UL type and component certification scheme for wind turbines

UL Solutions

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Version 1.0 | 2023.03.15

Table of contents

1.0 Introduction and purpose

The purpose of this document is to define the requirements of the UL Type and Component Certification Scheme for wind turbines (“Scheme”). It stipulates the rules and procedures for the performance of a third-party conformity assessment activity to demonstrate compliance of wind turbines with defined requirements. The Scheme is owned, developed and maintained by UL LLC. The Scheme is managed by the Conformity Assessment Programs Office (“CPO”) and operated by one or more Certification Bodies (CB) within the UL Family of Companies (see 2.2).

This Scheme is an enhancement of the well-recognized IEC 61400-22 scheme and reflects the modified market requirements arose since the release of the IEC 61400-22 in 2010 and its withdrawal in 2018. An overview of the possible combination of the evaluation depth and combination of different evaluation elements and modules is shown later in this document.

Changes to the scheme will be published.

A description of the Scheme can be found on the UL Schemes and Certification Bodies webpage of the external UL.com website. UL also operates other certification schemes for wind turbines and grid compatibility testing per UL standards.

2.0 Scope

2.1 **Scope of the Scheme**

This scheme is applicable to onshore wind turbines (according to IEC 61400-1), offshore wind turbines (according to either IEC 61400-3 or IEC 61400-3-1 or IEC TS 61400-3-2) and small wind turbines (according to IEC 61400-2).

Vertical Axis wind turbines (regardless of the application) are also covered by this Scheme. Deviation to the requirements from the applicable standard of the IEC 61400 series shall be defined at the project start and evaluated within the design basis module.

2.2 **Authorized Bodies**

2.2.1 Certification Body

2.2.1.1 DEWI-OCC Offshore Certification Centre GmbH, a legal entity in the UL family of companies, is the only certification body (“CB”) that is authorized to operate the Scheme. The CB utilizes staff employed by the CB legal entity, personnel under contract with the CB (employed by legal entities under the common corporate structure with DEWI-OCC).

2.2.1.2 Authorized CB shall operate this Scheme in compliance with ISO/IEC 17065.

2.3 **Testing activities**

Testing activities necessary for the certification shall be performed according to the relevant standards and in agreement with the CB. The measurements shall be performed by an accredited ISO/IEC 17025 testing laboratory with appropriate scope or, if applicable, an approved IECRE testing laboratory. If none of the options listed above is possible, the CB shall witness the testing to verify the compliance with ISO/IEC 17025 requirements.

2.4 Products Excluded from the Scheme

2.4.1 UL places the highest priority on being an ethical, responsible corporate citizen with a highly valued brand. Therefore, the Scheme does not permit evaluations for products that:

A. Directly or indirectly compromise safety;
B. Are designed to or could function to cause physical harm, or significantly elevate the risk of injury or death;
C. Encourages unsafe behavior, especially by children;
D. Are associated with or promote illegal or unethical activities;
E. Include packaging, advertising, or markings that could mislead users as to the intended use or function of the product or the scope of UL's certification;
F. Negatively impact UL's reputation or brand;
G. Conflict with UL's Mission; or
H. Are manufactured or sold by UL or one of its affiliates and are recorded on the Products Ineligible for Certification list to ensure that UL will not certify these products or the same product for another company.

3.0 Scheme description and certification services

3.1 General

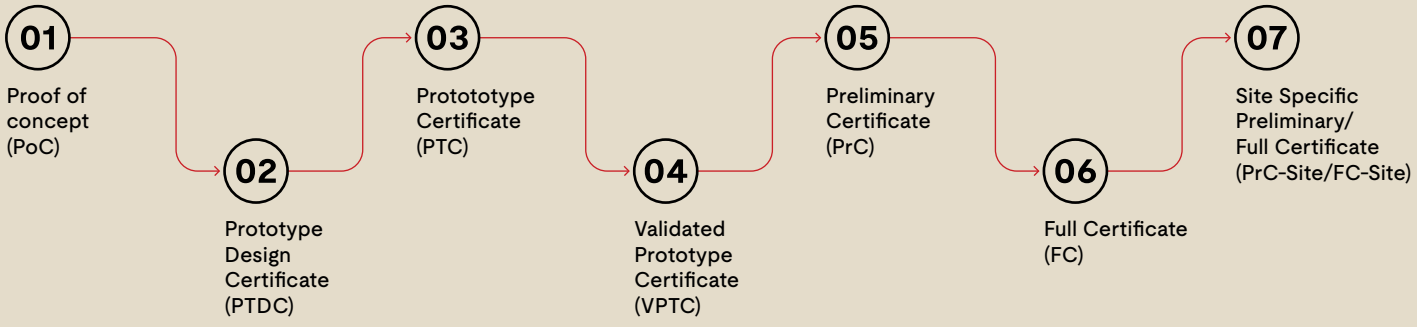
The scheme covers the third party conformity assessment of documentation related to wind turbine and their components. Several certification services are defined in this Scheme to issue compliance statements and certificates along the several stages of development of the product to be certified.

Generally, each stage shown below is based on the evaluation of some modules. Each module is defined by several elements. A detailed description of the modules and their elements can be found in chapters 7-12.

Each stage can be applied to a full wind turbine, to a RNA (Rotor Nacelle Assembly) or to one of the following components:

- Rotor Blade;
- Tower;
- Gearbox;
- Generator;
- Bearing;
- Substructure and
- Floater.

Development stage

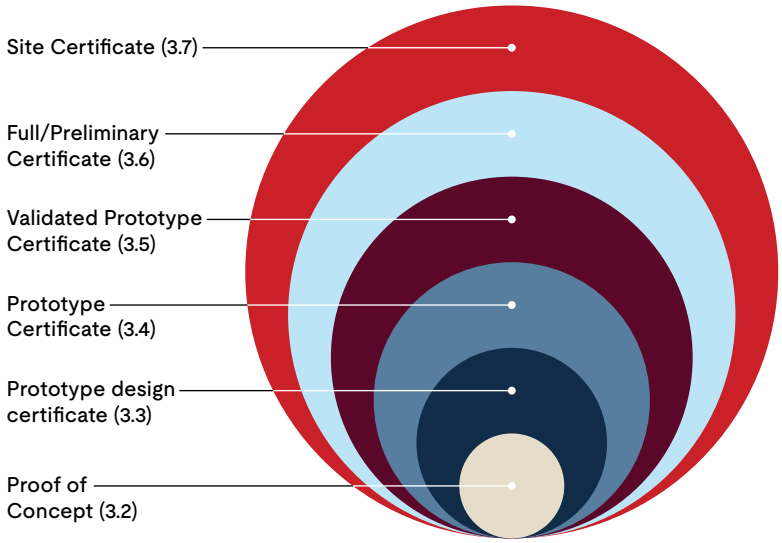


Further, components may be also covered by the certification after agreement with the CB. Additionally a load component certificate is defined by this scheme (see chapter 3.8 for more details). In the final assessment report it is clearly to mention which modules and element have been considered within the evaluation.

The result of each module is a compliance statement which lists the assessment report(s) relevant to the module. It is recommended to have an assessment report for each element but the Scheme allows the CB to combine more than one element into an assessment report.

If there are any deviations from the scheme requirements they shall be discussed and agreed with the head of the CB and the scheme owner. The deviation from this scheme and from technical requirements shall be clearly recorded in the documentation for the design basis and for the specific technical area.

An overview of the available certification services is given here:



Further elements can be included in the certificate upon customer request such as Lifetime Extension certification according to UL 4143 or DNV-ST-0262 or other defined requirements and schemes; Grid code compliance certification according to specific grid codes; Process design evaluation (see section 3.9), which enables a more streamlined and quicker evaluation by covering the specific evaluation of the product under certification as well an overview and evaluation of the methods and design process of the customer.

Each additional element will be covered by a compliance statement connected to the certificate via the final assessment report. The execution of additional modules has to follow the specific process defined in the relevant applicable technical standard.

This scheme does not cover Environmental Health and Safety (EHS) aspects.

Specific requests (e.g. compliance to EN 50308) may be agreed with the customer and explicitly mentioned within the design basis.

In case of deviation from the certification process described it shall be approved by the CB. The acceptance of the deviation will be judged from the CB on a case-by-case decision. Further analyses and documentation may be requested from the customer for a deviation to be accepted by the CB.

3.2 Proof of concept (PoC)s

Objective of the PoC is to confirm that the submitted design is conceptually acceptable and feasible.

The proof of concept can be achieved by a successful evaluation of the following elements a nd relative modules:

Module	Element	Remark
Design Basis	Design Basis	Complete Evaluation (see 7)
Design	Load Assumption	Plausibility Evaluation (see 8.2)
	Safety and Control System	Plausibility Evaluation (see 8.3)
	Rotor Blade	Plausibility Evaluation (see 8.4)
	Rotor and Nacelle System	Plausibility Evaluation (see 8.5)
	Support structure (optional in case of RNA)	Plausibility Evaluation (see 8.6)
	Foundation (optional)	Plausibility Evaluation (see 8.7)
	Electrical System	Plausibility Evaluation (see 8.8)

The assessment is concluded with the issue of a compliance statement for the proof of concept. This statement has no limit with regards to validity and does not require any surveillance.

3.3 Prototype design certificate (PTDC)

Objective of the prototype design certification is demonstration that the design of the wind turbine is fulfilling the requirements in applicable technical standard mentioned and preparing for the step of testing by reducing risks arising from design related items. The prototype design certificate can be achieved without performing any test. Performing any specific tests (e.g. heat-run test for the generator, lightning protection system tests, material tests, etc.) is voluntary in support of issuance of the Prototype design certificate . The assessment report is to clearly mention if the requested tests have been performed.

The Prototype design certificate can be achieved by a successful evaluation of the following elements and relative modules:

Module	Element	Remark
Design Basis	Design Basis	Complete Evaluation (see 7)
Design	Load Assumption	Complete Evaluation (see 8.2) Fatigue evaluation can be limited to the validity of the certificate
	Safety and Control System	Complete Evaluation (see 8.3)
	Rotor Blade	Complete Evaluation (see 8.4) Fatigue design shall fulfill at least the validity of the certificate
	Rotor and Nacelle System	Complete Evaluation (see 8.5) Fatigue design shall fulfill at least the validity of the certificate
	Support structure (optional in case of RNA)	Complete Evaluation (see 8.6) Fatigue design shall fulfill at least the validity of the certificate
	Foundation (optional)	Complete Evaluation (see 8.7)
	Electrical System	Complete Evaluation (see 8.8)
	Manuals and Personnel Safety	Partial Evaluation (see 8.10) Manuals can be considered as preliminary.
Final Assessment and Certificate	Final Assessment and Certificate	See Chapter 12.

The assessment is concluded with the issue of a compliance statement for the Modules Design Basis and the Design. Upon agreement with the CB it is possible to combine the Module Design Basis directly in the Module Design and in its compliance statement. Afterwards a Prototype design certificate based on the compliance statement and a Final Assessment report is issued.

The compliance statement does not have any limitation on validity.

The certificate validity shall not exceed three years. The certificate requires surveillance as defined in chapter 6.8.

For component evaluations, the required modules are those related to the component under evaluation.

3.4 Prototype certificate (PTC)

The objective of the prototype certification is the demonstration of fulfillment of the applicable technical requirements for the design of the wind turbine and the safety relevant tests. If the Prototype Certificate is requested as an enhancement of an existing Prototype Design Certificate, testing is required (i.e. heat-run test for the generator, lightning protection system tests, material tests, etc.). In this situation the compliance statement for the design must be updated.

The Prototype certificate builds on the Prototype design certificates and adds to the following modules:

Module	Element	Remark
Type Testing	Safety System Functional Test	Complete Evaluation (see 9.2)
	Mechanical Load Measurement and Validation	Reduced Evaluation (see 9.5) The evaluation can be limited on eigenfrequency measurements of blade and tower, to be compared against the design values.
	Full Scale Blade Test	Reduced Evaluation (see 9.6) The evaluation can be limited to the static blade test as per IEC 61400-23.
Final Assessment and Certificate	Final Assessment and Certificate	See Chapter 12.

Optionally Noise (see 11.2), Power quality (see 11.3) and Grid Code Capability (see 11.4) can be included as well. If one of these elements is included, then a Type Characteristics compliance statement will be also included in the Prototype Certificate.

Regarding the type testing all the other elements can be included, upon customer's request, as optional elements.

By including the compliance statement obtained during the Prototype Design Certificate (see 3.3) the assessment of the additional modules considered is concluded with issue of a compliance statement for the type testing. Afterwards a Prototype certificate based on the compliance statements and on a final assessment report is issued.

In case of a component certificate the necessary modules are only the ones related to the component under evaluation.

The certificate validity shall not exceed three years. The certificate requires surveillance according to chapter 6.8.

3.5 Validated prototype certificate (VPTC)

Objective of the validated prototype certification is demonstration that the design of the wind turbine is fulfilling the requirements in applicable technical standard and that the test results are confirming the design submitted. In this way the possibility to sell the design as a license can be considered a risk reduced process.

The validated prototype certificate builds on the Prototype certificate and it adds following modules on top of the prototype certificate:

Module	Element	Remark
Type Testing	Personnel Safety and Commissioning	Complete Evaluation (see 9.3)
	Power Performance	Complete Evaluation (see 9.4)
	Mechanical Load Measurement and Validation	Complete Evaluation (see 9.5)
	Full Scale Blade Test	Complete Evaluation (see 9.6)
	Gearbox Field Test	Complete Evaluation (see 9.7)
Final Assessment and Certificate	Final Assessment and Certificate	See Chapter 12.

By including the compliance statement obtained during the Prototype Design Certificate (see 3.3) the assessment of the additional modules considered is concluded with issue of a compliance statement for the type testing. Afterwards a Prototype certificate based on the compliance statements and on a final assessment report is issued.

Optionally Noise (see 11.2), Power quality (see 11.3) and Grid Code Capability (see 11.4) can be included as well. If one of these elements is included, then a Type Characteristics compliance statement will be also included in the Prototype Certificate.

In case of a component certificate the necessary modules are only the ones related to the component under evaluation.

The certificate validity shall not exceed three years. The certificate requires surveillance in accordance with chapter 6.8.

3.6 **Preliminary/Full certificate (PrC/FC)**
The Preliminary and Full certificate requires a complete evaluation of the following modules and the respective mandatory modules:

- Design Basis (see Chapter 7);
- Design Evaluation (see Chapter 8);
- Manufacturing Evaluation (see Chapter 10);
- Type Testing (see Chapter 9) and
- Final Assessment and Certificate (see Chapter 12).

All optional elements and the type characteristics module (see Chapter 11) can be included in the type certificate.

This module is applicable to whole wind turbines, RNA and component certificate.

A full certificate validity shall not exceed 5 years and is subjected to annual reporting and a half-cycle inspection (see chapter 6.8 for surveillance requirements).

The certificate is considered preliminary in case some of the evaluation items are not properly covered. These items shall not be relevant for the structural integrity and primary safety of the wind turbine/RNA/component under evaluation. The preliminary certificate validity shall not exceed 1 year. The outstanding items will be clearly remarked in the relevant compliance statements, final assessment report and certificate.

3.7 **Preliminary/Full Site certificate (PrC-Site/FC-Site)**
Similar to the certificates shown in chapter 3.6 this option foresees following additional elements:

Design Basis – no further requirements.

Design Evaluation:
- site condition (see 8.9) – mandatory;
- foundation design evaluation (optional).

Manufacturing Evaluation:
- foundation manufacturing evaluation (optional).

Type Testing – no further requirements (if not explicitly mentioned in the design basis and/or design evaluation modules).

3.8 Load Component Certificate (LCC)

A particular case of the component certificate is the load component certificate which foresees the following activities:

Module	Element	Remark
Design Basis	Design Basis	Limited only to the load assessment relevant topics
Design	Load Assumption	Complete Evaluation (see 8.2)
	Safety and Control System	Partial evaluation limited to the interfaces with the load assumption evaluation (see 8.3)
Type Testing	Mechanical Load Measurement and Validation	Complete Evaluation (see 9.5) The measurement scope can be limited in agreement with the CB. The aim is to validate the load assumption model used within the design
	Power Performance (optional)	
Final Assessment and Certificate	Final Assessment and Certificate	See Chapter 12.

Optionally Noise (see 11.2) can be added as a part of this certification service. If this element is included, then a Type Characteristics compliance statement will be also included in the Load Component Certificate.

The aim of this certificate is to enable the usage of validated models for an LTE analysis by using applicable schemes (i.e. UL 4143, Draft IEC TS 61400-28). The modification of components on the WTG used for obtaining the component certificates (i.e. re-blading, re-controlling) requires an additional evaluation of all the modules shown above (including a partial measurement campaign if no sufficient justification is provided by the applicant) to enable the evaluation of the modification within LTE evaluations. The LTE evaluation is not covered by this scheme.

3.9 Process Design Evaluation

A process evaluation certificate can be applied to a design process of wind turbine components, as part of the design evaluation elements.

The process evaluation shall be conducted at the customers design office, either by physical or by remote inspection. The component design process shall be demonstrated by customer, for all design phases starting from the used inputs and ending at the finalized component design. Relevant component parameter verified in the process evaluation shall match with the parameter submitted for the component design evaluation.

The design processes shall be compliant with standards and guidelines defined in the component specific work instruction.

The process evaluation is applicable for rotor blades, towers and gearboxes. Further components can be also evaluated according the process evaluation per agreement with the CB.

4.0 Applicable documents

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. Only active editions of standards are allowed to be used. The specific edition of the standard that was used shall be identified.

Item No.	Document No.	Title
1	IEC 61400-1	Wind energy generation systems – Part 1: Design requirements
2	IEC 61400-2	Wind turbines – Part 2: Small wind turbines
3	IEC 61400-3	Wind turbines – Part 3: Design requirements for offshore wind turbines
4	IEC 61400-3-1	Wind energy generation systems – Part 3-1: Design requirements for fixed offshore wind turbines
5	IEC TS 61400-3-2	Wind energy generation systems – Part 3-2: Design requirements for floating offshore wind turbines
6	IEC 61400-4	Wind turbines – Part 2: Design requirements for wind turbine gearboxes
7	IEC 61400-5	Wind energy generation systems – Part 5: Wind turbine blades
8	IEC 61400-6	Wind energy generation systems – Part 6: Tower and foundation design requirements
9	IEC 61400-11	Wind turbines – Part 11: Acoustic noise measurement techniques
10	IEC 61400-12-1	Wind energy generation systems – Part 12-1: Power performance measurements of electricity producing wind turbines
11	IEC 61400-12-2	Wind turbines – Part 12-2: Power performance of electricity producing wind turbines based on nacelle anemometry
12	IEC 61400-13	Wind turbines – Part 13: Measurement of mechanical loads
13	IEC 61400-21	Wind turbines – Part 21: Measurement and assessment of power quality characteristics of grid connected wind turbines
14	IEC 61400-22	Wind turbines – Part 22: Conformity testing and certification
15	IEC 61400-23	Wind turbines – Part 23: Full-scale structural testing of rotor blades
16	IEC 61400-24	Wind energy generation systems – Part 24: Lightning protection
17	GL 2010	Rules and Guidelines Industrial Services – Guideline for the Certification of Wind Turbines
18	DNV-SE-0441	Service Specification – Type and component certification of wind turbines.
19	DNV-SE-0074	Service Specification – Type and component certification of wind turbines according to IEC 61400-22
20	DNV-ST-0376	Standard – Rotor blades for wind turbines
21	DNV-ST-0076	Standard – Design of electrical installations for wind turbines

Item No.	Document No.	Title
22	DNV-ST-0119	Standard – Floating wind turbine structures
23	DNV-ST-0126	Standard – Support structures for wind turbines
24	DNV-ST-0361	Standard – Machinery for wind turbines
25	DNV-ST-0437	Standard – Loads and site conditions for wind turbines
26	DNV-ST-0438	Standard – Control and protection systems for wind turbines
27	DNV-SE-0436	Service Specification – Shop approval in renewable energy
28	ISO 19901-1	Petroleum and natural gas industries – Specific Requirements for offshore structures – Part 1: Metocean design and operating considerations
29	ISO 19901-4	Petroleum and natural gas industries – Specific Requirements for offshore structures – Part 4: Geotechnical and foundation design considerations
30	ISO 19901-6	Petroleum and natural gas industries – Specific Requirements for offshore structures – Part 6: Marine operations
31	ISO 19901-7	Petroleum and natural gas industries – Specific Requirements for offshore structures – Part 7: Stationkeeping systems for floating offshore structures and mobile offshore units
32	ISO 19904-1	Petroleum and natural gas industries – Floating offshore structures – Part 1: Ship-shaped, semi-submersible, spar and shallow-draught cylindrical structures
33	ISO MSC.267(85)	Resolution MSC.267(85) – Adoption of the international code on intact stability, 2008 (2008 is code)
34	UL 4143	Standard for Safety Wind Turbine Generator – Life Time Extension (LTE)
35	IEC TS 61400-28[1]	Wind energy generation systems - Part 28: Through life management and life extension of wind power assets
36	EUROCODE 2 DIN EN 1992	Eurocode 2: Design of concrete structures (all relevant parts)
37	EUROCODE 3 DIN EN 1993	Eurocode 3: Design of steel structures (all relevant parts)
38	DIN 18088	Structures for wind turbines and platforms (all relevant parts)
39	FGW TG4	Fördergesellschaft Windenergie und andere Erneuerbare Energien: Technical Guidelines for Power Generating Units and Systems Part 4: Demands on Modelling and Validating Simulation Models of the Electrical Characteristics of Power Generating Units and Systems
40	ISO 9001	Quality management systems - Requirements

As a general rule the undated standard above can be applied in the actual valid version or the previous major version. A deviation from this criteria shall be agreed with the CB and shall be documented clearly within the design basis. On the certificates the standard(s) used for the certification shall be clearly marked.

1. At the issue of this Scheme the technical specification is still at as a draft stage. Once released the published version is to be used.

5.0 Terms, definitions and abbreviations

Abbreviations:

AEP	:	Annual Energy Production	TT	:	Type Testing
CB	:	Certification Body	TCS	:	Type Characteristics
CC	:	Component Certificate	POC	:	Proof of concept
CS	:	Compliance Statement	PTDC	:	Prototype design Certificate
DB	:	Design Basis	PTC	:	Prototype Certificate
DE	:	Design Evaluation	RNA	:	Rotor Nacelle Assembly
FAR	:	Final Assessment Report	VPTC	:	Validated Prototype Certificate
GTC	:	General Terms of Contract	PRC	:	Provisional Type Certificate
LTE	:	Lifetime Extension	PRCC	:	Provisional Component Certificate
HSE	:	Health and Safety Environment	FTC	:	Full Type Certificate
ME	:	Manufacturing Evaluation	FCC	:	Full Component Certificate
MTAC	:	Material Type Approval Certificate	WTG	:	Wind Turbine Generator

The relevant terms and definitions in ISO/IEC 17000 and ISO/IEC 17067 apply. In addition, the following items are directly referenced in this document:

- **CB Certification Agreement –** Legal contract for the provision of activities by a certification body to its customers, as described in and required by ISO/IEC 17065.
- **Re-blading –** Identifies an activity where the rotor blades are exchanged with different ones to improve the wind turbine behavior (i.e. load reduction, AEP increase, etc.).
- **Re-controlling –** Identifies an activity where the control system is exchanged with a different one to improve the wind turbine behavior (i.e. load reduction, AEP increase, etc.).

6.0 Scheme activities and general requirements

6.1 **General**
The following activities are included in the Scheme (as per ISO/IEC 17067).

Records of the activities done in order to perform the certification will be kept by the CB according to its internal process.

The certification is based on the evaluation of several conformity assessment modules which are considered in each certificate/compliance statement as described in chapter 3.0.
Each module is based on several elements.
The evaluation of each module is concluded by a compliance statement, unless the module description enables a different process.

6.2 **Application and Application Review**
The customer shall provide all necessary information to complete the certification process as required by the certification agreement. This information includes, but is not limited to:

- the products to be certified;
- relevant drawings and schematics;
- the standards or other normative documents to be applied (may require consultation with the CB);
- the physical location of the customer;
- all manufacturing locations that will be producing the product or parts used in the product.

The CB shall conduct an application review to ensure that the CB has received the needed information to conduct the certification.

6.3 **Evaluation**
The evaluation will be carried out by the CB based on the submitted documentation and product, as applicable, against the requirements of this scheme shown in clauses 7-12 based on the application request from the customer on the product defined in chapter 3.0.

6.4 **Review and certification decision**
The review and certification decision as per requirements of ISO/IEC 17065 are covered within the final assessment and certificate module (see chapter 12).

6.5 **Directory of certified products**
After completion of the certification a ctivities the CB will list the certificate in its certification directory.

6.6 **Preliminary Certificates/Preliminary Compliance Statements**
Provisional certificates are issued on the basis of provisional compliance statement. The statement as well as the certificate and the linked final assessment report shall clearly include which are the items not fulfilling the scheme and/or the technical standard requirement. The items listed shall not be relevant for the primary safety and for the structural integrity. The fatigue design evaluation shall at least cover the validity span of the certificate (see chapter 6.7).

6.7 **Validity of Certificates**
Following validity applies to the different products (regardless if wind turbine/ RNA/component):

- Proof of Concept: Limitless (Compliance Statement);
- Prototype design certificate/Prototype Certificate/Validated prototype certificate: Up to 3 years subject to annual surveillance according to chapter 6.8;
- Provisional Certificate/Provisional Certificate – Site: up to 1 year, and
- Full Certificate/Full Certificate – Site: up to 5 years subject to surveillance according to chapter 6.8.

6.8 **Certificate Surveillance Activities**
Regardless of severe damages and other relevant issues, which shall be immediately communicated to the CB, it is mandatory, in order to keep the validity of an issued certificate, to perform a regular annual surveillance (see 6.8.1) and an half-cycle inspection (see 6.8.2). In case the surveillance activities are not properly carried out and/or the severe damages are not properly investigated by the customer, the CB has the right to suspend/withdraw the certificate.

6.8.1 Annual Surveillance

The customer shall provide at least annually the following documentation:

- List of design modifications and related documentation;
- List of installed WTG including relevant information (blade type, hub height, tower type, location) and
- List of damages related to the certified components and, if applicable, root cause analysis and corrective actions.

6.8.2 Half-cycle inspection (2.5 year inspection)

Periodic inspection are request at least every 2.5 years to verify that the production of the WTG/RNA/component are carried out in accordance to the issued type certificate. The inspection can be performed at the facility for Rotor and Nacelle Assembly, at a recent commissioned wind turbine or in the component workshop.

6.9 **Re-certification**
Once the certificate reaches its end validity a re-certification is possible. The aim is to perform a new manufacturing evaluation as per chapter 10 to demonstrate that the WTG/RNA/component is still produced within the same framework.
The re-certification is possible only if completed within the expiry date of the original certificate.

6.10 **Product modifications**
The customer will notify the CB of any proposed changes to the equipment so their impact on the certification can be considered. The extent of the requested update shall be agreed with the CB and may involve an update of all the relevant modules for the certification.

6.11 **Acceptance/embedding of existing component certificates**
Embedding of certificates and conformity statement is possible. In case the certified component has a certificate and/or a conformity statement related to a different scheme a gap analysis will be performed by the CB to demonstrate the compliance with this scheme. Eventual identified gaps shall be properly documented and closed for the issue of the selected product according to this scheme.

6.12 **Customer obligations**
Documentation provided shall be in English language. Different languages can be accepted after consultation with the certification body.

The customer shall accept the general terms of contract (GTC) and certification regulation, submitted (or referenced) at the application stage by the CB offering the service.

The application shall be accepted by the customer in written form. The CB will perform an application review and confirm the acceptance and compliance with the scheme of the application in written form.

The certificate shall be used by the customer in non-misleading ways.

7.0 Module: Design basis

The design basis module consists of a unique element. The aim of the design basis is to clearly state which design principles have been followed including but not limiting the list to:

- standard and guidelines (incl. deviation to the one mentioned in this document) used for the design, including, revisions and if any, deviations to be considered;
- description of the component or the wind turbine under evaluation;
- external conditions (environmental, climatic, wind conditions, wave conditions (if applicable), electric, etc.);
- design parameters, assumptions, methodologies and principles considered in the load assumption;
- softwares used in simulations, simulation methodology;
- design life assumption of the load carrying components and drive train components;
- safety factors on loads and materials;
- inspection scope and frequency;
- requirements of condition monitoring systems (if applicable);
- risk reduction methodology;
- electrical system overview;
- environmental conditions relevant for installation;
- design basis requirements for manufacture, transport, installation, operation and maintenance (if any) and
- deviations to the standards.

The outcome of the design basis evaluation can be summarized in a report or directly included in the design assessment report of the wind turbine / component under evaluation.

The assessment report should be included in a design basis compliance statement. Alternatively, the assessment report can be included in the design evaluation compliance statement.

Following documents shall be submitted for evaluation, which includes the design basis principles listed above:

- Wind turbine description;
- Explanation of methodologies, principles and standard to be used in the design of the wind turbine and
- Description of any deviation from the standard.

8.0 Module: Design evaluation

8.1 **General**
The design evaluation module consists of the elements 8.2 to 8.10. The aim of the design evaluation is to assess the conformity of the design against this certification scheme and the design basis covered in chapter 7. The assessment is summarized in at least one assessment report. It is recommended to have one assessment report per element, nevertheless it is possible to combine more elements in a unique assessment report. The evaluation is finalized by issuing a compliance statement for the design.

8.2 **Element: Load Assumptions**
Load assumptions shall fulfill valid technical standard of the IEC 61400 series.

The load assumption shall assess following topics:

- Combination between external conditions and the applied design load cases as per applied technical standard. The design load cases shall follow as a minimum the one defined in the respective technical standard. Further load cases can be defined by the applicant/requested as outcome of the safety and control evaluation element as a measure to risk mitigation.
- Description of calculation models and mathematical models considered covering, but not limited to, aerodynamic, structural, hydrodynamic (if applicable) and control aspects. Also the load calculation and post-processing software shall be presented: a proof of the validation may be necessary.

At least the following items need to be provided and are subjected to assessment:

- Sensor and co-ordinate system used;
- Time series (including inputs channel like wind and/or waves and/or faults like short circuit);
- Post-processed results including, but not limited to, FFT analyses, Rainflow-Counting, 1Hz Damage Equivalent Loads, Load spectra, Load duration distribution, Markov Matrices, extreme loads and loads histograms per sensor showing the load level of each design load case. The analysis shall be carried out at the most relevant load station related with load carrying components (i.e. along the blade, blade root, hub, shaft, main and rear frame, along the tower and foundation), on the main drive train components (gearbox, shaft, brakes and generator(s)) and on the locking devices.
- The interface with the safety and control system shall be considered.

The CB will verify the presented documentation in an adequate extent including independent analyses. The interface with the safety and control system assessment element shall be considered for the evaluation of the fault conditions and for the parked conditions used for maintenance. Any deviation from the technical requirement of the chosen standard shall be clearly explained and be also presented in the design basis module.

Based on the requirement of the chosen certificate a reduced evaluation can be performed which can be limited to the plausibility evaluation of the selected parameters and set-up of the whole load assumption.

For prototypes the fatigue load evaluation can be limited to a duration greater or equal to the validity duration of the certificate.

For an extreme temperature range of 50°C or higher, impacts on loads & wind turbine control due to density, material specifications (including lubricants) and measures to protect the electrical components (e.g. cooling systems) shall be evaluated. DNVGL Note of engineering details GL RC-L-SCHL-extern-009 can be referred for further guidance.

For cold climate and icing conditions reference to IEC 61400-1:2019 or alternatively DNVGL-RP-0363 or GL Wind-Technical Note 067. The selected technical standard and connected evaluations shall be clearly remarked in the design basis and implemented in this element. The required interfaces with the other design elements shall be considered

For offshore wind turbine configurations appropriate load cases shall be considered according either IEC 61400-3, IEC 61400-3-1, IEC TS 61400-3-2.

Lifetime extension methodologies shall follow the requirements of UL 4143 and/or IEC TS 61400-28 (upon release). Additional requirements for the loads which may arise as a result of a risk analysis as per one of the selected standard shall be considered.

The selected technical standard and connected evaluations related to extreme temperatures (hot climate, cold climate) and lifetime extension shall be clearly remarked in the design basis and implemented in this element. The required interfaces with the other design elements shall be considered.

Following documents shall be submitted for evaluation, insofar applicable:

- Wind turbine description;
- Aeroelastic Model and DLL of the used controller;
- Load calculation report including Load cases definition and post-processing results; covering ULS, FLS and blade deflection analysis;
- Time Series (incl. wind model), Markov Matrices, Load Duration Distribution;
- Load Measurement Program.

Load assumption carried out accordingly to GL 2010, DNV-ST-0437 may be considered applicable. This will be a case by case decision by the CB after evaluation of the submitted documentation.

8.3 **Element: Safety and Control System**
Safety and Control System shall fulfill valid technical standard of the IEC 61400 series or the previous major version.

Following items shall be at least presented by the applicant and verified by the certification body:

- Description of the wind turbine and its design limits (electrical limits, mechanical limits in terms of wind speed, rotational speed, etc.);
- Safety & Control System concept including interface with the controller used for the load calculation;
- Independence and redundancy requirements of the safety system;
- Behavior of the wind turbine during different operational and fault conditions;
- Safety relevant parameters (SRP) including but not limited to the controller parameters used for load assumption;
- Monitoring and protective devices;
- Braking System(s) concept and description (including aerodynamic breaking, mechanical braking, yaw system description, pitch and yaw brakes, pitch and yaw locks and their design limits;
- Risk analysis and Failure analysis to identify possible failure modes to be covered during the assessment of the load assumptions. Optional evaluation according to ISO 13849-1 or IEC 62061 for the identification of the requested performance level may be performed. Alternative methods for risk mitigation and reliability can be used only upon agreement with the CB during the design basis evaluation.
- System schematics (electrical, hydraulic, pneumatic, etc.);
- Software documentation (including the implementation chain for modifications) and software version control and
- Test plan for the safety system functional test.

In case of additional control features (i.e. active damping, resonance avoidance, individual pitch control) additional documentation may be requested. It shall be demonstrated how these features have been considered in the load assumption.

Further requirements related to offshore conditions may be necessary. These shall be clearly identified within the design basis module and properly documented during the evaluation.

Following documents shall be submitted for evaluation, insofar applicable:

- Control and Safety System description, behavior of the wind turbine during different operational and fault conditions;
- Software version and control;
- Controller parameters;
- Monitoring and protective devices description (including sensors and measurement equipment);
- Risk analysis incl. Performance level calculation (if applicable);
- System schematics (electrical, hydraulic, pneumatic, etc.);
- Braking system description and
- Test plan for the safety system functional test.

Evaluations carried out accordingly to GL 2010, DNV-ST-0438 may be considered applicable. This will be a case by case decision by the CB after evaluation of the submitted documentation

Lifetime extension methodologies shall follow the requirements of UL 4143 and/or IEC TS 61400-28 (upon release). Additional requirements for the loads which may arise as a result of a risk analysis as per one of the selected standard shall be considered in the interface of the load assumption. The risk analysis shall be evaluated according the applied technical standard or based on an appropriate standard selected during the design basis.

8.4 **Element: Rotor blade**

Rotor blades shall fulfill the valid technical standard of the IEC 61400 series or alternatively widely used industrial guidelines or best practices. As per the actual state the rotor blade evaluation can be carried out according to either IEC 61400-5 Ed. 1, DNV GL-ST-0376 or GL2010. A combined evaluation, covering the requirement of more than a single standard is possible upon agreement with the CB.

Other standards may be used only after agreement with the CB. Deviations shall be explicitly mentioned in the design basis. At least the following items shall be submitted and verified by the CB:

- Design calculation as per chosen standard;
- Drawings including technical specifications and tolerances;
- Material data, which shall be either verified by accredited tests or covered by a valid Material type approval certificate (MTAC);
- Manufacturing instructions (as a link to the manufacturing evaluation, see 10.3);
- Blade test program and
- Manuals for transport, installation, and maintenance including relevant parameters (i.e. loads for transportation and installation, support devices, etc.).

Optionally repair processes can be included in the assessment. The applicant shall submit sufficient documentation to demonstrate how the repair process shall be performed and the necessary qualification/skills requested for this.

Following documents shall be submitted for evaluation, insofar applicable:

- Design calculation reports;
- Drawings with geometrical data (casted, forged, welded, assembly etc.);
- CAD models in .iges or .step format for components designed with FEM;
- Specifications (design, material, test etc.);
- Material Certificate/Material Type Approval Certificate and
- Test plan.

Independent analysis may be carried out from the certification body. A process design evaluation (see 3.9) can be carried out to reduce the required amount of independent analysis.

8.5 Element: Rotor and Nacelle System

8.5.1 General

Evaluation of machinery structures and mechanical components including dynamically stressed bolted connections shall fulfill valid technical standard of the IEC 61400 series or the previous major version. An evaluation following DNV-ST-0361 may be considered applicable except the partial safety factors for materials. This will be a case by case decision by the CB after evaluation of the submitted documentation and shall be clearly listed in the design basis.

The ultimate and fatigue strength verification shall be verified by calculations, tests or both. Other standards may be used only in agreement with the CB (e.g. VDI 2230 for bolts considering partial safety factors for fatigue in the afore mentions guidelines). For the standard materials, the characteristic values from recognized standards shall be used. For non-standard materials and in case of exceptions, DNVGL-ST-0361 shall be followed. These standards shall be clearly stated in the design basis.

8.5.2 Structural Components (incl. bolted connections)

The machinery structures including the bolted connections like:

- Hub;
- Shaft;
- Main bearing housing;
- Main frame;
- Gearbox structures;
- Generator frame;
- Tower top flange/adapter and
- Generator stator and rotor for Direct Drive.

which are transmitting the force and moments and are critical to the integrity of the wind turbine and also present a potential danger to human life are subjected to the it's limit state verification (extreme, fatigue and serviceability), in so far applicable. Calculations shall be performed as per the requirement in IEC 61400 series.

8.5.3 Mechanical Components

The mechanical components like pitch bearing, pitch drive, main bearing, LSS shrink disc, HSS coupling, yaw bearing, yaw drive, elastomer bearing, rotor brake, etc. which transmits the relative motion including hydraulics schematics shall be evaluated as per the IEC 61400 series.

8.5.4 Nacelle covers and Spinner

The evaluation shall be performed as per GL 2010.

8.5.5 Drive Train Dynamics

The evaluation shall be performed as per GL 2010.

8.5.6 Gearbox

The mechanical aspects of the gearbox including the structural aspect as listed in 8.5.2 shall be evaluated as per IEC 61400-4. The test specification of the field test can be a part of the design but shall be agreed latest with the certification body prior to the field test.

Following documents shall be submitted for evaluation, insofar applicable:

- Design calculation reports;
- Drawings with geometrical data (casted, forged, welded, assembly etc.);
- CAD models in .iges or .step format for components designed with FEM;
- Specifications (design, material, test etc.);
- Test reports and
- Data sheets.

Independent analysis may be carried out from the certification body. A process design evaluation (see 3.9) can be carried out to reduce the required amount of independent analysis.

8.6 **Element: Supporting Structure and Foundation interface**

The supporting structure including the interface with the foundation shall be evaluated for compliance with the requirements of the valid standard of the IEC 61400 series or the previous major version, and the agreed additional codes and standards as defined in the design basis.

The tower element is optional in case of a RNA certificate. The substructure evaluation is optional for offshore WTG.

Under supporting structure are included the tower and the sub-structure (usually offshore) connecting the tower to the foundation.

As per the actual state following technical standards are applicable for evaluation of towers:

Tower Type/ Standard	Tubular Steel Tower	Concrete Tower	Hybrid Tower (Steel/Concrete)	Hybrid Tower (Steel/Lattice)
IEC 61400-6	X	X	X	X
EUROCODE 2 DIN EN 1992[2]		X	X	
EUROCODE 3 DIN EN 1993[3]	X		X	X
DIN 18088-1 + DIN 18088-2		X	X	
DIN 18088-1 + DIN 18088-3	X		X	X

As per the actual state the following technical standards are applicable for evaluation of substructures:

Substructure Type/Standard	Monopile	Jacket	Tripod
IEC 61400-6	X	X	X
EUROCODE 3 DIN EN 1993[3]	X	X	X
DIN 18088-1 + DIN 18088-3	X	X	X

The following documents shall be submitted for evaluation, if applicable, for tower and substructure:

- Design calculation reports;
- drawings with geometrical data, tolerances and applicable standards;
- CAD models or FEM- files and
- specifications and manuals.

A combined evaluation covering both IEC 61400-6, Eurocode 2 and/or 3, and DIN EN 18088 is possible. At least one standard among IEC 61400-6, Eurocode 2 and/or 3 or DIN EN 18088 shall be fulfilled accordingly to the definition made in the design basis.

The interface to the foundation shall be performed as per chapter 8.3.10 of the IEC 61400-22. Deviations from the scope defined above as well usage of different standards may be accepted case by case based on submitted documentation and in consultation with the CB.

Independent analysis may be carried out from the certification body. A process design evaluation (see 3.9) can be carried out to reduce the required amount of independent analysis.

2. For Eurocode 2 are all the relevant parts to be considered.
3. For Eurocode 3 are all the relevant parts to be considered.

8.7 Element: Foundation Design

8.7.1 General

The foundation design element is optional. The requirements are subjected to the type of foundation used as listed in chapter 8.7.2, 8.7.3 and 8.7.4.

8.7.2 Onshore

The purpose of the evaluation of the foundation is to verify whether the turbine foundation is designed in accordance with the foundation interface (see chapter 8.6) and if it is in accordance with the agreed applicable standards and codes. The foundation shall fulfill either the requirements of IEC 61400-6 or DIN EN 1992-1 or DIN EN 1997-1 or 18088-2 or 18088-4 depending on the type of foundation. A combined evaluation is possible. Deviations from the scope defined above as well usage of different standards may be accepted case by case based on submitted documentation and in consultation with the CB.

8.7.3 8.7.3 Offshore/bottom fixed

Additionally to the requirements of chapter 8.7.2 the offshore foundation shall cover also the connection between substructure and foundation. The design shall fulfill either IEC 61400-6 or DIN EN 1993-1. A combined evaluation is possible. Deviations from the scope defined above as well usage of different standards may be accepted case by case based on submitted documentation and in consultation with the CB.

8.7.4 Offshore/floating

The floating foundation and station keeping design of the wind turbine shall be designed in line with the IEC 61400 series and ISO standards. Following technical standards and technical specifications are applicable:

General design requirements can be found in the IEC TS 61400-3-2. This technical specification is pointing back to IEC 61400-3-1 and IEC 61400-1 for some topics. Alternatively a foundation design according to DNV-ST-0119 and/or combination with the IEC TS 61400-3-2 may be accepted after consultation with the CB.

Metocean design, operating and geotechnical considerations shall follow the requirements of ISO 19901-1 and ISO 19901-4. The floater structural design shall fulfill ISO 19904-1. The Stationkeeping design shall follow ISO 19901-7 as well as DNVGL-ST-0119 requirements. Floating stability shall follow IMO MSC.267(85) as well as DNVGL-ST-0119 and the marine operations shall follow ISO 19901-6.

Corrosion protection shall be implemented accordingly to ISO 19904-1 and ISO 12944-9.

Marine systems (bilge and ballast systems) shall be designed in accordance with recognized standards (e.g. ISO 19901-4) considering IMO requirements.

Additional load assumptions for ULS, FLS, SLS and ALS specifically with regard to the floating foundation and stationkeeping system as outlined in ISO 19901-7 and DNVGL-ST-0119 are to be considered. The interface between these additional load cases and the load assumption for the wind turbine shall be covered within this element. For load validation, scaled model tests, demonstrator- or full-scale measurements are to be performed.

Depending on floater design and stationkeeping system concept, as-built test requirements shall be agreed with the certification body and may include inclining test, decay test, anchor holding capacity tests and testing of ballast and emergency and other mechanical, marine and electrical systems where relevant for the safe operation. The test plan shall be approved by the CB. A witnessing of the testing from the CB may be necessary on a case by case agreement.

Transport and installation (T&I) design for the floating foundation shall be in line with ISO 19901-6. Due to the diverse nature of T&I operations, other codes and

standards may be required and accepted on a case-by-case basis. The T&I design documentation shall be submitted in terms of (procedural) drawings, specifications of involved assets, manuals and procedures. T&I specific load assessments are to be submitted for evaluation. The interface between these additional load cases and the load assumption for the wind turbine shall be covered within this element.

Deviations from the scope defined above as well usage of different standards may be accepted case by case based on submitted documentation and in consultation with the CB.

8.8 **Element: Electrical System**

Electrical Systems shall fulfill valid technical standard of the IEC 61400 series or the previous major version. Furthermore DNV-ST-0076 is accepted in evaluation area where IEC standards are inconclusive. As a minimum system description, schematics, wiring diagrams, calculations, data sheets and drawings shall be submitted. Design consideration about electrical power network conditions (voltage variation, frequency variation, voltage imbalance, auto-reclosing cycles, admissible network outages, etc. shall be submitted by the applicant.

Further standard can be considered only upon agreement with the CB during design basis evaluation.

The generator shall be designed according to IEC 60034 series. Direct drive generators shall be designed based on the principles and standards defined in the design basis, as the IEC 60034 is not applicable for those. Specification and data sheet with rating of the machines, equivalent circuit diagram, heat-run test (converter operated, if applicable), vibration test, routine test, cooling system description, cable connection and interfaces, installation and environment conditions and protection and earthing shall be submitted by the applicant.

The type tests (including heat run tests) of the generator and converter combination shall be witnessed by UL unless the testing facility is accredited according to ISO/IEC 17025 or an agreement with the supplier/manufacturer is made in consultation with CB prior to the testing.

The power converter shall be evaluated against IEC 62477-1 or IEC 61800-4 if Ur > 1kV AC. Data sheets, chopper calculation, short circuit calculation, equivalent circuit diagram, EMC regulations, IP and pollution level, type and routine test shall be submitted as also the insulation design documentation.

The power transformer is mandatory if included in the turbine. The evaluation shall follow the IEC 60076 series for Sr > 100kVA. Data sheet, rating plate, circuit diagram, insulation calculation for design lifetime, type and routine test, Vibration test, environmental testing, cooling system description, installation and earthing as also protection and monitoring equipment shall be submitted by the applicant.

The low voltage circuit breakers shall follow the IEC 61439 (series) and IEC 60947-2 standards. Data sheets, short circuit capacity, fault setting (LSIG) and test reports shall be submitted by the applicant.

The high voltage switch gear shall follow IEC 62271 (series). Data sheets, test reports, short circuit calculation, internal faults testing, pressure relief measures and their possible influence on the installation environment shall be submitted by the applicant.

Calculation of stored energy supply for the pitch system to bring the turbine to standstill from normal operating conditions in the event of a grid failure shall be submitted by the application, Data sheets of the pitch system, data sheets of back up energy supply (batteries, ultracapacitors) and calculation report shall be submitted by the applicant.

Cables should be designed according to IEC 60364-5-52 or equivalent standard that is agreed with the CB during design basis evaluation. Data sheets, ampacity calculations, insulation protection (abrasion, wear, clamps, supports, strain relief measures, fire and environmental hazards) and mechanical stability of vertical cables shall be submitted by the application.

Busbards (if any) shall be designed according to IEC 61439 (series). Data sheets, ampacity calculations, protection to personnel,

environmental protection and mechanical stability shall be submitted by the applicant.

The lightning protection system shall fulfill the IEC 61400-24 Ed. 2 LPL I requirements. Reference to a previous version of the standard are permitted in consultation with UL.

Following elements are recommended but not considered as mandatory:

- Bearing rating life calculation for the generator according to ISO 281;
- Slip rings and
- EMC testing according to IEC 61800-3 or different standard as agreed in the design basis.

8.9 **Element: Site Condition**

Site specific external conditions are submitted by the applicant. This covers, but is not limited to, environmental condition (i.e. wind distribution, turbulence distribution, wind shear, inflow conditions, air density, 50 year wind speed, 1 year recurrence wind speed, typhoons, storms,...), electrical conditions (i.e. type of grid connection including voltage and frequency, network outages, isle operation,...) and other relevant conditions (i.e. earthquakes, icing,...). A review of the submitted documentation is performed by the CB to assess the determination process and the applicability of the values to all the turbines at the site.

8.10 **Element: Manuals and Personnel Safety**

Manuals related to the following topics shall cover the product under assessment:

- Manufacturing:
  - manufacturing specifications;
  - work instructions, purchase specifications;
  - quality control procedures;
  - equirements for workshop tests.
- Transport:
  - technical specifications applicable for the transportation;
  - limiting environmental conditions;
  - transportation arrangement including required fixtures, tooling and equipment;
  - transportation loads and load conditions.
- Installation and Commissioning:
  - identification of human resource requirements and skills;
  - identification of interface points and any required technical specifications for civil and electrical construction works including earthing system;
  - identification of specialized tooling and required lifting fixtures or equipment;
  - quality control check points, measurements and inspections, required by the design;
  - description of personnel safety and planned environmental protection measures;
  - outline of planned installation manual;
  - commissioning procedures and check-list;
  - quality recording and record keeping processes
  - Operation and Maintenance: scheduled maintenance actions including inspection intervals and routine actions;
  - identification of all safety-related operational procedures or maintenance activities;
  - description of planned environmental protection measures;
  - identification of required specialized tooling and maintenance equipment;
  - identification of human resource requirements and skills;
  - outline of planned operating instructions and maintenance manual;
  - description of quality recording and record keeping processes.

The personnel safety measures implemented shall be documented. The standards to be considered for personnel safety shall be defined in the design basis. It is recommended to follow EN 50308. The evaluation of personnel safety aspects shall include but are not limited to:

- safety instructions;
- climbing facilities;
- access ways and passages;
- standing places, platforms and floors;
- hand rails and fixing points;
- lighting;
- electrical and earthing system;
- fire resistance;
- emergency switching off buttons;
- provision of alternative escape routes;
- provision for emergency stay in an for offshore wind turbine for one week;
- offshore specific safety equipment for an offshore wind turbine.

9.0 Module: Type testing evaluation

9.1 **General**
The type testing evaluation is based on measurement carried out at the wind turbine. This is applicable also for RNA, where the RNA shall be mounted on a tower.

For component certificates only the specific component relevant element applies.

The elements shown in this section shall be covered by measurement performed by either an ISO/IEC 17025 accredited testing laboratory or by an IECRE approved testing laboratory (for established competence area). Deviations from this requirement are permitted in case the CB will witness the test on-site.

For small wind turbines, with a rotor swept area below 200 m^2 it is possible to perform a reduced set of mechanical load measurement, in order to validate the load assumption, in accordance with the CB by undergoing a full duration test as per IEC 61400-2.

9.2 **Safety system functional test**
This element covers the test of the safety system according to the test plan approved during the design phase. At least chapter 3 of annex D of the IEC 61400-22 shall be fulfilled.

Additionally any further tests identified as necessary during design evaluation shall be performed. Tests carried out according to GL 2010 or DNV-ST-0438 may be accepted upon agreement with the CB.

9.3 **Personnel safety and commissioning**
The WTG shall be inspected on-site by the CB to verify the implementation of the personnel safety measures identified at the design stage and to verify the implementation of the commissioning manual during the commissioning at one of the first prototypes (see chapter 8.10).

9.4 **Power performance**
The power performance measurements shall be carried out at a representative wind turbine. The measurement shall fulfill the requirements of the IEC 61400-12-1. Further standards can be considered only upon agreement with the CB. Deviations related to the power curve evaluated within the load assumption (see chapter 8.2) shall be justified by using an appropriate ∀ load model in conjunction with the mechanical load validation (see chapter 9.5). Country specific requirements on measurements are generically not considered and can be implemented upon customer request.

9.5 **Mechanical Load Measurement and Validation**
The mechanical load measurement shall comply with IEC 61400-13. Further standard can be considered only upon agreement with the CB. The results of the measurement shall be used for validation of the simulation model used for load assumption. The measurement results shall be compared by the customer with the outcome of the load assumption and demonstrate that the turbine behavior in terms of mechanical loading and power performance is in alignment with the design assumptions. Deviations shall be clearly mentioned and justified in the assessment report.

For Offshore floating wind turbines it is to verify that the overall weight, center of gravity and the mass moment of inertia are matching with the submitted design. In case the standards used within the design are requesting further test on-site (i.e. DNV-ST-0119), these need to be covered within this element.

9.6 **Full scale blade test**
The full scale blade test shall comply with the requirement of IEC 61400-23. Further standard can be considered only upon agreement with the CB. The test shall be carried out according to the approved test plan (see chapter 8.4). Deviations shall be clearly mentioned and justified in the assessment report.

A full scale blade test can be performed as testing for similarity upon agreement with the CB. The testing for similarity may allow with one physical blade test program to be carried out, to cover also tests for one or more additional blades or to reduce test efforts for additional

blades. It is mandatory that unique design attributes such as same aerodynamical profiles, same raw materials, similar outer geometry and similar sectional stiffness are shared by additional blades.

The physical test shall cover the failure efforts related to the design loads for each blade. This may lead to overload the physical tested blade in order to cover additional blades to be tested for similarity. It is solely the decision of the CB whether a blade test for similarity can be accepted or not.

9.7 **Gearbox field test**

The gearbox field test shall be carried out according to IEC 61400-4. In case of a component certificate this element can be considered as in interface item to be taken care during the integration of the gearbox in the WTG/RNA. Further standards can be considered only upon agreement with the CB. After the test, the gearbox shall be visually inspected including the check of contact patterns and oil analysis. The endoscopy report shall be submitted after the field test. The duration of operation prior to the endoscopy and oil analysis shall be specified in the test specification in consultation with the certification body.

The visual inspection is not mandatory to be witnessed by the certification body. In such case, the visual report shall include at least the following information:

- Location of the wind turbine;
- Installation and commissioning logbook with date of installation as appendix;
- Oil test results from accredited testing laboratory as appendix;
- Photo with proof of operating time + produced energy;
- Photo of the wind turbine with type plate;
- Photo of the main gearbox with type plate;
- Photo of torque arm, elastomer bearing support with serial number;
- Photo of oil filter, oil cleanliness sensor, cooling system, pump, with serial number and model number;
- All Joint photos like Torque Arm and LSS ring gear. etc.;
- Photo of oil tank with oil level;
- Photo of videoscopy of all the stages of gears and bearings (generator side, rotor side, middle). Load flank and back flank for gears and inner- and outer raceway for bearings;
- Explanation on findings along with the action plan;
- Photo of oil sampling taken before and after the filter and
- Qualification record of Personnel performing endoscopy.

10.0 Module: Manufacturing evaluation

10.1 **General**

The manufacturing evaluation covers mainly two aspects: the quality management system and the manufacturing inspection.

The quality management system shall meet the ISO 9001:2015 requirements. A certificate to ISO 9001:2015 (with an appropriate scope) issued by a CB accredited by an IAF member organization can be used to satisfy this requirement. If the manufacturer is not performing any product development the certificate can cover only the manufacturing side and skipping the "design and development" part. In case the ISO 9001 certificate is not available or no longer valid an assessment of the quality management system shall be performed by the certification body. Any product modification will require a further assessment.

In the case of a shop approval according to DNV-SE-0436 or GL 2010, the manufacturing evaluation can be, upon agreement, reduced to a product-specific document review, and the site visit can be typically omitted and replaced by a document-based manufacturing evaluation, based on the found agreement.

10.2 **Element: Hub and Nacelle Assembly**

The Hub and Nacelle Assembly manufacturing inspection requires following criteria to be fulfilled:

- Implementation of design specifications (drawings, work instructions, purchase specifications, etc.);
- Inspection of manufacturer workshop;
- Review of material certificates;
- Review of incoming good inspection processes and
- Review of critical production processes.

The applicant shall submit the following documentation:

- Production plan;
- Procedures for quality control and work instructions;
- Product related specification (drawings, work instructions, purchase specifications, etc.);
- Records of quality control including material certificates and test reports if applicable and
- Valid ISO 9001 certificate (or alternatively undergo a product specific assessment related to quality management). A certificate to ISO 9001:2015 (with an appropriate scope) issued by a CB accredited by an IAF member organization can be used to satisfy this requirement.

The following components can be inspected as a part of incoming goods inspection during the site inspection of hub and nacelle assembly:

- Rotor hub;
- Rotor shaft;
- Main bearing;
- Main bearing housings;
- Main frame;
- Generator;
- Converter;
- Transformer;
- Pitch and yaw bearings;
- Pitch and yaw drives;
- Couplings;
- Licking devices;
- Mechanical brake;
- Housings and
- Any other components in agreement with CB.

Upon its successful evaluation, the components along with it's manufacturer can be a part of the assessment report detailing clearly that it was a part of incoming goods inspection.

10.3 **Element: Rotor Blade**

The Rotor Blade manufacturing inspection requires the following criteria to be fulfilled:

- Implementation of design specifications (drawings, work instructions, purchase specifications, etc.);

- Inspection of manufacturer workshop;
- Review of material certificates;
- Review of incoming good inspection processes and
- Review of critical production processes.

The applicant shall submit the following documentation:

- Production plan;
- Procedures for quality control and work instructions;
- Product-related specifications (drawings, work instructions, purchase specifications, etc.);
- Records of quality control including material certificates and test reports if applicable and
- Valid ISO 9001 certificate (or undergo a product-specific assessment related to quality management)

The on-site inspection can be also carried out on blades that are similar to the blade under evaluation. A justification, explaining the similarity, shall be provided to the certification body.

10.4 **Element: Tower**

The Tower manufacturing inspection requires the following criteria to be fulfilled:

- Implementation of design specifications (drawings, work instructions, purchase specifications, etc.);
- Inspection of manufacturer workshop;
- Review of material certificates;
- Review of incoming good inspection processes and
- Review of critical production processes.

The applicant shall submit the following documentation:

- Production plan;
- Procedures for quality control and work instructions;
- Product-related specifications (drawings, work instructions, purchase specifications, etc);
- Records of quality control including material certificates and test reports if applicable;
- Valid ISO 9001 certificate (or undergo a product-specific assessment related to quality management) and
- The minimum qualification for welding works is an ISO 3834-2 certificate. Should these qualifications be not available an alternative manufacturing standard may be agreed with the CB.

In case of offshore wind turbine the same activities have also to be performed for the substructure.

The tower/substructure manufacturing evaluation can be skipped for RNA certification.

10.5 **Element: Gearbox**

The manufacturing inspection of the main gearbox requires following criteria to be fulfilled:

- Implementation of design specifications (drawings, work instructions, purchase specifications…);
- Inspection of manufacturer workshop;
- Review of material certificates;
- Review of incoming good inspection processes;
- Review of critical production processes.

The applicant shall submit following documentation:

- Production plan;
- Procedures for quality control and work instructions;
- Product related specification (drawings, work instructions, purchase specifications,…);
- Records of quality control including material certificates and test reports, if applicable and
- Valid ISO 9001 certificate (or alternatively undergo a product specific assessment related to quality management).

10.6 Element: Welded Structures

In includes the manufacturing evaluation of critical welded structures like frames and generator rotor and stator for Direct Drive.

The manufacturing inspection requires following criteria to be fulfilled:

- Implementation of design specifications (drawings, work instructions, purchase specifications, etc.);
- Inspection of manufacturer workshop;
- Review of material certificates;
- Review of incoming good inspection processes and
- Review of critical production processes.

The applicant shall submit following documentation:

- Production plan;
- Procedures for quality control and work instructions
- Product related specification (drawings, work instructions, purchase specifications…)
- Records of quality control including material certificates and test reports if applicable
- Valid ISO 9001 certificate (or alternatively undergo a product specific assessment related to quality management).

Specific welding details in chapter 10.7.3 shall be followed.

10.7 Element: Foundation Manufacturing

10.7.1 General

The foundation manufacturing is an optional element. The requirements for the different foundation types are covered in chapter 10.7.2 and 10.7.3.

10.7.2 Onshore/Offshore bottom fixed

The manufacturing inspection of the foundation requires following criteria to be fulfilled:

- Implementation of design specifications (drawings, work instructions, purchase specifications…)
- On-site witnessing of foundation manufacturing process (only onshore)/ Inspection of manufacturer workshop (only offshore)
- Review of material certificates
- Review of incoming good inspection processes
- Review of critical production processes.
- The applicant shall submit the following documentation:
- Production plan
- Procedures for quality control and work instructions
- Product-related specifications (drawings, work instructions, purchase specifications, etc.)
- Records of quality control including material certificates and test reports if applicable
- Valid ISO 9001 certificate (or undergo a product-specific assessment related to quality management).

10.7.3 Offshore – Floating

- Additionally to the requirements shown in chapter 10.7.1 the manufacturing inspection at the workshop will focus on qualification for welding works according to ISO 3834-2. Should these qualifications be not available an alternative manufacturing standard may be agreed with the CB.

11.0 Module: Type characteristics evaluation

11.1 **General**
This module is an optional module consisting of the elements listed below.

11.2 **Element: Noise**
The acoustic noise measurement shall comply with the requirement of IEC 61400-11. Further standard can be considered only upon agreement with the CB. The test shall be carried out by either an ISO/IEC 17025 accredited testing laboratory or an approved IECRE testing laboratory for this competence area. Are neither of the both options possible the test can be also executed under witnessing by the CB. Deviations shall be clearly mentioned and justified.

11.3 **Element: Power Quality**
The power quality measurement shall comply with the requirement of IEC 61400-21. Further standard can be considered only upon agreement with the CB. The test shall be carried out by either an ISO IEC 17025 accredited testing laboratory or an approved IECRE testing laboratory for this competence area. Are neither of the both options possible the test can be also executed under witnessing by the CB. Deviations shall be clearly mentioned and justified.

11.4 **Element: Grid code capability**
The electrical characteristics of the wind turbine must show compliance to the local requirements for connection to a local grid. To show this compliance the wind turbine must follow the local requirements in case of testing, simulation models and certification.

This procedure describes the defined functions and characteristics as a maximum capability which can be used to support the local grid code compliance certification:

Testing:
The testing must be done by a testing laboratory accredited according ISO/IEC 17025 following the general procedure of FGW TG3 latest Revision or similar. The final test procedure must be aligned with the corresponding CB. Deviation shall be agreed with the CB.

Certification:
The certification must be done by an accredited certification body acc. ISO/IEC 17065 following the general procedure of FGW TG8 latest Revision or similar. The content of the evaluation and possible grid codes will be aligned between the certification body and the customer as the basis for the certificate.

Goal of this certification is to show the maximum capability for at least the following characteristics while perform tests and show detailed description:

- Voltage and Frequency Range for Operation;
- Active power capability;
- Active power set-point control/accuracy;
- Voltage dependent Reactive power capability;
- Reactive power set-point control/accuracy;
- Power Quality acc. IEC 61400-21-1 like Harmonics/Interharmonics/Higher Frequencies, Flicker, etc.;
- Low Voltage Ride Through and High Voltage Ride Through capability in case of ride through, active and reactive current feed pre-/during and post-fault;
- LFSM-O/LFSM-U and FSM and
- ROCOF.

The Simulation Model should cover at least the following functions:

- Voltage and Frequency Range for Operation;
- Reactive Power capability PQU-Diagram;
- LFSM-O/LFSM-U/FSM and
- FRT (HVRT/LVRT).

These characteristics must be validated following the validation procedure of FGW TG4 latest Revision or similar by a CB.

The outcome of these Evaluation work will be an Assessment Report documenting the evaluation results like test report review, evaluation and description of the named functions. The model validation report shall be documented in the Assessment Report or an separate Validation Report.

Optionally, if agreed with the customer, based on this evaluation and validation results the certification body will issue a unit certificate based on the maximum capability and selected characteristics.

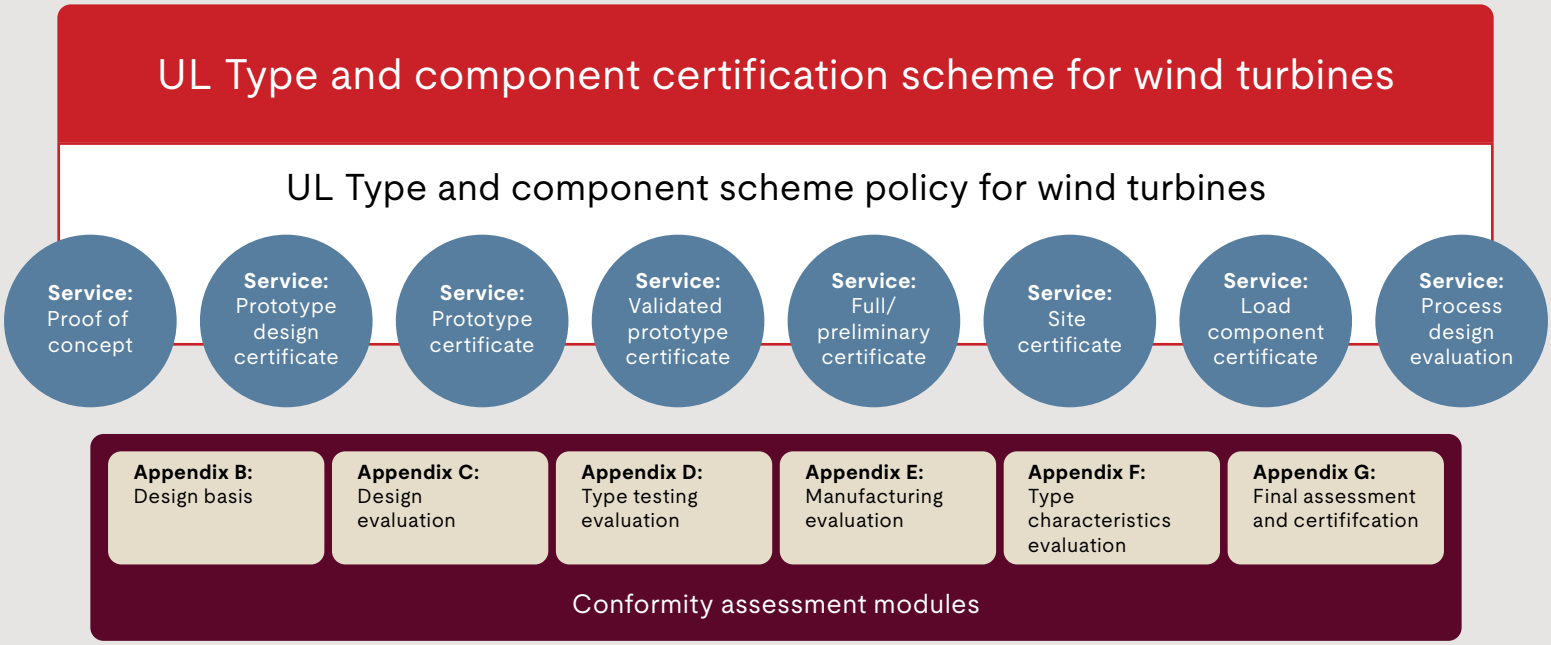
12.0 Module: Final assessment and certification

This module will cover the final assessment, with its assessment report, and covers the certification decision as per ISO/IEC 17065.

The final assessment module shall verify that all the necessary evaluation and eventually open interfaces have been clearly addressed.

Upon competition of the final assessment the review process can be started which will lead to the certification decision and consequently, if positive, issue of the certificate.

13.0 Appendix A (informative) – scheme structure for UL type and component certification scheme for wind turbines



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