testing of material properties and degradation mechanisms.
- Tests of components, sub-assemblies and assemblies to verify the functional requirements of a new type design.
- Model basin tests, testing of global response of a device in survival and operational conditions. The testing of the operational condition shall include testing of the control system.
- Simulation of the interaction between the control system and the structural behaviour.
- Small scale prototype tests (1:10 to 1:4 scale) in order to gain experience of deployment systems, control systems and to gain initial indicative reliability and performance data in an uncontrolled environment.

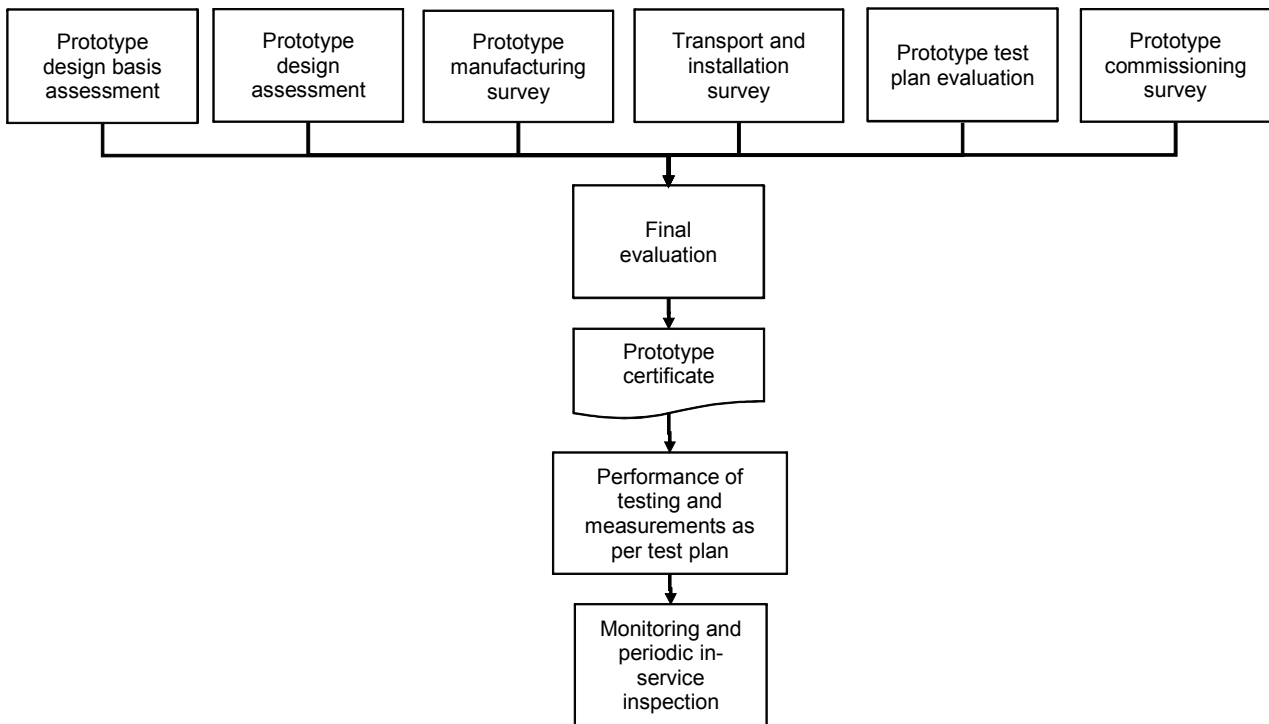
Qualification by testing shall be undertaken to address a component or system failure mode that has been identified as novel or high risk through the technology qualification process. DNV GL involvement in technology qualification tests shall be agreed as part of the certification plan.

## 3.3 Prototype certification

### 3.3.1 General

Prototype certification is performed to manage risk and enable the testing of prototypes for the purpose of collection of data and is based, in principle, on a preliminary design evaluation. Load measurements shall be performed within 2 years of installation. Load measurements shall be used to validate the values calculated during the design phase. Power performance measurements should take place within the 2 year period following installation and before extension to certificate.

Based on the certification plan DNV GL will issue a prototype certificate following successful evaluation of all modules leading to the issue of a prototype certificate as shown in [Figure 3-1](#):



**Figure 3-1 Certification modules for prototype certification**

The location of the device will be stated in the certificate and the period of validity will be limited in time. The certification scope takes into account the duration of deployment and its final objectives. The limitation is proposed in the following subsections.

The maintenance of the prototype certificate is based on successful evaluation of prototype periodical inspections and performance of the testing and characteristic measurements according to the test plan.

Additional requirements from regulatory bodies that have jurisdiction should be observed.

### 3.3.2 Scope of prototype certification

#### 3.3.2.1 General

In general all modules of the certification scope as outlined in [2.3] shall be complied with. However, the extent of some modules may be reduced for the prototype certification as described in the following subsections.

The scope of tidal turbine prototype certification may include the elements defined under [2.3.3.8] for an array where they are included in the scope of the prototype certificate. For example prototypes may incorporate elements such as foundation, substructure, subsea cables and connectors that are typically part of an array development. Activities under certification will be for the assurance of integrity of the prototype and limited to the fulfilment of objectives of deployment.

In the case that the responsibility of prototype deployment is distributed between more than one party, an agreement shall be established defining the overall aspects covered, interfaces and final deliverables consistent with the objectives of deployment.

#### 3.3.2.2 Prototype design basis assessment

Reference is made to [2.3.2].

Considering the nature and objective of prototypes some of the information in the design basis may be based on some preliminary targets and subject to adjustment after information is obtained from the deployment. It is also possible that some of the targets are adjusted at the prototype phase. In this case, it is important that the target for the prototype phase will not impair the required learning and data acquisition to support the development to achieve type certification.

### 3.3.2.3 Prototype design assessment

Reference is made to [2.3.3].

During the prototype design assessment, depending on the design life and objectives of the prototype, areas having been assessed as low risk to the prototype integrity within the period of validity may be assessed using simplified methods.

All items with safety implications, all support structures and related load assumptions must be analysed in detail. National or local regulations may also require additional detailed analysis.

The following aspects are to be addressed:

- safety and protection systems
- loads and load effects
- blades
- structural components
- machinery components
- electrical installations
- hydraulic components.

Depending on the defined design life of the prototype, fatigue assessment may be assessed in a simplified approach. Refer to [3.3.3] regarding additional activities for extending the validity of a prototype certificate.

### 3.3.2.4 Prototype manufacturing survey

Reference is made to [2.3.4].

The prototype manufacturing surveys will be carried out by DNV GL. The extent of the evaluation and the amount of samples to be surveyed depends on the standard of the quality management measures, the requirements of this service specification and the actions in the certification plan and shall be agreed with DNV GL.

### 3.3.2.5 Prototype test plan evaluation

Reference is made to [2.3.5].

A test plan for the prototype shall be submitted for evaluation. The test plan shall specify the main components to be tested during the test period and loads to be documented during the tests.

Other tests may be included in the test plan such as acoustic characterisation on request of the technology developer.

### 3.3.2.6 Prototype transport and installation survey

Transport and installation scope in [2.3.6] to be evaluated for impact on risk and assessed within prototype certification scope. Should responsibility be held by more than one party this should be addressed in line with the approach in [3.3.2.1].

### 3.3.2.7 Prototype commissioning survey

Reference is made to [2.3.7].

Commissioning may occur onshore (pre-deployment) and offshore (post-deployment). The configuration of the prototype to be commissioned shall be confirmed in a declaration by the manufacturer to be submitted to DNV GL prior to the survey. This declaration shall list at least the types and serial numbers of the main components, such as rotor blade, rotor brake, gear box, generator, converter, power transformer, yaw motor and gear, pitch motor and gear, and the electrical cabinets.

Successful execution of the commissioning survey is a prerequisite for issuance of the prototype certificate.

The implementation planning of the commissioning survey depends on the accessibility for visual inspections and the conditions for testing of the different components and systems of the tidal turbine.

### 3.3.2.8 Prototype final evaluation

Reference is made to [2.3.8].

### 3.3.2.9 Testing and characteristic measurements

Reference is made to [2.3.5] and DNVGL-ST-0164.

During the final evaluation the test plan shall be agreed with DNV GL. The agreed testing and characteristic measurements shall take place during prototype operation for the verification of assumptions, processes and analytical modelling used in design.

Load measurements to validate design analysis shall be carried out within the first 2 years prior to the extension of certificate. Where power performance is to be demonstrated this should occur within the first 2 years prior to extension of prototype certificate.

Extended testing may be carried out following the issue of extension to prototype certificate. The purpose of this testing would be to reduce uncertainties through the collection of data on long term degradation effects and to quantify the design margins.

### 3.3.2.10 Prototype periodic in-service inspections

Reference is made to [2.3.9].

The prototype periodic in-service inspections are required for the maintenance of prototype certificate and any long-term extension validity.

## 3.3.3 Validity of the prototype certificate

### 3.3.3.1 Prototype certificate

The prototype certificate is valid for a specific location and limited to two years starting from the date of the commissioning. In case the period between installation of the prototype at the site and commissioning is longer than 3 months DNV GL reserves the right to limit the period of validity.

**Guidance note:**

The technology developer may target a design life of greater than 2 years. This requires completing activities outlined in the sections [3.3.3.2] to [3.3.3.3] prior to deployment with the exception of in-service measurements which should be completed within the first two years for endorsement of the prototype certificate.

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### 3.3.3.2 Extension of the initial prototype certificate up to 5 years

Conditions for the extension of the validity of the prototype certificate for up to five years, starting from deployment date, shall be agreed with the DNV GL. In general the following shall be considered:

- after two years a comparison of the measured power curve and loads with assumptions made during design is performed
- a further operation of the prototype is permissible if the original assumptions are verified by the measurements and/or if corrective measures are taken in case of safety relevant deviations
- FLS of the rotor, the nacelle load carrying frame, the support structure and the related load assumptions shall be assessed in detail
- modifications, e.g. to the control system, are permissible, provided that the safety of the device is not adversely influenced.

### 3.3.3.3 Long term extension of the prototype certificate beyond 5 years

For long-term extension of the prototype certificate beyond five years from deployment the following conditions shall be considered:

- The number of prototype certificates is generally limited to 10 turbines for the type in question and its variants.
- In addition to the requirements for the extended prototype certificate an inspection of the turbine shall be performed by the DNV GL surveyor according to an agreed maintenance schedule. The inspection includes the detachable parts of the turbine (inspection at the berth) as well as the submerged structure by remote operating vehicles. If the submerged structures were designed to allow for no inspection during the full in-service life with adequate safety factors a reduction of inspection is allowed.
- Maintenance and CMS protocols are assessed.
- A full assessment of the control and protection system, loads and load cases, blades, main structural

and electrical components and personnel safety issues shall be performed considering all limit states (ULS, FLS, SLS, ALS). The structural components to be considered shall include the full load carrying structure, including foundation. The electrical components include all main components up to the grid connection point.

- Further modifications, e.g. to the control and safety system are not permissible.

**Guidance note:**

The limit to 10 turbines is based on the level of consequence for project risk assuming ten 1.0 to 1.5MW prototype turbines are used.

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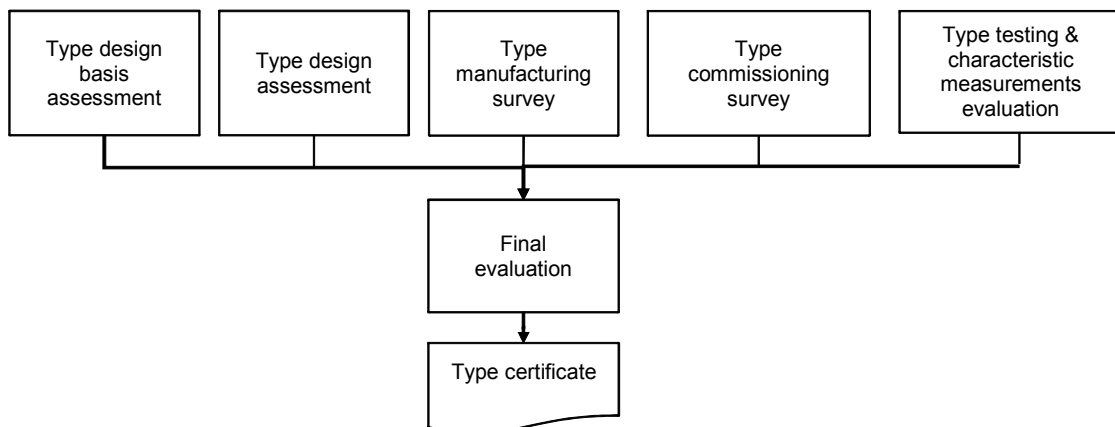
### 3.3.4 Documentation for the prototype certification

The documentation listed in Appendix [A.1] shall be submitted to DNV GL for assessment. The exact document types and level of detail is to be agreed upon with DNV GL.

## 3.4 Type certification

### 3.4.1 General

During type certification the overall design of the tidal turbine is assessed. The type certificate is issued for a tidal turbine for serial production with no outstanding issues. To obtain a type certificate the certification modules shown in Figure 3-2 are to be carried out.



**Figure 3-2 Certification modules for type certification**

### 3.4.2 Scope of type certification

#### 3.4.2.1 General

All modules of the certification scope as outlined in [2.3] with the exception of array infrastructure in [2.3.3.8] shall be complied with.

The certification covers all components and elements of the tidal turbine built in series over a number of units. Evaluation, assessment and certification include (but are not limited to) safety, design, construction, manufacturing and overall quality. DNV GL will issue a type certificate following successful evaluation of the following:

#### 3.4.2.2 Type design basis assessment

Reference is made to [2.3.2].

#### 3.4.2.3 Type design assessment

Reference is made to [2.3.3].

#### 3.4.2.4 Type manufacturing survey

Reference is made to [2.3.4].

### 3.4.2.5 Type testing and characteristic measurements evaluation

Reference is made to [2.3.5] and DNVGL-ST-0164.

The purpose of type testing is to prove the tidal turbine performance with respect to power production and to verify the load calculations and turbine design. A test plan comprising the following elements shall be provided and approved by DNV GL:

- safety and function test and type inspection
- power performance measurements
- load measurements
- blade tests
- other tests including gearbox/PTO field test
- characteristics measurements including power quality tests and low-voltage ride-through (LVRT) tests.

All tests and measurements shall be performed according to the DNV GL approved test plan by accredited test laboratories or measurement institutes, respectively. For non-accredited laboratories and institutes, DNV GL will witness the tests and measurements.

Other tests may be included in the test plan such as acoustic characterisation on request of the developer.

### 3.4.2.6 Type commissioning survey

Reference is made to [2.3.7] and shall be completed for the first device to be installed. A commissioning manual shall be produced.

### 3.4.2.7 Type final evaluation

Reference is made to [2.3.8].

The purpose of the final evaluation is to provide documentation of the findings from the evaluation of the elements of the type certification.

The final evaluation module summarizes the mandatory modules and the status of the activities in the certification plan. It will address whether the type design documentation is complete and whether the type test results confirm the relevant design assumptions. Also the final tidal turbine documentation including drawings, specifications and manuals is reviewed for compliance with the manufacturing survey and the design calculations.

The final evaluation report is issued when a satisfactory result of the evaluation has been achieved.

The final evaluation report will contain a reference list of all supporting product documentation. It will contain an evaluation of whether the detailed documentation is complete. It will also contain an evaluation of whether the type test results confirm that all relevant requirements set forth in the design documentation have been met.

The final evaluation report will contain a review of the final product documentation and will confirm that it is consistent with the supporting design calculations and with relevant design assumptions. The documentation will include:

- drawings
- components list
- procurement specifications
- manuals.

The type certificate for the tidal turbine type subject to certification will be issued based on a satisfactory final evaluation. The type certificate refers to the statements of compliance for the completed modules:

- type design basis assessment
- type design assessment
- type manufacturing survey
- type commissioning survey
- type testing and characteristics measurements.

### 3.4.2.8 Type periodic in-service inspection

Reference is made to [2.3.9].

## 3.4.3 Validity of the type certificate

### 3.4.3.1 General

Reference is made to [2.5].

The type certificate refers to statements of compliance issued for the completed modules. The type certificate is valid for 5 years after date of first issuance, except for the conditioned type certificate whose validity is limited to one year.

Changes of the tidal turbine design may lead to issuance of a new revision of the certificate upon successful review. The new revision will have the same expiry date as the original certificate. In case of major changes, a new certificate with 5-year validity will be issued upon successful review.

Maintenance of the type certificate is conditioned on:

- annual reporting by client covering all installed turbines of the certified type and including information about:
- abnormal or deviant operating experience or operating failures
- minor modifications
- reporting by the client of planned major modifications without delay and in sufficient time to allow for evaluation by DNV GL before implementation and to enable update of the type certificate
- inspections during the validity period of the certificate performed by DNV GL during maintenance work of the tidal turbine onshore.
- Periodic inspection of one production example of a turbine every 2.5 years for assurance that the design as per Type Certificate is used unchanged.

Optionally, DNV GL may issue a statement of compliance confirming acceptance of annual reporting by the client.

Modifications to a tidal turbine for which a type certificate has been issued are permitted only if they do not change or affect the principal characteristics. Any of the following changes will require a new type certificate:

- change in rotor diameter by more than 2%
- change in rotor rotational speed by more than 2%
- changes to the design of the safety system
- changes to the method for limiting the power output
- modified blade profiles
- modifications which lead to a significant increase in the load spectrum
- increase of the rated power by more than 5%
- major modifications to the tidal turbine design
- change of main components.

**Guidance note:**

Examples of major design changes:

- change in number or quality of bolts
- change in geometry of components
- change in type and quality of material
- change in sub supplier e.g. bearing, gearbox, hydraulic unit and controller.

Example of minor design changes:

- additional drilled holes in non-loaded areas of housing
- change of standard parts (screws, springs etc.)
- new corrosion protection according to specification
- exchange of catalogue parts (circuit breakers, resistors, fittings, hoses, etc.).

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DNV GL may require recertification if additional requirements for maintenance of the type certificate are set by national authorities or by the applicable design code or standard during the validity period of the certificate.

Upon failure to conform to the conditions of the type certificate, the client will be requested by DNV GL to correct the non-conforming situation within a specified time frame.

If no satisfactory corrective action is taken, the type certificate in question will be withdrawn and the accreditation authority, under whose authority the type certificate was issued, will be informed accordingly. Certification documents issued by DNV GL shall upon withdrawal or suspension be returned as requested by DNV GL.

Major revision to a referenced standard as well as other new industry learning during the validity period for a type certificate will be evaluated by DNV GL. If such a revision is judged to have implications for the integrity and safety of the certified tidal turbine, the turbine will have to be modified and/or re-evaluated in order to retain its type certificate. Transition periods and guidance for implementation of new revisions will be established by DNV GL for each individual case.

#### **3.4.3.2 Conditioned type certificate**

The conditioned type certificate is a specific type certificate issued to allow for 0-series production, as well as to allow for outstanding matters with no safety implication. The conditioned type certificate is based on the full certification scope with the exception that outstanding issues are permitted. These outstanding issues (all of which must be addressed within a maximum of 1 year) are limited to:

- areas with no safety implication
- areas related to the finalization of manuals and quality control procedures
- areas related to the finalization of inspections regarding the implementation of the manufacturing survey.

#### **3.4.4 Documentation for the type certification**

The documentation listed in appendix [A.1] shall be submitted to DNV GL for assessment. The exact scope is to be agreed upon with DNV GL based on the requirements of DNVGL-ST-0164 and the certification plan.

### **3.5 Component certification**

A Component Certificate can be issued for specific components; such as blades, gearbox and machinery and with Technology Class 1 or, in some cases, Technology Class 2 (see [3.2.3], Table 3-2). Component certification covers the relevant modules of type certification to an extent that depends on the component in question. For component certification it is required that the interface shall be clearly defined. Sections [3.4.1] to [3.4.3] are also applicable for component certification.

### **3.6 Project certification**

#### **3.6.1 General**

Project certification shall confirm, for a specific site, that the tidal turbine or array of turbines meets requirements governed by site-specific external conditions. It shall also demonstrate the tidal turbine to be in compliance with other requirements relevant to the site (such as soil and environmental conditions, etc.) and includes a design assessment of site-specific built components.

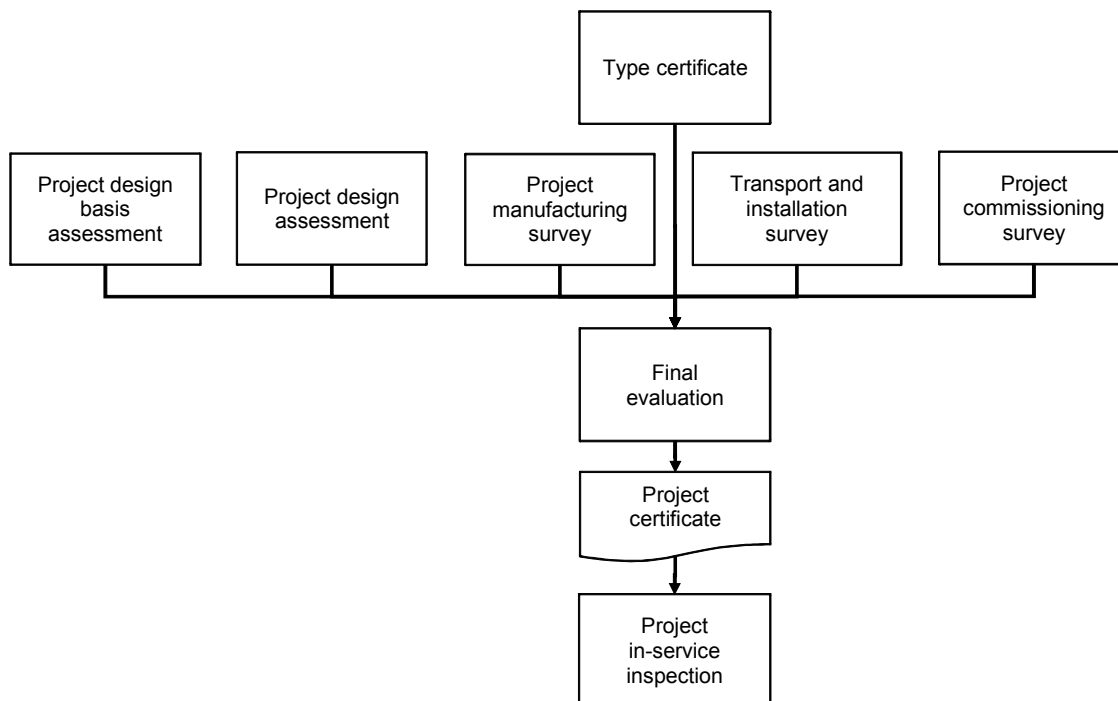
Project certification shall be based upon type certification, and includes all the elements thereof. Any additional site specific designs and/or design changes related to the tidal turbine are to be considered within project certification.

Monitoring and surveys are performed during all critical phases of the power plant life. Surveillance begins during the manufacturing process, and continues during transport and installation of the tidal turbine(s). The commissioning of a device is witnessed, and periodic monitoring is carried out at agreed intervals.

Project certification as a rule covers more than one tidal turbine, i.e. an entire array. It includes consideration of array effects, the design, manufacturing, installation and commissioning of all necessary installations, power cabling, power transmission and the transformer substation.



To obtain a project certificate the certification modules shown in Figure 3-3 are to be carried out.



**Figure 3-3 Certification modules for project certification**

## 3.6.2 Scope of project certification

### 3.6.2.1 General

All modules of the certification scope as outlined in Figure 3-3 shall be complied. DNV GL will issue a project certificate following successful evaluation of the following:

- project design basis assessment
- project design assessment including:
  - support structure design assessment
  - Project infrastructure design assessment.
- project manufacturing surveys including:
  - support structure manufacturing survey
  - Project infrastructure manufacturing survey.
- project characteristics measurements (optional)
- project transport and installation survey
- project commissioning survey
- project final evaluation
- project periodic in-service inspection.

In the case that a DNV GL type certificate is not available then the elements of type certification as defined in [3.4] shall be completed within the project certification scope.

### 3.6.2.2 Project design basis assessment

Reference is made to [2.3.2].

The assessment of the site-specific design basis includes the examination of environment-related influences (design conditions) on the tidal turbine and the turbine array as well as auxiliary structures of the tidal turbine and the mutual influence of the configuration.

The following (but not limited to) site design conditions shall be documented:

- marine conditions (bathymetry, currents, tides, waves, correlation of wind and waves, sea-ice, scour, marine growth, directionality etc.)
- soil conditions
- site and tidal energy converter configuration
- other environmental conditions, such as: salt content of the air/water, temperature, ice and snow (for floating), humidity, etc.
- electrical network conditions
- influence of nearby turbine arrays.

The site design conditions shall be summarized in the design basis. Furthermore, the design basis shall include all parameters relevant for the tidal turbine array design, stating the methods to be used. If values are taken from background documents, those shall be referenced. All background documentation shall be handed in. The reports shall be provided by accredited measurement institutes. The design basis will be assessed for consistency, quality and completeness.

### **3.6.2.3 Project design assessment**

Reference is made to [2.3.3].

The project design assessment is based on the external conditions at the site and takes place with subdivision into the following assessment steps:

- site-specific load analyses, including requirements for the electrical power network conditions
- comparison of site-specific loads with those from the design assessment of the Tidal Turbine type
- site-specific support structure and foundation
- modifications to the machinery components and blades in relation to design assessment, if applicable
- stress reserve calculations for the machinery components and blades, if load comparison indicates higher loads than considered in the Tidal Turbine type design assessment
- site-specific electrical installation, cables and connections.

During the assessment it shall be shown that the tidal turbine is suitable for the intended site and that the requirements for the structural integrity of the tidal turbine are met with due consideration for the external conditions.

For the installation of a tidal turbine within an array the influence on the loads due to blockage and wake effects shall be determined. For confirmation that type certification conditions are not exceeded limited load monitoring should be distributed within the operational array.

Verification of the structural integrity can be provided through a comparison of the loads calculated for the site with the loads used for the design assessment within the type certification. It shall be shown that the loads and deflections occurring at the tidal turbine are smaller for all relevant sections than those assumed within the type certification design assessment. The scope of the comparison shall be determined in consultation with the DNV GL.

If the site-specific loads are higher than assumed during the above mentioned design assessment, the verification for certain components can be provided in consultation with the DNV GL in the form of residual safety analyses.

It may become obvious during the site-specific design assessment that, due to increased loads, a component needs to be modified or substituted. In this case, the design assessment of this component shall be performed.

The design assessment of auxiliary structures shall be performed according to DNVGL-ST-0164.

At the date of issuance of the statement of compliance for the project design assessment a valid type certificate of the turbine shall be available.

### **3.6.2.4 Project manufacturing survey**

Reference is made to [2.3.4].

The scope of the project manufacturing surveys has to be agreed with and surveyed by DNV GL. DNV GL is obligated to follow up all quality-relevant non-conformities found during the surveys. Quality-relevant non-conformities and their consequences are communicated shortly after their finding. In case the requirements are not met, the amount of surveys will be increased accordingly.

The extent and amount of the project manufacturing surveys normally complies:

- manufacturing survey
- evaluation of client's quality system
- product related quality audits
- survey of manufacturer's quality activities
- periodic inspections.

### **3.6.2.5 Project transport and installation survey**

Reference is made to [2.3.6].

Survey during transport and installation is undertaken to ensure the structural integrity of the tidal turbines, offshore substation, infield cabling and the certification requirements are met.

Before work begins, transport and installation manuals shall be submitted, which take account of any special circumstances relating to the site, where necessary. Installation methods, reparation methods, precautions, application of protections, limit values (e.g. for bolting connection tightening), timing, shall be checked for compatibility with the assessed design as well.

The extent of the transport and installation survey activities and the amount of samples to be surveyed depends on the quality management measures of the companies involved in transport and installation. However, the scope of transport and installation surveys has to be agreed with DNV GL. Transport and installation of at least one whole tidal turbine shall be surveyed by DNV GL. If required, DNV GL can extend the scope of the survey depending on the success of the processes. DNV GL is obligated to follow up major damages with impact to the integrity of the tidal turbine found during surveys. Quality-relevant non-conformities and their consequences are communicated shortly after their finding. In case the requirements are not met, the number of surveys will be increased accordingly.

### **3.6.2.6 Project commissioning survey**

Reference is made to [2.3.7].

The project commissioning survey is to be performed for a tidal turbine array and shall finally confirm that every turbine is ready to operate and fulfils all standards and requirements to be applied.

The scope of the project commissioning survey has to be agreed with DNV GL. At least one whole tidal turbine shall be surveyed by DNV GL. DNV GL is obligated to follow up quality-relevant non-conformities found during the survey. Quality-relevant non-conformities and their consequences are communicated shortly after their finding. In case the requirements are not met, the amount of surveys will be increased accordingly.

In the course of commissioning, all the functions of the tidal turbine derived from its operating mode shall be tested. This includes the following tests and activities:

- functioning of the emergency stop buttons
- testing of all braking programs
- functioning of the yaw system, if applicable
- behaviour at loss of load (grid loss)
- behaviour at overspeed
- functioning of automatic operation
- visual inspection of the installation as far as possible
- checking the logic of the control system's indicators
- operation of ballast system and bilge pumps, if applicable
- draught and stability for floating structures
- check the corrosion protection system

- check on damages
- compliance of the main components with the certified design, traceability and numeration.

Overall project commissioning survey activities have to be divided into onshore commissioning at the manufacturer yard, harbour pre-sail commissioning and offshore post-installation commissioning.

Before the project commissioning survey starts, commissioning documentation (i.e. description of all onshore, harbour and offshore commissioning activities planned) shall be submitted to DNV GL.

Before the start of the offshore post-installation commissioning, the manufacturer shall provide proof that the tidal turbines have been erected properly and, as far as necessary, tested to ensure that the operation is safe. In the absence of such proof, appropriate tests shall be carried out when putting the tidal turbines into operation.

#### **3.6.2.7 Project final evaluation**

Reference is made to [2.3.8].

Final evaluation is carried out prior to the issue of the project certificate. All parts of the certification (certification reports and statements of compliance, type certificate) will be checked for consistency and completeness with regard to the elements and modules described in this specification.

#### **3.6.2.8 Project periodic in-service inspections**

Reference is made to [2.3.9].

Periodic in-service inspections of tidal turbines, cables, subsea substation, etc. shall be carried out to maintain the validity of the certificate. The condition of the tidal turbine, cables, substation, etc. shall be monitored periodically by DNV GL. The periodic in-service inspections interval is five years as a rule. This interval may be varied depending on the condition of the array and requirements in the certification plan based on a risk assessment. The numbers of turbines in an array to be inspected will be agreed prior to inspection and numbers will be adjusted based on findings.

To maintain validity of the certificate the following must be reported and assessed for impact on certification by DNV GL:

- Any damage or major repairs
- Any alterations
- Maintenance records.

The extent to which repair, modification and maintenance work should be supervised should be agreed with DNV GL.

#### **3.6.2.9 Power plant performance**

Optionally power plant performance may be evaluated through measurements at locations representing the site conditions with due attention to blockage and wake effects.

### **3.6.3 Validity of the project certificate**

Reference is made to [2.5].

The DNV GL project certificate refers to statements of compliance issued for the completed modules of the project certification.

The statements of compliance and project certificate are only issued in case of absence of outstanding items. Where non safety-relevant items remain outstanding, a conditioned statement of compliance can be issued. One or more conditional statements of compliance or a conditional type certificate lead to a conditional project certificate.

In general the maximum validity of the project certificate is limited to the design life-time of the installation stated in the project certificate, subject to annual endorsement. The validity of the project certificate is conditioned on successful periodic in-service inspections performed by DNV GL. The operator is responsible for the following:

- annual reporting covering the certified tidal turbine project and including information about:

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- installed tidal turbines and additional installations on the site
  - deviating operating experience
  - minor modifications
  - reporting by the client of planned major modifications without delay
  - the tidal turbine array and the assets are maintained to comply with the requirements of applicable codes and relevant manuals
  - Periodic in-service inspections by DNV GL.

If these conditions are not fulfilled, the DNV GL is entitled to require re-certification or to terminate the Project certificate's validity.

The project certificate is valid for one year after the date of the first issuance. If a periodical in-service agreement for the tidal turbine array is in place between DNV GL and the client, the validity period of the project certificate is extended to the duration of the service agreement plus one year; however, five years is the maximum period of validity. Following a successful completion of an in-service inspection, an in-service statement of compliance will be issued that validates the project certificate.

DNV GL may require re-certification 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.

Major revision to a referenced standard as well as other new industry learning during the validity period for a project certificate will be evaluated by DNV GL. If such a revision is judged to have implications for the integrity and safety of the certified tidal turbine array, the array will have to be modified and/or re-evaluated in order to retain its project certificate. Transition periods and guidance for implementation of new revisions will be established by DNV GL for each individual case.

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

#### 3.6.4 Documentation for the project certification

The documentation listed in appendix [\[A.2\]](#) shall be submitted to DNV GL for assessment. The exact scope is to be agreed upon with DNV GL.

## APPENDIX A DOCUMENTATION

### A.1 Documentation required for the certification

The typical documentation to be submitted in connection with certification is described below. The level of detail and areas to be covered will depend on the certification phase.

Depending on the type of device, parts of or whole groups of documentation described in the following will not be relevant. A detailed list reflecting the type of converter and operational mode must therefore be established in each case. More information on documentation to be submitted is given in the different parts of this service specification.

#### A.1.1 General information

The following general information shall be submitted:

- General description of the tidal converter, including the energy conversion concept (generator/converter system), power generation targets and installation concept.
- Listing of the primary components to be used (e.g. blades, main bearing, gearbox, brake, generator, converter etc.).
- Map of the installation location, bathymetry, metocean site conditions (currents, sea states, ice, currents, tidal levels), load case definitions as well as assumptions for marine growth and density etc.
- Access and maintenance concept.

#### A.1.2 Design basis

##### A.1.2.1 Documents including but not limited to the following information as required for the design activities.

- general system description
- operating limitations
- design parameters
- standards and codes applied for design
- provisions for authority requirements
- main principles for manufacturing, transportation, installation, commissioning, operation and maintenance as well as abandonment
- materials selection
- environment (internal and external)
- definition of turbine operational modes and limits
- variable functional loads
- main principles for quality assurance
- reliability targets.

#### A.1.3 Environmental data

The environmental data used as basis for the design should be submitted. This should include:

- wave data
- wind speeds, if relevant
- current profile and turbulence intensity
- water depths
- soil conditions
- marine growth, thickness and specific weight
- seismic conditions
- design temperatures.

## A.1.4 Validation of loads

The manufacturer shall document the load analysis and also provide a summary of the loads used for the design. The documentation shall include a load case description and a description of calculation models and input data such as

- parameter values relating to hydrodynamics
- structural characteristics
- parameter values relating to the control system.
- report on the result from the load analysis
- description of load analysis software including post processing tools as well as version control/validation of the applied software
- description of type of sensors used to collect data for validation of the load analysis
- full input and output data including time series, FFT spectra, statistics, RFC spectra, Markov matrices, extreme loads, fatigue load spectra
- load analysis result summary for key locations and individual components such as blade, hub, shaft, gearbox, yaw system, supporting structure.

## A.1.5 Structural design

### A.1.5.1 Fixed structures

The documentation to be submitted for verification of the structural design of a fixed structure shall include:

- general arrangement plan
- description of computer programs used in design
- location and orientation of the Tidal Turbine
- soil data and foundation analysis
- description of scour protection system, if relevant
- structural design brief
- plan defining design load cases to be used, including design accidental loads
- design calculations including results of the complete load analysis, i.e. extreme and fatigue load tables, maximum rotor speed, maximum blade deflection and a Campbell diagram shall be submitted
- structural categorization plan
- selection of materials
- structural drawings
- fabrication specification including welding procedures
- design analyses, both global and local design including temporary phases such as transit
- standard details
- local arrangement plans
- corrosion protection
- description of access for inspection and maintenance of the system.

### A.1.5.2 Floating structures

The documentation to be submitted for the verification of the structural design of a floating structure shall include:

- general arrangement plan
- structural design brief
- design load plan, including design accidental loads
- structural categorization plan
- selection of materials
- plans for spaces and compartments
- structural drawings

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- model test documentation
  - loading manual containing the design loading and ballast conditions, including transport and operational conditions upon which the approval of hull scantlings is based
  - fabrication specification, including welding procedures
  - design analyses, global and local design, including temporary phases such as transit
  - standard details
  - local arrangement plans
  - corrosion protection
  - stability, including inclining test procedure, stability manual, watertight integrity plans, etc.
  - freeboard plan and list of watertight and weather tight items
  - description of access for inspection and maintenance of the structure.

#### **A.1.5.3 Blades**

The documentation to be submitted for verification of the blades shall include:

- main drawings of the rotor blade, including structural design and blade connection
- calculation reports for blade.

#### **A.1.5.4 Moorings**

Typically the mooring will comprise the anchors, anchor lines, windlasses and winches on board of the Tidal Turbine. The following documentation shall be submitted:

- line and anchor pattern
- type and weight and dimension of all line segments
- characteristic line length
- anchor type, size, weight and material specification
- arrangement and pretensions of fairleads and anchor points
- position and weight of buoyancy elements and ballast elements
- position and type of connection elements, such as Kenter shackles, D-shackles and triplates
- windlass, winch and stopper design
- mooring line tensions in ULS (including abnormal limit states) and ALS limit states
- fatigue calculations of mooring line segments and accessories
- strength calculations of anchors, windlass components and fairleads
- corrosion allowance.

#### **A.1.6 Machinery and marine systems**

Typical Machinery and marine systems include ballast system, bilge system, HVAC system. Documentation for such systems shall include:

- functional descriptions
- piping (or ducting) and instrumentation diagrams
- piping specifications
- control system
- reliability studies for critical systems
- description of the condition monitoring system
- description, drawings and calculations of power take-off system and components.

#### **A.1.7 Hydraulic systems**

Documentation required for verification of hydraulic systems shall include:

- hydraulic diagram
- functional specification



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- functional description, including references to valve positions for different operational states
  - pressure vessel design calculations
  - piping specifications
  - control system and instrumentation specifications
  - reliability studies of critical components.

### A.1.8 Electrical systems

The verification of the electrical system will be based on the following typical documentation:

- system description
- line diagram
- generator and main electric components specification and data sheet
- converter specification
- overall single line diagram for emergency power
- principal cable routing sketch
- cable selection philosophy
- load balance
- discrimination analysis
- electrical system calculations
- battery systems
- reliability studies for critical systems.

### A.1.9 Instrumentation and control systems

Typical documentation for the instrumentation and control systems shall include:

- functional description of control and safety system
- system block diagrams
- power supply arrangements
- user interfaces
- instrumentation and equipment lists
- arrangement and layouts
- description of functions covered by software
- black start arrangements
- emergency shutdown system
- reliability studies for critical systems.

## A.2 Documentation required for the project certification

### A.2.1 Turbine and support structure / moorings:

- site conditions
- design calculations addressing the turbine at the site conditions (including temporary phases).

### A.2.2 Subsea power cables:

The documentation to be provided should comply with DNVGL-RP-0360 *Subsea power cables in shallow water* (section 9) and DNVGL-ST-0359 *Subsea power cables* (Appendix 1) covering the cable system design, cables, route, protection, interface at fixed offshore units, landfall, manufacturing, installation, operation and maintenance.

### A.2.3 Substation:

- design basis
- structural design and geotechnical design
- electrical design
- main system design and component loading (main transformer, switchgear, cables and, if applicable, semiconductor converter)
- arrangement of components, with regard to safety
- system earthing
- cabling
- emergency power system.

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

- functional design specification
- single line diagrams including identification of components
- data sheets for electrical equipment
- system earthing and bonding principles.

The following documentation for cabling shall be submitted for verification:

- cable selection philosophy
- cable routing sketch
- cable sizing and specifications, including fire properties and certificate reference
- cable schedules.

Specific studies for which documentation shall be made available include:

- short circuit study
- discrimination study
- load calculations on emergency power systems.

The verification activities will include review of the following:


- high-voltage / power equipment safety
- control and protection systems
- main component (main transformer, converter, switchgear) utilization and protection
- emergency generation capabilities
- heating/ventilation/air conditioning, also as corrosion protection measure.

The power and communication cables will be reviewed with regard to

- selection of low smoke, low fume types suitable in offshore environments
- cable loading
- cable routing.

Optionally, the electrical performance of the substation connected to tidal array and grid can be reviewed by analysing:

- tidal array electrical layout
- active and reactive power flows
- influence on existing electrical power grid (harmonics, flickers, lines overload, compensation)
- critical details
- fire and explosion protection design
- access and transfer design
- emergency response design

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- load-out, transportation, installation and commissioning plan
  - operation and maintenance plan.

#### A.2.4 Subsea substations:

Documentation should cover:

- stability during deployment and at seabed
- watertight integrity
- connection and disconnection
- retrieval.

## APPENDIX B SCOPE OF CERTIFICATION - OVERVIEW

The table below outlines and summarises the overall scope of certification based on the risk levels identified in DNV GL-ST-0164.

**Table B-1**

Certification module	Scope	Statement of feasibility	Prototype certification			Type certification	Project certification
			2 years	Extension to 5 years	Extension greater than 5 years		
Technology qualification	Systems and components		As per section [3.2]				
Design basis assessment	Review of design basis	[2.3.2]	As per [3.3.2.2]			As per [3.4.2.2]	As per [3.6.2.2]
Design assessment	Safety system		As per [2.3.3.2]			As per [2.3.3.2]	As per [2.3.3.2]
	Control system		High level review focus on safety	As per [2.3.3.2]		As per [2.3.3.2]	As per [2.3.3.2]
	Load case description		Review load case table including site specific requirements			Review load case table	Review load case table including site specific requirements
	Extreme loads		Review of documentation and simplified independent assessment	Document review and independent assessment		Document review and independent assessment	Document review and independent assessment
	Fatigue loads		High level review	Document review, independent assessment and review of measurements		Document review and independent assessment including prototype measurement results	Document review and independent assessment
	Rotor blade design		As per [2.3.3.4]			As per [2.3.3.4]	
	Structures		Main structure and focus on strength	Detail assessment of structures increased focus on degradation	As per [2.3.3.5]	As per [2.3.3.5]	As per [3.6.2.3]
	Machinery components		High level review focus on safety	As per [3.3.2.2] and review of in-service records		As per [2.3.3.6] or as per [3.5]	As per [3.6.2.3], site specific components and changes to type certified components

Table B-1 (Continued)

Certification module	Scope	Statement of feasibility	Prototype certification			Type certification	Project certification
			2 years	Extension to 5 years	Extension greater than 5 years		
Design assessment (Continued)	Electrical components and systems		High level review focus on safety	As per [3.3.2.2] and review of in-service records		As per [2.3.3.7] or as per [3.5]	As per [3.6.2.3], site specific components and changes to type certified components
	Design for transportation, installation and maintenance		As per [2.3.3.9]	As per [2.3.3.9] review of maintenance plan based on operational experience		As per [2.3.3.9]	As per [2.3.3.9]
	Personnel safety		As per [2.3.3.10]				
	Quality management		[2.3.3.11]				
	Array infrastructure						As per [2.3.3.8]
Manufacturing survey	Survey of components and structures		As per [3.3.2.4]			As per [3.4.2.4]	As per [3.6.2.4]
Testing	Safety and function tests		According to agreed test plan as per [3.3.2.5]	Retest if changes made to system or components		as per [3.4.2.5]	site specific components and changes to type certified components
	Power performance measurements		According to agreed test plan as per [3.3.2.5]	Extend data collection to reduce uncertainty levels		as per [3.4.2.5]	Optional performance testing of power plant as per [3.6.2.9]
	Load measurements		According to agreed test plan as per [3.3.2.5]	Extend data collection to reduce uncertainty levels		as per [3.4.2.5]	Review monitoring plan and measurement results
	Blade tests		According to agreed test plan as per [3.3.2.5]	Blade inspection during maintenance periods		as per [3.4.2.5]	
	Other tests		According to agreed test plan as per [3.3.2.5]			as per [3.4.2.5]	site specific components and changes to type certified components
Installation survey	Risk control of installation elements		As per [3.3.2.6]	Review updates to procedures			As per [3.6.2.5]

**Table B-1 (Continued)**

Certification module	Scope	Statement of feasibility	Prototype certification			Type certification	Project certification
			2 years	Extension to 5 years	Extension greater than 5 years		
Commissioning survey	Systems commissioning		As per [3.3.2.7]	If changes made		Commissioning takes place as part of project scope	As per [3.6.2.6]
	Visual inspection of the tidal turbine		During onshore commissioning	Accessible areas during maintenance		Final inspection	Final inspection for accessible components and structures
	Witnessing and evaluation of safety-related tests selected from the commissioning manual		As per [2.3.7.6]	Retest if changes made to system or components		As per [2.3.7.6]	As per [2.3.7.6]
	Witnessing and evaluation of condition monitoring system functionality		During commissioning	Review data log and reports		As sample during in-service	As sample during in-service
Final evaluation	Final review and completion of activities		As per [2.3.8] within limitations in [3.3.2.1]	Additional requirements in [3.3.3.2]	Additional requirements in [3.3.3.3]	As per [3.4.2.7]	As per [3.6.2.7]
Periodic in-service inspection	Maintenance of validity of certificate		[3.3.2.10]			As per [2.3.9]	As per [3.6.2.9]
Deliverable			Prototype certificate valid for 2 years	Prototype certificate validity extended for 5 years	Prototype certificate validity extended for >5 years	Type certificate	Project certificate

## APPENDIX C EXAMPLES OF CERTIFICATION DELIVERABLES

# STATEMENT OF FEASIBILITY

Statement No.: SOF-DNVGL-SE-0163-[ID with 5 digits]-[rev.] Issued: [YYYY]-[MM]-[DD]

Issued for:

## Qualification of new technology

of

### <Tidal turbine / component type>

Specified in Annex 1

Issued to:

### <Tidal turbine / component manufacturer>

< Address line >

< Address line >

According to:

### DNVGL-SE-0163:2015-10, Certification of tidal turbines and arrays

Based on the document:

CR-F-DNVGL-SE-0163-[ID]-[rev.] Certification report, dated yyyy-mm-dd  
CP-F-DNVGL-SE-0163-[ID]-[rev.] Certification plan, dated yyyy-mm-dd

Changes of the design are to be approved by DNV GL.

Place, yyyy-mm-dd

For DNV GL Renewables Certification

[Name of SLL for "Cert. decision"]  
[Function]



By DAkKS according DIN EN IEC/ISO 17065 accredited Certification Body for products. The accreditation is valid for the fields of certification listed in the certificate.

Place, yyyy-mm-dd

For DNV GL Renewables Certification

[Name of PM "responsible"]  
[Function]

The accredited certification body is Germanischer Lloyd Industrial Services GmbH, Brooktorkai 18, 20457 Hamburg. DNV GL Renewables Certification is the trading name of DNV GL's certification business in the renewable energy industry.

# PROTOTYPE CERTIFICATE

Certificate No.:  
PT-DNVGL-SE-0163-[ID with 5 digits]-[rev.]

Issued:  
[YYYY]-[MM]-[DD]

Valid until:  
[YYYY]-[MM]-[DD]

Issued for:

**<Tidal turbine type / component type>**

Specified in Annex 1

Issued to:

**<Tidal turbine / component manufacturer>**

< Address line >

< Address line >

According to:

**DNVGL-SE-0163: 2015-10, Certification of tidal turbines and arrays**

Based on the documents:

DB-DNVGL-SE-0163-[ID]-[rev.]

Design basis statement of compliance, dated yyyy-mm-dd

D-DNVGL-SE-0163-[ID]-[rev.]

Design statement of compliance, dated yyyy-mm-dd

M-DNVGL-SE-0163-[ID]-[rev.]

Manufacturing statement of compliance, dated yyyy-mm-dd

[CB certificate ref.]

Component certificate issued by <CB> for <Component>

CR-TTR-DNVGL-SE-0163-[ID]-[rev.]

Test plan certification report, dated yyyy-mm-dd

TI-DNVGL-SE-0163-[ID]-[rev.]

Transport and installation statement of compliance,  
dated yyyy-mm-dd

CT-DNVGL-SE-0163-[ID]-[rev.]

Commissioning statement of compliance, dated yyyy-mm-dd

FCR-PT-DNVGL-SE-0163-[ID]-[rev.]

Final certification report, dated yyyy-mm-dd

Changes of the system design, the production and erection or the manufacturer's quality system are to be approved by DNV GL.

Outstanding issues are listed in Annex 2.

**Place, yyyy-mm-dd**

**For DNV GL Renewables Certification**

**[Name of SLL for "Cert. decision"]**  
[Function]



By DAkkS according DIN EN IEC/ISO 17065 accredited Certification Body for products. The accreditation is valid for the fields of certification listed in the certificate.

**Place, yyyy-mm-dd**

**For DNV GL Renewables Certification**

**[Name of PM "responsible"]**  
[Function]

The accredited certification body is Germanischer Lloyd Industrial Services GmbH, Brooktorkai 18, 20457 Hamburg.  
DNV GL Renewables Certification is the trading name of DNV GL's certification business in the renewable energy industry.



# TYPE CERTIFICATE

Certificate No.:  
TC-DNVGL-SE-0163-[ID with 5 digits]-[rev.]

Issued:  
[YYYY]-[MM]-[DD]

Valid until:  
[YYYY]-[MM]-[DD]

Issued for:

**<Tidal turbine type / component type >**

Specified in Annex 1

Issued to:

**<Tidal turbine / component manufacturer>**

< Address line >

< Address line >

According to:

**DNVGL-SE-0163: 2015-10, Certification of tidal turbines and arrays**

Based on the documents:

DB-DNVGL-SE-0163-[ID]-[rev.]

D-DNVGL-SE-0163-[ID]-[rev.]

M-DNVGL-SE-0163-[ID]-[rev.]

[CB certificate ref.]

TT-DNVGL-SE-0163-[ID]-[rev.]

C-DNVGL-SE-0163-[ID]-[rev.]

FCR-TC-DNVGL-SE-0163-[ID]-[rev.]

Design basis statement of compliance, dated yyyy-mm-dd

Design statement of compliance, dated yyyy-mm-dd

Manufacturing statement of compliance, dated yyyy-mm-dd

Component certificate issued by <CB> for <Component>

Type test statement of compliance, dated yyyy-mm-dd

Commissioning statement of compliance, dated yyyy-mm-dd

Final certification report, dated yyyy-mm-dd

Changes of the system design, the production and erection or the manufacturer's quality system are to be approved by DNV GL.

Place, yyyy-mm-dd

For DNV GL Renewables Certification

[Name of SLL for "Cert. decision"]  
[Function]



By DAkkS according DIN EN IEC/ISO 17065 accredited Certification Body for products. The accreditation is valid for the fields of certification listed in the certificate.

Place, yyyy-mm-dd

For DNV GL Renewables Certification

[Name of PM "Responsible"]  
[Function]

The accredited certification body is Germanischer Lloyd Industrial Services GmbH, Brooktorkai 18, 20457 Hamburg. DNV GL Renewables Certification is the trading name of DNV GL's certification business in the renewable energy industry.

# PROJECT CERTIFICATE

Certificate No.:  
PC-DNVGL-SE-0163-[ID with 5 digits]-[rev.]

Issued:  
[YYYY]-[MM]-[DD]

Valid until:  
[YYYY]-[MM]-[DD]

Issued for:

**<Tidal array>**

Comprising:

**<Tidal turbines, substation and power cables>**

Specified in Annex 1

Issued to:

**<Tidal array developer>**

< Address line >

< Address line >

According to:

**DNVGL-SE-0163:2015-10, Certification of tidal turbines and arrays**

Based on the documents:

DB-DNVGL-SE-0163-[ID]-[rev.]

Design basis statement of compliance, dated yyyy-mm-dd

D-DNVGL-SE-0163-[ID]-[rev.]

Design statement of compliance, dated yyyy-mm-dd

M-DNVGL-SE-0163-[ID]-[rev.]

Manufacturing statement of compliance, dated yyyy-mm-dd

TI-DNVGL-SE-0163-[ID]-[rev.]

Transport and installation statement of compliance,  
dated yyyy-mm-dd

C-DNVGL-SE-0163-[ID]-[rev.]

Commissioning statement of compliance, dated yyyy-mm-dd

TC-DNVGL-SE-0163-[ID]-[rev.]

Type certificate, dated yyyy-mm-dd

FCR-DNVGL-SE-0163-[ID]-[rev.]

Final certification report, dated yyyy-mm-dd

Conditions:

- Annual reporting covering the certified tidal array or assets, including abnormal or deviant operating experience or operating failures as well as minor modifications
- Tidal array or assets are maintained or repaired according to the maintenance manuals
- Periodic inspection is carried out according to the standard listed
- Safety relevant incidents or major modifications shall be reported without delay

Changes of the certified tidal array assets are to be approved by DNV GL.

Place, yyyy-mm-dd

For DNV GL Renewables Certification

[Name of SLL for "Cert. decision"]  
[Function]



By DAKKS according DIN EN IEC/ISO 17065 accredited Certification Body for products. The accreditation is valid for the fields of certification listed in the certificate.

Place, yyyy-mm-dd

For DNV GL Renewables Certification

[Name of PM "responsible"]  
[Function]

The accredited certification body is Germanischer Lloyd Industrial Services GmbH, Brooktorkai 18, 20457 Hamburg.  
DNV GL Renewables Certification is the trading name of DNV GL's certification business in the renewable energy industry.

# STATEMENT OF COMPLIANCE

Statement No.: SOC-DNVGL-SE-0163-[ID with 5 digits]-[rev.] Issued: [YYYY]-[MM]-[DD]

Issued for:

**<Certification module>**

of

**<Tidal turbine type>**

Specified in Annex 1

Issued to:

**<Tidal turbine manufacturer>**

< Address line >

< Address line >

According to:

**DNVGL-SE-0163:2015-10 Certification of tidal turbines and arrays**

Based on the document:

CR-SOC-DNVGL-SE-0163-[ID]-[rev.] Certification report, dated yyyy-mm-dd

Changes of the system design are to be approved by DNV GL.

Place, yyyy-mm-dd

For DNV GL Renewables Certification

[Name of SLL for "Cert. decision"]  
[Function]



By DAKKS according DIN EN IEC/ISO 17065 accredited Certification Body for products. The accreditation is valid for the fields of certification listed in the certificate.

Place, yyyy-mm-dd

For DNV GL Renewables Certification

[Name of PM "responsible"]  
[Function]

The accredited certification body is Germanischer Lloyd Industrial Services GmbH, Brooktorkai 18, 20457 Hamburg. DNV GL Renewables Certification is the trading name of DNV GL's certification business in the renewable energy industry.



**DNV GL**

Driven by our purpose of safeguarding life, property and the environment, DNV GL enables organizations to advance the safety and sustainability of their business. We provide classification and technical assurance along with software and independent expert advisory services to the maritime, oil and gas, and energy industries. We also provide certification services to customers across a wide range of industries. Operating in more than 100 countries, our 16 000 professionals are dedicated to helping our customers make the world safer, smarter and greener.