IEC 61400-22

Edition 1.0 2010-05

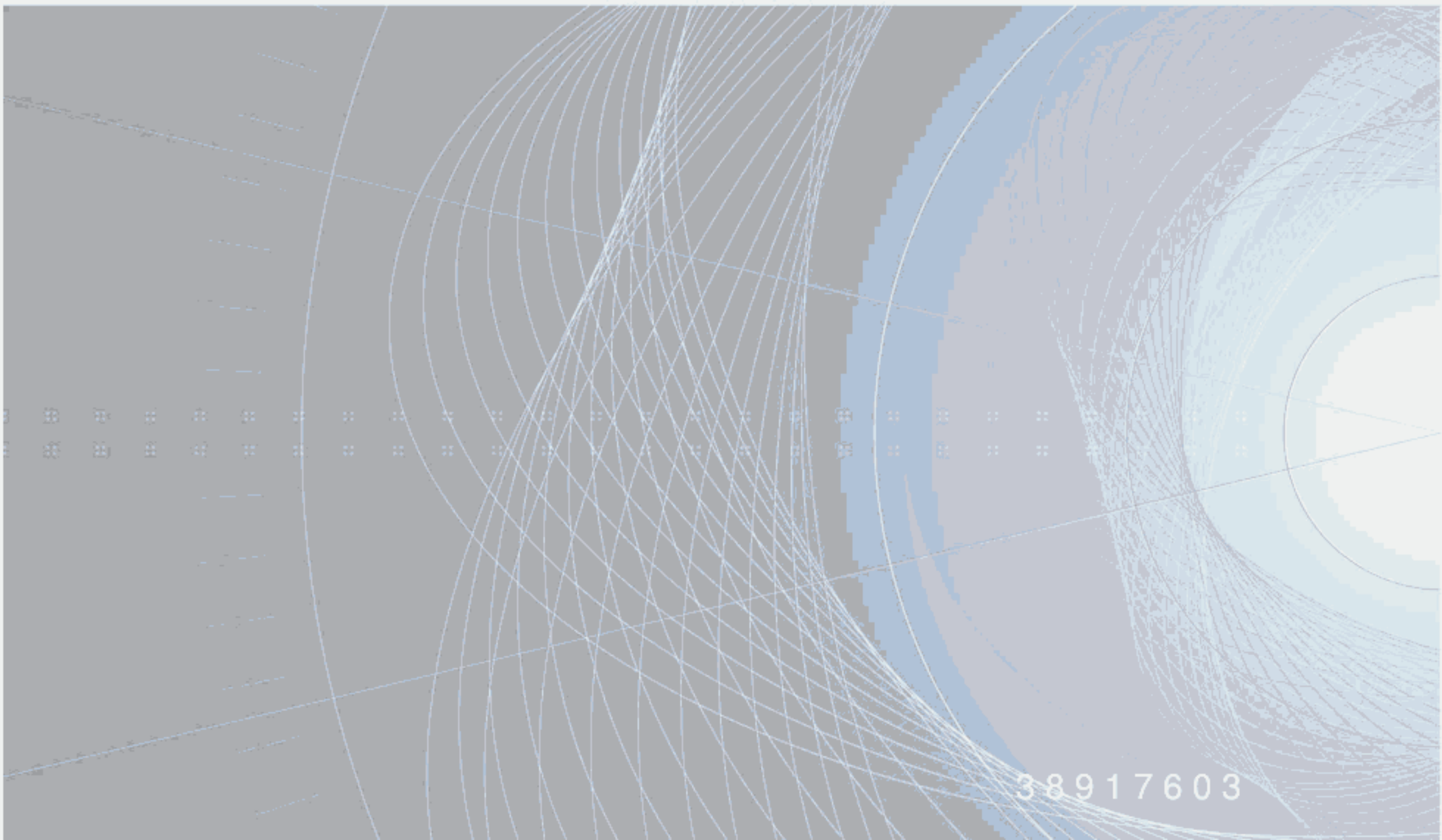
INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Wind turbines –
Part 22: Conformity testing and certification

Eoliennes –
Partie 22: Essais de conformité et certification



IEC 61400-22:2010

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Part 22: Conformity testing and certification

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 61400-22 has been prepared by IEC technical committee 88: Wind turbines.

This standard cancels and replaces IEC WT 01 (2001): IEC System for Conformity Testing and Certification of Wind Turbines – Rules and Procedures.

The text of this standard is based on the following documents:

FDIS	Report on voting
88/365/FDIS	88/368/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of the IEC 61400 series, under the general title: *Wind turbines*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

This International Standard defines rules and procedures for conformity testing and certification of wind turbines with respect to standards and technical requirements for wind turbines and wind farms. It is intended to facilitate mutual recognition (reciprocal acceptance) by participants of test results and certificates issued by other participants for obtaining certification at national level and operates within the scope of the IEC 61400 series of standards and technical specifications for wind turbines.

The certification procedures in this standard constitute a complete third party conformity evaluation of a wind turbine type, a major component type or one or more wind turbines at a specific location.

In addition to design verification and testing, this standard provides information for the recognition of or assessment for approval of the supplier's quality system, regular surveillance through inspection of the supplier's quality system and quality plans, and audit testing of samples. The standard is amongst others intended to result in significant benefit to the applicant by reducing the number of steps necessary to obtain certification or approval at national level.

WIND TURBINES –

Part 22: Conformity testing and certification

1 Scope

This International Standard defines rules and procedures for a certification system for wind turbines (WT) that comprises both type certification and certification of wind turbine projects installed on land or off-shore. This system specifies rules for procedures and management for carrying out conformity evaluation of WT and wind farms, with respect to specific standards and other technical requirements, relating to safety, reliability, performance, testing and interaction with electrical power networks. It provides:

– definitions of the elements in a wind turbine certification process;

– procedures for conformity evaluation in a wind turbine certification system;

– procedures for conformity surveillance;

– rules for the documentation that is to be supplied by an applicant for the conformity evaluation; and

– requirements for certification and inspection bodies and testing laboratories.

The rules and procedures are not limited to WT of any particular size or type. However, special rules and procedures apply for small wind turbines (SWT). Some elements of certification are mandatory, whilst provision is specifically made for others to be optional. For type certification, the document describes procedures relating to conformity testing, design, manufacture, and the plans for transportation, erection, installation and maintenance. The procedures deal with the assessment of loads and safety, testing, characteristics measurements and surveillance of manufacturing. For project certification, the document describes procedures relating to the assessment that particular wind turbines and support structure/foundation designs in a project are appropriate for the application and relating to transportation, installation, commissioning, operation and maintenance. The procedures deal with assessment in accordance with all modules in this document, e.g. the site conditions, the design of site-specific components and surveillance of manufacturing, transportation, installation and operation.

The purpose of the rules and procedures is to provide a common basis for certification of wind turbines and wind turbine projects, including a basis for acceptance of operating bodies (i.e. certification bodies, inspection bodies and testing laboratories) and mutual recognition of certificates.

The rules and procedures are intended to be used in conjunction with the appropriate IEC/ISO standards and Guides, see Clause 2.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE In the case where an earlier or withdrawn edition of the referenced normative document is used together with this document, these earlier editions must be specified in the Agreement for Certification, see Subclause 6.2, and in conformity statements and certificates.

IEC 60034 (all parts), *Rotating electrical machines*

IEC 60050-415, *International Electrotechnical Vocabulary – Part 415: Wind turbine generator systems*

IEC 61400 (all parts), *Wind turbines*

IEC 61400-1, *Wind turbines – Part 1: Design requirements*

IEC 61400-2, *Wind turbines – Part 2: Design requirements for small wind turbines*

IEC 61400-3:2009, *Wind turbines – Part 3: Design requirements for offshore wind turbines*

IEC 61400-11, *Wind turbine generator systems – Part 11: Acoustic noise measurement techniques*

IEC 61400-12-1, *Wind turbines – Part 12-1: Power performance measurements of electricity producing wind turbines*

IEC/TS 61400-13, *Wind turbine generator systems – Part 13: Measurement of mechanical loads*

IEC 61400-21, *Wind turbines – Part 21: Measurement and assessment of power quality characteristics of grid connected wind turbines*

IEC/TS 61400-23, *Wind turbine generator systems – Part 23: Full-scale structural testing of rotor blades*

IEC 61400-24, *Wind turbines – Part 24: Lightning protection*

ISO/IEC 17020, *General criteria for the operation of various types of bodies performing inspection*

ISO/IEC 17021, *Conformity assessment – Requirements for bodies providing audit and certification of management systems*

ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

ISO/IEC Guide 2: *Standardization and related activities – General vocabulary*

ISO/IEC Guide 65, *General requirements for bodies operating product certification systems*

ISO 9001:2008, *Quality management systems – Requirements*

ISO 81400-4:2005, *Wind turbines – Part 4: Design and specification of gearboxes* [1)]

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1) To be replaced by IEC 61400-4.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply, together with the relevant definitions contained in ISO/IEC Guide 2 and IEC 60050-415.

3.1
accreditation
procedure by which an authoritative body gives formal recognition that a body is impartial and technically competent to carry out specific tasks such as certification, tests, specific types of tests etc.

NOTE Accreditation is awarded following successful assessment and is followed by appropriate surveillance.

3.2
applicant
entity applying for certification

3.3
certificate holder
entity holding a certificate after the certificate is issued

NOTE This entity may not be the original applicant but nevertheless is responsible for maintenance of the certificate.

3.4
certification
procedure by which a third party gives written assurance that a product, process or service conforms to specified requirements, also known as conformity assessment

3.5
certification body
body that conducts certification of conformity

3.6
certification system
system that has specific rules for procedure and management to carry out certification of conformity

3.7
commissioning
process that encompasses functional safety checks, connecting the wind turbine to the grid and putting it into operation

3.8
conformity statement
document issued upon successful completion of evaluation of a certification module

The statement includes identification of the receiver, the object, the main normative standards, evaluation and measurement reference reports, validity and certification body.

3.9
evaluation for conformity
systematic examination of the extent to which a product, process or service fulfils specified requirements

3.10
final evaluation report
report containing the results of conformity evaluations relating to type certification

the basis for the decision to issue the type certificate

3.11
inspection
systematic examination of the extent to which a product, process or service fulfils specified requirements by means of measuring, observing, testing or gauging the relevant characteristics

3.12
installation
process that encompasses site fabrication, assembly and erection

3.13
manufacture
process that encompasses fabrication and assembly in a factory or workshop

3.14
manufacturer
entity manufacturing the wind turbine or, where relevant, main components of the wind turbine

3.15
modification
a new installation or changes to an existing installation, which changes the original design/specification

3.16
operating body
body that conducts certification of conformity, testing or inspection

3.17
project certificate
document issued upon successful completion of project certification

3.18
project certification
procedure by which a certification body gives written assurance that one or more specific wind turbines including support structure and possibly other installations are in conformity with requirements for a specific site

3.19
rotor nacelle assembly
RNA
part of a wind turbine carried by the support structure, see 3.22

3.20
repair
repair of a unit or a piece of equipment to its original design/specification

3.21
replacement
replacement of a unit or a piece of equipment in conformance with its original design/specification

3.22
support structure
part of a wind turbine consisting of the tower, sub-structure and foundation, see Figure 1 of IEC 61400-3

3.23
surveillance
continuing monitoring and verification of the status of procedures, products and services, and analysis of records in relation to referenced documents to ensure specified requirements are met

3.24
type certificate
document issued upon the successful completion of type certification

3.25
type certification
procedure by which a certification body gives written assurance that a wind turbine type conforms to specified requirements

3.26
type testing
action of carrying out tests for a given wind turbine type according to specified procedures

3.27
wind turbine type
wind turbines of a common design, materials and major components, subject to a common manufacturing process and uniquely described by specific values or ranges of values of machine parameters and design conditions

4 Symbols and abbreviations

4.1 Symbols

The relevant symbols contained in IEC 61400-1 are applicable.

4.2 Abbreviations

RNA	rotor/nacelle assembly
SWT	small wind turbine(s)
WT	wind turbine(s)

5 Acceptance of operating bodies

5.1 General

Operating bodies shall be capable and competent to operate their elements of the wind turbine certification process in an impartial manner and shall comply with the relevant ISO/IEC publications among the following: ISO/IEC 17020, ISO/IEC 17021, ISO/IEC 17025 and ISO/IEC Guide 65.

5.2 Accreditation

Operating bodies shall be accredited by a national or international accreditation body that has been internationally evaluated. This requirement is intended to facilitate recognition arrangements on an international level of certificates and test results and to increase public confidence in the competence and impartiality of the operating bodies.

5.3 Recognition arrangements

Operating bodies shall seek to obtain, preferably multilateral, recognition arrangements for the acceptance of each other's work, e.g. test results or quality system certificates. Such arrangements shall be established with reference to the requirements of this standard.

When the operating bodies have been accredited by a common accreditation body or where recognition arrangements exist between the corresponding accreditation bodies, the accreditation forms a sufficient basis for mutual recognition of work under the accreditation.

If a recognition arrangement based on accreditation is not possible, a recognition arrangement between operating bodies should include:

- the scope of the agreement;
- specification of the parts of the wind turbine certification system with unrestricted acceptance;
- identification of the signatories and their legal status;
- agreement regarding surveillance of each other's work;
- a procedure for handling complaints and appeals;
- definition of the parties' responsibilities;
- details of lines of communication;
- undertakings regarding confidentiality and security; and
- a procedure for maintenance of a register of certificates, conformity statements and test reports issued by the bodies of the agreement.

5.4 Advisory committee

Certification bodies operating type and project certification according to this standard shall seek to establish and participate in a joint advisory committee. The committee should establish by-laws and provide advice to the operating bodies on:

- harmonization of requirements for documentation for certification;
- mutual recognition;
- need for amendments to procedures and requirements;
- interpretation of procedures and requirements for documentation for conformity assessment; and
- interpretation of technical requirements.

The recommendations from meetings of the advisory committee shall be made available to accreditation institutes or other relevant boards.

6 Management of the certification system

6.1 General

The certification system shall be managed and operated in accordance with ISO/IEC Guide 65. For project and prototype certification the system may alternatively be managed and operated in accordance with ISO/IEC 17020, in which case certification system elements on 8.3 or 9.5 shall be managed and operated in accordance with ISO/IEC Guide 65.

6.2 Agreement on certification

A certification body shall upon request be prepared to take on work for certification of wind turbines or wind farm projects according to the rules of this standard. The services of the certification body shall be available to all applicants without undue financial or other conditions.

Prior to starting certification work an agreement between applicant and certification body shall be made. In addition to financial and other usual contract conditions, the agreement shall include:

- the scope of the certification;
- the identification of collaborating bodies (inspection or testing bodies), their accreditation and their responsibilities;
- the set of IEC 61400 standards and other technical requirements to which conformity shall be evaluated;
- a description of the scope of documentation to be supplied by the applicant for evaluation, e.g. see Annex A: Design documentation; and
- conditions for reporting and investigating incidents.

6.3 Issue of certificates and conformity statements

The certification system covers the issue of certificates and conformity statements.

A certificate or conformity statement is based on evaluation of wind turbine documentation and the results of inspection, surveillance or testing, as applicable. The results of evaluation shall be documented in a final report. A certificate or a conformity statement shall be issued on the basis of an assessment of the completeness and correctness of an evaluation report or reports.

In the case of outstanding issues of no importance to the primary safety of the certified object, a provisional certificate or conformity statement may be issued for a limited period of validity that permits evaluation and verification of the outstanding issues.

A certificate or conformity statement shall identify the scope of evaluation, the wind turbine, the supplier, the design assumptions and the set of normative documents, standards and other technical requirements. Examples, showing a suitable format and the minimum information, are given in Annex B.

6.4 Security of relevant documentation

The certification body shall keep a file of all received material that is relevant to the certificate or conformity statement. This file shall be kept in a place with restricted access for at least 5 years plus the design lifetime of the object, for certification after the later date of receipt of the material or expiry of the last certificate issued. Subsequently the material and any copies shall be returned to the applicant or destroyed with written notice thereof.

6.5 Validity, maintenance and expiration of certificates

6.5.1 General

The period of validity and/or the period of review or monitoring shall be clearly stated in the certificate. The period of validity for type and component certificates and associated conformity statements shall not exceed 5 years. The period of validity of a prototype certificate shall not exceed 3 years.

The period of validity of a provisional certificate or conformity statement during which all outstanding issues shall be documented by the applicant and evaluated by the certification body shall not exceed 1 year.

A project certificate is valid for the installation at the site specified in the certificate and has no period of validity. In the case of a provisional certificate or conformity statement the period during which all outstanding issues shall be documented by the applicant and evaluated by the certification body shall not exceed 1 year.

6.5.2 Maintenance of type certificate

In order to maintain validity of the type certificate, the following requirements shall be met by the applicant and the certification body:

– the applicant shall prepare an annual report for the certified wind turbine to be sent to the certification body for review. The report shall include information on installed turbines and abnormal operating experience or failures known to the certificate holder and any minor modifications;

– the applicant shall report major modifications to the certified product to the certification body without delay and provide corresponding design documentation, procedures, specifications or processes. In case the certificate holder intends to maintain and/or extend the validity of the certificate, update of all documents affected by such modifications shall be provided; and

– the certification body shall perform periodic surveillance with the purpose to check that the wind turbines produced correspond to the type-certified turbines and meet the required surveillance according to ISO/IEC Guide 65. The period shall in general not exceed 2,5 years, if the serial production has started. Such surveillance shall be on a recently installed wind turbine or in the workshop. The scope of the surveillance has to be significantly lower than for the inspections as they were performed as a part of the type certificate. If the applicant does not operate a quality system that is certified according to ISO 9001, the certification body shall verify at least once a year that manufactured wind turbines continue to be in conformance with the certified design. This verification shall follow the elements of 8.5.2 and 8.5.3.

6.5.3 Maintenance of project certificate

A project certificate is issued for wind turbine(s) and additional installation(s) as installed at the site specified in the certificate at the date of issue.

A certification body may perform operation and maintenance surveillance, see 9.16, in order to confirm that operation and maintenance is carried out according to certified O&M manuals at periodic intervals. In this case, major modifications to the site or the wind turbines shall be reported to the certification body without delay.

In order to reissue a project certificate the following requirements shall be met by the applicant and the certification body:

– the applicant shall prepare an annual report for the certified project to be sent to the certification body for review. The report shall include information on installed wind turbine(s) and additional installation(s) as installed at the site, deviant operating experience known to the certificate holder and minor modifications;

– the applicant shall report major modifications to the certified project to the certification body without delay. In case the certificate holder intends to update the certificate, the update of all documents affected by the modification shall be provided; and

– a certification body shall perform operation and maintenance surveillance, see 9.16, with the purpose of checking that a specific wind turbine installation or wind turbine project at a specific site is operated and maintained in conformity with the relevant manuals included in the design documentation and meets the required surveillance according to ISO/IEC Guide 65. The period shall in general not exceed 2,5 years.

6.5.4 Dealing with outstanding matters

A provisional certificate or associated conformity statement can be issued to allow for 0-series manufacture as well as to allow for outstanding matters with no safety implication.

The outstanding matters should be limited to:

– matters with no safety implication within the period of validity (maximum 1 year); and
– matters related to the finalization of manuals and quality control procedures.

In cases where a project certificate has been issued based on a provisional type certificate with outstanding matters, the owner of the certificate shall inform the project certification body of the results of the type certification body's evaluation and verification of the outstanding matters.

In cases where a project certificate has been issued based on a provisional type certificate, the project certification body shall evaluate the needs for changes in the project, on the basis of the results of the type certification body's verification of outstanding matters. The owner of the project shall be informed of any need for changes.

6.6 Corrective actions

The certification body shall be informed if, from log-book data or other information brought to the attention of the certificate holder, a wind turbine or project in question is shown not to function according to the design specifications and/or other criteria relevant to the certificate.

Incidents known to the certificate holder where the safety of a wind turbine, project or the surroundings is involved shall be reported to the certification body without delay.

If after preliminary evaluation the certification body determines a serious defect affecting the safety of a wind turbine in question, the certificate shall be immediately suspended. The certification body shall subsequently carry out a thorough evaluation of the defect. This evaluation shall result in either reaffirmation or withdrawal of the certificate.

7 The extent of certification

7.1 General

The certification procedures specified in this standard constitute a complete third party conformity evaluation of a wind turbine type, a major component type or one or more wind turbines at a specific location, from design evaluation to monitoring of commissioning and operation. An evaluation results in one of the following:

– a type certificate;
– a project certificate;
– a component certificate; or
– a prototype certificate.

A type certificate covers a wind turbine, including the tower and the proposed type of connection between tower and foundation. It also covers the requirements governing the foundation, insofar as they arise from the wind turbine design, and may include one or more foundations.

A project certificate covers one or more wind turbines, including the foundation(s) and optionally other installations at the site, evaluated for specific external conditions at an installation site. A project certificate presumes a type certificate and includes site conditions assessment and foundation design evaluation as mandatory modules.

A component certificate covers a major wind turbine component such as a blade or gearbox.

A prototype certificate covers a wind turbine not ready for series manufacture at a specific site.

The approach given in this standard has a modular structure in order to account for requests for individual conformity statements, e.g. design evaluation.

The normative documents, i.e. standards and other specified technical requirements, conformity with which shall be evaluated in the certification process, shall be IEC or ISO standards, when available.

7.2 Type certification

The purpose of type certification is to confirm that the wind turbine type is designed, documented and manufactured in conformity with design assumptions, specific standards and other technical requirements. Demonstration that it is possible to install, operate and maintain the turbines in accordance with the design documentation is required. Type certification applies to a series of wind turbines of common design and manufacture. It consists of the mandatory modules:

– design basis evaluation;
– wind turbine design evaluation;
– type testing;
– manufacturing evaluation; and
– final evaluation;

and the optional modules:

– foundation design evaluation;
– foundation manufacturing evaluation; and
– type characteristic measurements.

The modules are illustrated in Figure 1. Satisfactory evaluation of each module is concluded with an evaluation report and a conformity statement.

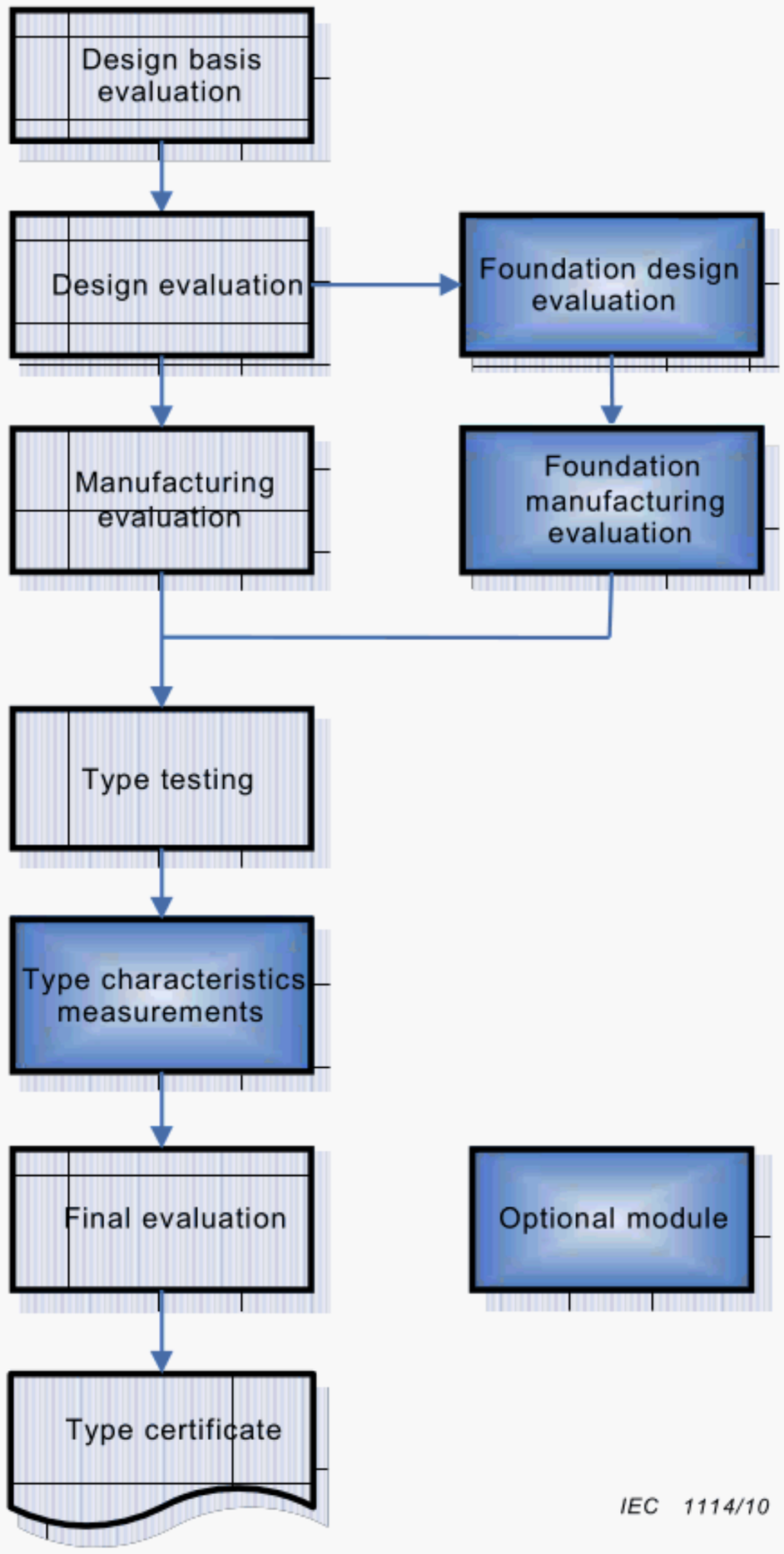

Figure 1 – Modules of type certification

A type certificate is issued for a wind turbine designed and evaluated for conformance with the technical requirements of this standard and IEC 61400-1, IEC 61400-2 or IEC 61400-3, on the basis of the completeness and correctness of a final evaluation report.

A type certificate documents conformity for all the mandatory modules and may additionally document conformity for optional modules.

The modules and their application are described in Clause 8.

7.3 Project certification

The purpose of project certification is to evaluate whether type-certified wind turbines and particular support structure/foundation(s) designs are in conformity with the external conditions, applicable construction and electrical codes and other requirements relevant to a specific site. If there is no type certificate issued for the wind turbine, the mandatory module type certificate within project certification, see Figure 2, shall be fulfilled, and hence the mandatory modules of type certification covered by the project certification shall be evaluated with respect to the specific project and site-specific conditions. The certification body shall evaluate whether the wind conditions, other environmental conditions, electrical network conditions and soil properties at the site conform with those defined in the design documentation for the wind turbine type and foundation(s). The evaluation includes safety and quality.

Project certification of type-certified wind turbines consists of the following modules:

– site conditions evaluation;
– design basis evaluation;
– integrated load analysis;
– site-specific wind turbine/RNA design evaluation;
– support structure design evaluation;
– other installations design evaluation;
– wind turbine/RNA manufacturing surveillance;
– support structure manufacturing surveillance;
– other installations manufacturing surveillance;
– project characteristics measurements;
– transportation and installation surveillance;
– commissioning surveillance;
– final evaluation; and
– operation and maintenance surveillance.

The modules are illustrated in Figure 2. Satisfactory evaluation of each module is concluded with an evaluation report and a conformity statement.

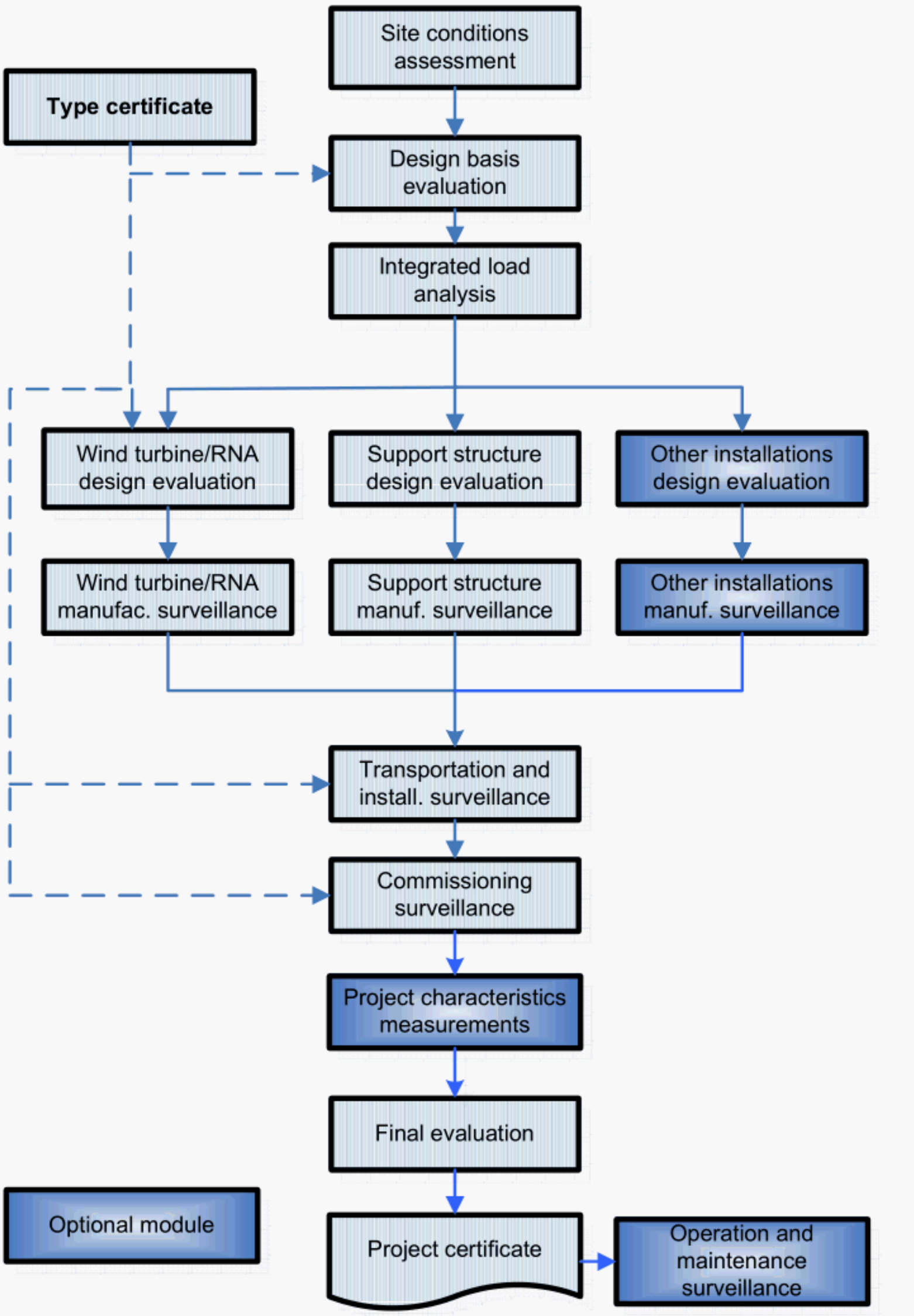

Figure 2 – Modules in project certification

A project certificate documents conformity for all the mandatory modules and may additionally document conformity for optional modules. The certificate is issued on the basis of the completeness and correctness of the evaluation reports and conformity statements.

The modules and their application are described in Clause 9.

7.4 Component certification

The purpose of wind turbine component certification is to confirm that a major component of a specific type is designed, documented and manufactured in conformity with design assumptions, specific standards and other technical requirements.

Component certification consists of the following modules:

- design basis evaluation[2)];
- design evaluation;
- type testing;
- manufacturing evaluation; and
- final evaluation.

These modules as well as their application for the type certification process are illustrated in Figure 3. The procedures for component certification should be in line with the type certification procedures described in Clause 8. The specific content of a module depends on the actual component. Where applicable, the evaluation elements described in Clause 8 should be applied. For components that are required to undergo specified type testing as part of the wind turbine type testing module, it is recommended that the type testing be included as part of any component certification.

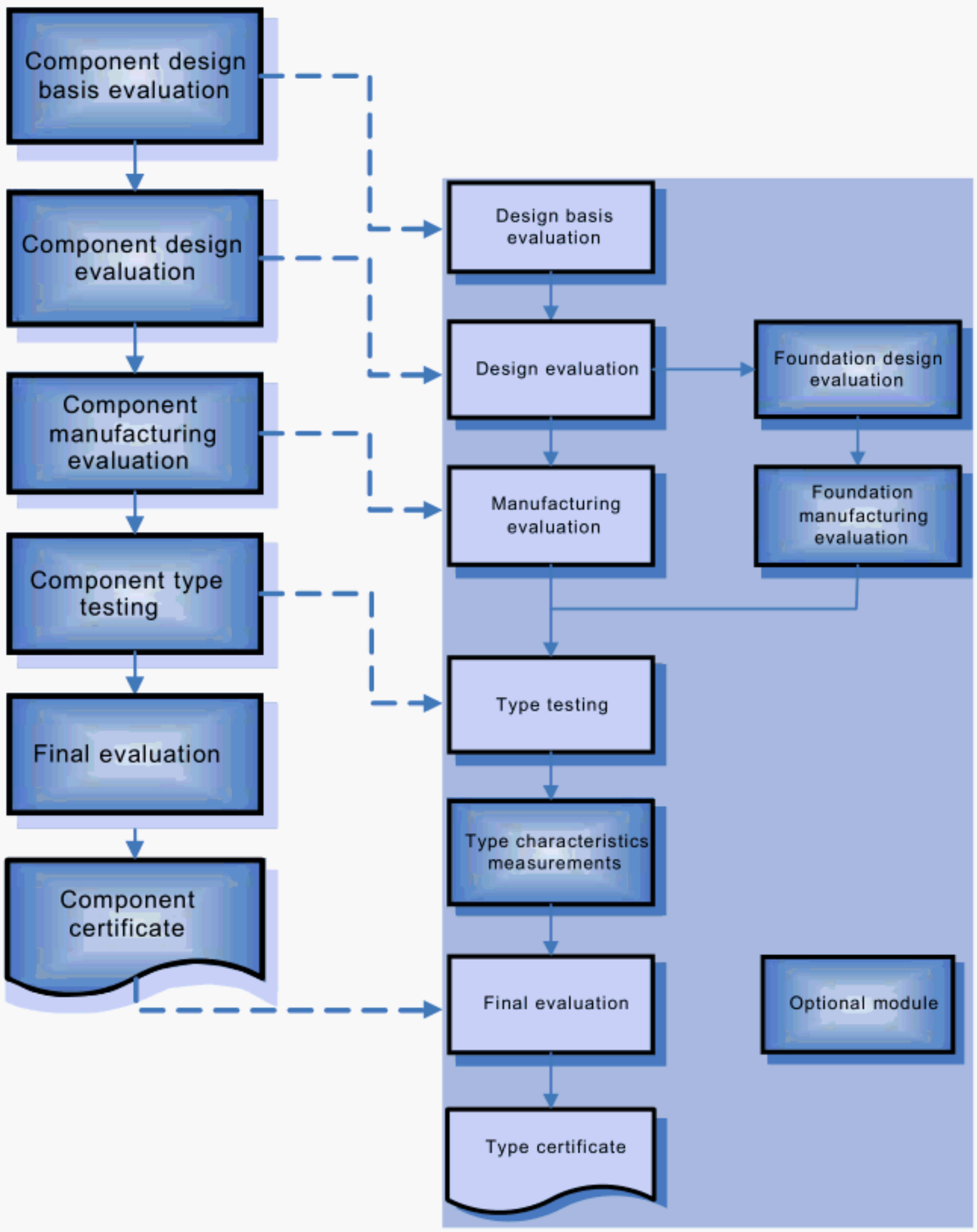

Figure 3 – Modules in component certification and their applications for type certification

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2) The process begins with design basis evaluation of the component or design evaluation, if the design basis for the wind turbine type for which the component is intended is applicable and has already been evaluated.

Special attention shall be given in design documentation to the specification of the interface between components and the rest of the wind turbine system and to the specification of critical conditions, such as operating conditions, loads and dynamic properties.

Component certificates may be issued for components designed and evaluated for conformance with the technical requirements of IEC 61400-1, IEC 61400-2 or IEC 61400-3 on the basis of completeness and correctness of final evaluation reports. A component certificate attests that conformity has been established for all modules of evaluation. Satisfactory evaluation of each module is concluded with an evaluation report and a conformity statement.

An example of a component certificate is given in Annex B.

7.5 Prototype certification

The purpose of wind turbine prototype certification is to enable testing of a new wind turbine type in order to obtain type certification in accordance with this standard.

A prototype certificate is issued for a wind turbine that is not yet ready for series manufacture, at a specific site and for a limited period of maximum 3 years.

The certification body shall evaluate that the prototype is safe during the specified period. If a prototype is modified affecting the safety of the wind turbine, a new prototype certificate is required.

Prototype certification consists of the following modules:

– basic design evaluation;
– prototype test plan evaluation; and
– safety and function test.

Basic design evaluation includes the mandatory modules design basis evaluation and wind turbine design evaluation, described in 8.2 and 8.3. The evaluation can be limited to control and protection system, loads and load cases, rotor blades, main structural and electrical components and personnel safety issues.

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

A prototype test plan comprises a minimum of the elements described in 8.4. The safety and function test shall be carried out and evaluated as part of prototype certification.

8 Type certification

8.1 General

Type certification shall confirm that the wind turbine type is designed in conformity with the design assumptions, specific standards and other technical requirements. It shall also confirm that the manufacturing process, component specifications, inspection and test procedures, and corresponding documentation are in conformity with the design documentation and that the manufacturer operates an accepted quality system. Furthermore, it covers the testing of the wind turbine.

The certification body shall require an applicant to provide documentation that meets all the requirements detailed in this clause. The wind turbine type shall be evaluated for compliance with the technical requirements of this standard, IEC 61400-1 or IEC 61400-2 and additional assumptions and requirements stated in the design basis by the designer and agreed with the certification body.

8.2 Design basis evaluation

The purpose of design basis evaluation is to examine that the design basis is properly documented and sufficient for safe design of the wind turbine type.

The design basis shall identify all requirements, assumptions and methodologies, which are essential for the design and the design documentation, including:

- codes and standards;
- design parameters, assumptions, methodologies and principles, and
- other requirements, e.g. for manufacture, transportation, installation and commissioning as well as for operation and maintenance.

Such identification may be carried out through references to this standard, IEC 61400-1, IEC 61400-2 or IEC 61400-3 and other applied codes and standards, or by listing specific design aspects and parameters. In particular, choices, supplementary information and deviations relating to the design issues shall be clearly stated in the design basis, e.g. for:

- external design parameters;
- design load cases;
- load factors and load reduction factors;
- partial safety factors applied on loads and materials;
- duration of simulation as well as number of simulations;
- methods for extreme and fatigue design loads/response analysis;
- environmental conditions relevant for installation;
- inspection scope and frequency;
- target lifetime of components, systems and structures, and
- requirements for condition monitoring systems.

8.3 Design evaluation

8.3.1 General

The purpose of design evaluation is to examine whether the wind turbine type is designed and documented in conformity with the design assumptions, specific standards and other technical requirements. Normally, the design evaluation comprises all of the elements shown in Figure 4.

For SWT designed according to IEC 61400-2 all elements of Figure 4 and additionally, the element “evaluation of test for design data” shall be considered. The element “evaluation of the rotor blade” can be replaced by the element “evaluation of static blade test”.

For SWT, the static blade test, test for design data and component tests can be performed in-house by the manufacturer, if agreed with the certification body.

The certification body shall require an applicant to supply all documentation necessary for design evaluation. A list of design documentation is provided in Annex A. This list may be extended or reduced, depending on the wind turbine concept and complexity of the design.

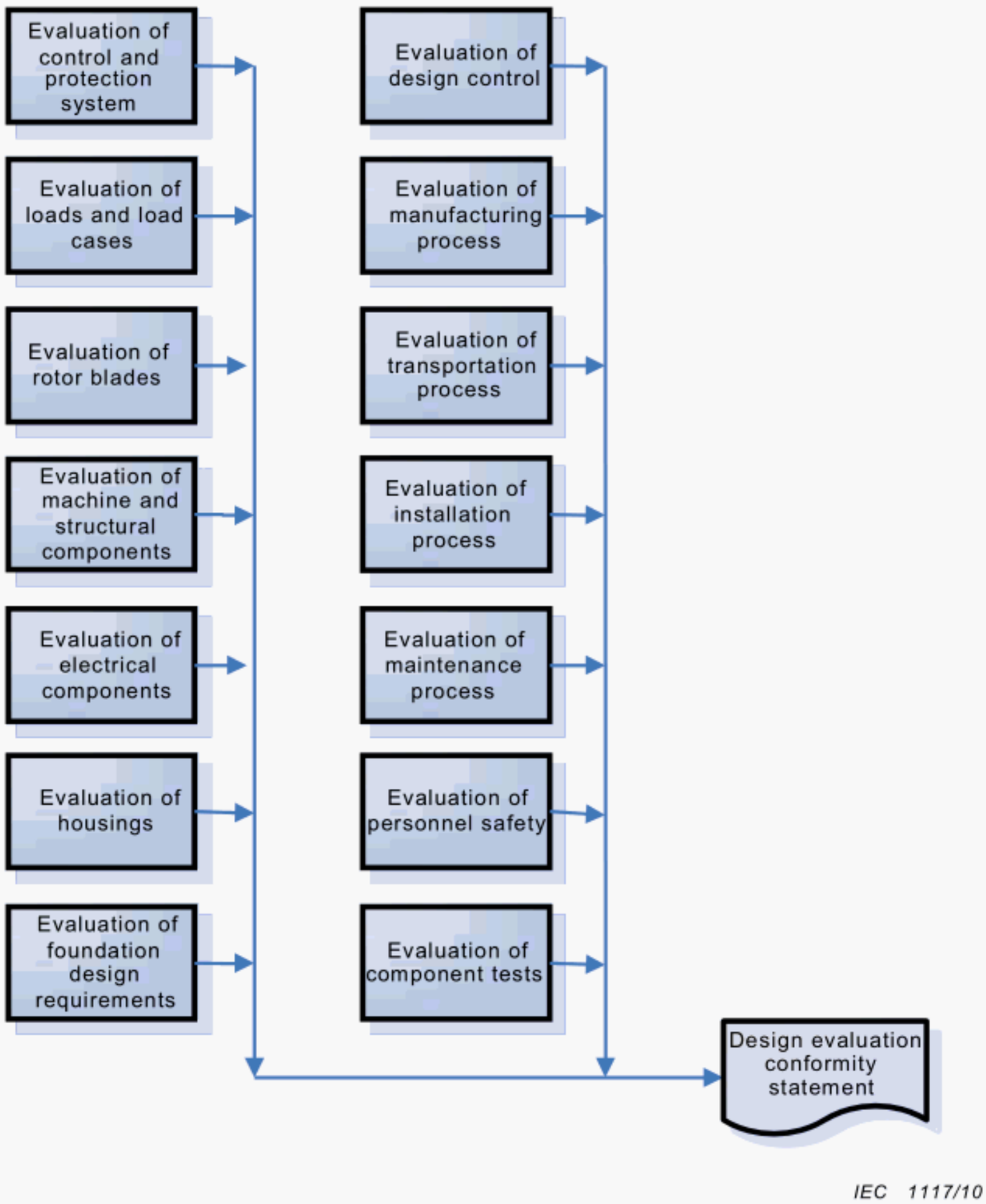

Figure 4 – Elements of design evaluation

8.3.2 Design control

The certification body shall evaluate the quality procedures used to control the design process. Design control procedures shall be required to:

- comply with ISO 9001 Subclause 7.3, Design and development; and
- include control of documents such that the revision status of every document is clear to all parties.

The requirement for evaluation is satisfied if the quality system of the applicant has been certified according to ISO 9001.

8.3.3 Control and protection system

The certification body shall evaluate the documentation of a control and protection system, comprising:

- description of wind turbine modes of operation;
- design and functionality of all elements;
- fail-safe design of the protection system;

- system logic and hardware implementation;
- authentication of reliability of all safety critical sensors;
- braking system(s) analysis;
- condition monitoring if applicable; and
- test plan for the verification of the control and protection system functions.

8.3.4 Loads and load cases

The certification body shall evaluate the loads and load cases for compliance with IEC 61400-1, IEC 61400-2 or IEC 61400-3 by independent analysis.

Description of loads shall be provided in a format that enables the certification body to carry out independent analysis.

The load values submitted shall be accompanied by the load case description, description of calculation models and input data such as:

- parameter values relating to aerodynamics;
- structural characteristics; and
- parameter values relating to the control system.

8.3.5 Rotor blades

The certification body shall evaluate the design of the rotor blades.

The rotor blades shall be evaluated for compliance with the requirements of this standard, IEC 61400-1, IEC 61400-2 or IEC 61400-3, IEC/TS 61400-23[3)] and the agreed additional codes and standards as defined in the design basis.

The design documentation relating to rotor blades will normally consist of specifications, descriptions, drawings and design calculations, which may be combined with measurement/test reports, schematics and part lists. The certification body shall require that the documentation clearly refers to the design basis and identifies the basis for the design. Additionally, the documentation shall contain sufficient information for evaluation of the design, such as

- codes, standards and references;
- design loads and relevant external conditions;
- static systems and boundary conditions;
- influence of adjacent structures and components;
- materials and permissible stresses;
- material and sub-component test program;
- full-scale blade test program;
- manufacturing processes;
- tolerances influencing the design; and
- quality control procedures and level.

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3) The content and the adequacy of the test programs for documentation of rotor blade strength is verified based on IEC/TS 61400-23. Requirements for full-scale tests are given in 8.4.5. Conformity between design requirements and the results of tests is evaluated in 8.9.

8.3.6 Machine and structural components

The certification body shall evaluate the design of all load-bearing machinery structures and components of the wind turbine such as:

- casted, forged or welded structures;
- nacelle frame;
- tower;
- pitch and yaw systems;
- bearings and elastomer bushings;
- gearboxes;
- brakes, couplings and locking devices;
- bolts for connecting these structures and components;
- cooling and heating systems; and
- hydraulic systems.

The machinery structures and components shall be evaluated for compliance with the requirements of this standard, IEC 61400-1, IEC 61400-2 or IEC 61400-3, and the agreed additional codes and standards as defined in the design basis.

The gearbox shall be evaluated for compliance with the requirements of ISO 81400-4[4)]. The result of the workshop test for the prototype gearbox as well as the prototype gearbox field test program shall be part of the design evaluation.

Furthermore, requirements for testing of components during manufacturing and assembly shall be specified and evaluated.

The design documentation relating to machinery structures and components will normally consist of specifications, descriptions, drawings and design calculations, which may be combined with measurement/test reports, diagrams, data sheets, schematics and part lists. The certification body shall require that the documentation clearly refers to the design basis and identifies the basis for the design. Additionally, the documentation shall contain sufficient information, for example on:

- codes, standards and references;
- design loads and relevant external conditions;
- static systems and boundary conditions;
- influence of adjacent structures and components;
- influence of drive train dynamics;
- materials and permissible stresses;
- type/data sheets (for mass-produced parts); and
- work instructions (for bolted connections).

8.3.7 Electrical components

The certification body shall evaluate the design of all electrical components of the wind turbine such as:

- generators;
- transformers;

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4) This standard will be substituted with IEC 61400-4, when available.

– converters;
– medium and high voltage components;
– electrical drives;
– charging equipment and storage batteries;
– switchgear and protection equipment;
– cables and electrical installation equipment; and
– lightning protection.

The electrical components shall be evaluated for compliance with the requirements of this standard, IEC 61400-1 and IEC 61400-2 or IEC 61400-3 as well as further IEC-standards and the agreed additional codes and standards as defined in the design basis.

For evaluation of lightning protection, reference is made to IEC 61400-24.

Workshop tests for the generator according to IEC 60034 series shall be carried out and documented. The result of the workshop test shall be considered during the design evaluation.

Furthermore, requirements for testing of components during manufacturing and assembly shall be specified and evaluated.

The design documentation relating to electrical components will normally consist of specifications, descriptions, drawings, diagrams, data sheets, type test reports and design calculations, which may be combined with schematics and part lists. The certification body shall require that the documentation clearly refers to the design basis and identifies the basis for the design. Additionally, the documentation shall contain sufficient information, for example on:

– codes, standards and references;
– design requirements and relevant external conditions;
– boundary conditions;
– influence of adjacent structures and components; and
– materials.

8.3.8 Housings

The certification body shall evaluate the design of all housings such as:

– spinners; and
– nacelle covers.

Housings shall be evaluated for compliance with the requirements of this standard, IEC 61400-1, IEC 61400-2 or IEC 61400-3 and the agreed additional codes and standards as defined in the design basis.

The design documentation relating to housings will normally consist of specifications, descriptions, drawings and design calculations, which may be combined with measurement/test reports, schematics and part lists. The certification body shall require that the documentation clearly refers to the design basis and identifies the basis for the design. Additionally, the documentation shall contain sufficient information, for example on:

- codes, standards and references;
- design loads and relevant external conditions;
- static systems and boundary conditions;
- influence of adjacent structures and components; and
- materials and permissible stresses.

8.3.9 Evaluation of component tests

The strength and other functional requirements of some structural, mechanical or electrical components may be documented by measurements or test results only.

When the relevant analysis for a component is found to be inadequate, the certification body may require additional component tests and/or measurements to be carried out as an alternative to further analysis. The certification body shall evaluate the design of such a component on the basis of the measurements and test reports and establish that test results are properly implemented in the design.

The certification body shall require that measurement and test reports clearly identify the component, the test standards or procedures, as well as the conditions for which the tests have been carried out.

8.3.10 Foundation design requirements

The certification body shall evaluate the foundation design requirements detailed in the design documentation for a turbine with respect to compliance of one or more foundation design(s) with IEC 61400-1, IEC 61400-2 or IEC 61400-3 and relevant agreed structural codes. In addition, the evaluation shall establish that the foundation design(s) conform to interface geometry requirements (flatness, level, and bolt pattern tolerances) and the strength requirements defined in the turbine design documentation.

For offshore wind turbines, the foundation design requirements shall also include design requirements for the sub-structure connecting the tower to the foundation.

The characteristic and design loads at the interfaces of tower, sub-structure and foundation stated in the design documentation shall be used as a basis for this evaluation. These loads shall include both horizontal and vertical forces as well as any moments about horizontal and vertical axes at the interface. The extreme dynamic loads as well as fatigue loads resulting from the combination of all relevant load cases shall be considered in the design evaluation. Because overall turbine and support structure system natural vibration frequencies and modes can be affected by foundation flexibility, a permissible range for horizontal, vertical and rotational foundation flexibility at the interface between foundation and sub-structure or tower shall be stated.

The resistance and flexibility of the foundation shall be evaluated in terms of representative soil conditions at sites suitable for installation of the foundation. These soil conditions shall be described in the foundation design documentation.

8.3.11 Manufacturing process

The certification body shall verify that the turbine design can be manufactured according to any quality requirements identified in the design documentation. The quality-relevant manufacturing processes shall be described.

The manufacturing process may be documented in preliminary

- manufacturing specifications;
- work instructions, purchase specifications; and
- quality control procedures.

In addition, requirements for workshop tests shall be specified.

The evaluation of the final version of these documents, at the latest, shall be part of final evaluation, Subclause 8.9.

8.3.12 Transportation process

The certification body shall verify that the turbine can be transported according to any requirements identified in the design documentation.

This description of the transportation process shall, if applicable, include:

- technical specifications applicable for the transportation;
- limiting environmental conditions;
- transportation arrangement including required fixtures, tooling and equipment; and
- transportation loads and load conditions.

The transportation process may be documented in a preliminary transportation/installation manual. The final description of the transportation process shall be evaluated at the latest during final evaluation, Subclause 8.9.

8.3.13 Installation process

The installation process shall be sufficiently described to allow the certification body to verify the adequacy of the turbine design, taking into account specified installation processes, including commissioning. This description of the installation process shall, if applicable, include:

- 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 specialised 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; and
- quality recording and record keeping processes.

The installation process may be documented in a preliminary installation/commissioning manual. The final description of the installation process shall be evaluated at the latest during Final Evaluation, Subclause 8.9.

8.3.14 Maintenance process

The maintenance process shall be sufficiently described to allow the certification body to verify the adequacy of the turbine design, taking into account specified maintenance processes. This description of the maintenance process shall, if applicable, include:

- 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 specialised tooling and maintenance equipment;
- identification of human resource requirements and skills;
- outline of planned operating instructions and maintenance manual; and
- description of quality recording and record keeping processes.

The maintenance process may be documented in a preliminary O&M manual. The final description of the maintenance process shall be evaluated at the latest during final evaluation, Subclause 8.9.

8.3.15 Personnel safety

The certification body shall evaluate personnel safety aspects in the design documentation (drawings, specifications and instructions) for compliance with IEC 61400-1, IEC 61400-2 or IEC 61400-3 and the agreed additional codes and standards, see 6.2.

Personnel safety aspects to be considered include:

- 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; and
- offshore specific safety equipment for an offshore wind turbine.

The certification body shall require an applicant to identify elements in the design documentation that pertain to personnel safety.

8.3.16 Design evaluation conformity statement

The certification body shall issue a conformity statement based on satisfactory evaluation of a design evaluation report(s). The conformity statement shall include:

- identification of the wind turbine type;
- identification of the applicant;
- list of IEC 61400 series standards used;

- specification of external conditions with reference to the WT class and other principal data; and
- specific reference to evaluation report(s).

Examples of conformity statements are given in Annex B.

8.4 Type testing

8.4.1 General

The purpose of type testing is to provide data needed to verify power performance, aspects that are vital to safety and need additional experimental verification, and any other aspects that cannot be reliably evaluated by analysis. Type testing comprises the elements shown in Figure 5.

The certification body shall evaluate that testing of these aspects, as applicable, has been carried out on a turbine or component of a turbine representative of the type to be certified. Inspection records shall be completed, preferably prior to the tests, to demonstrate satisfactory conformity of the turbine or component with the design documentation.

The detailed test program shall be defined by the applicant and be subject to approval by the certification body on a case by case basis.

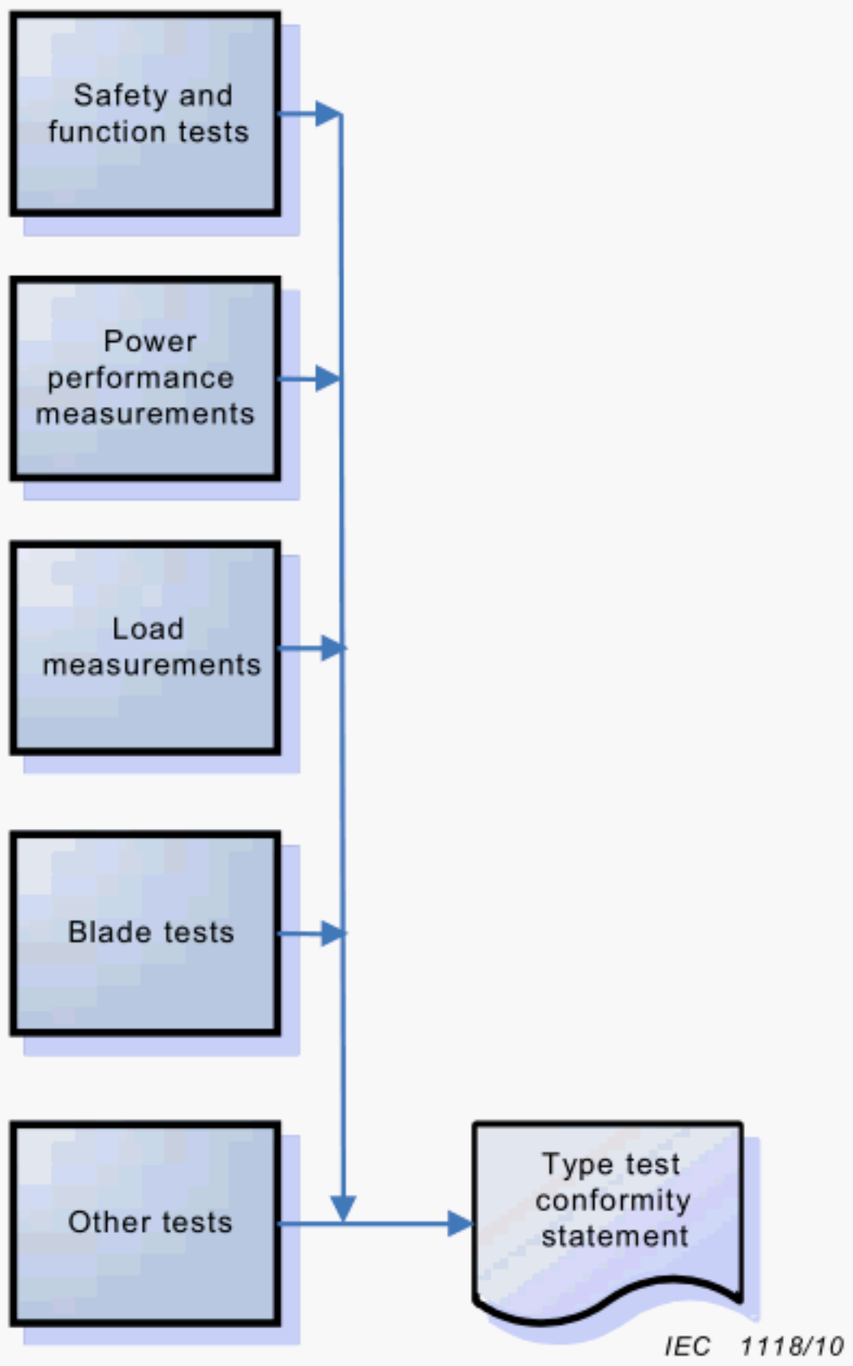

Figure 5 – Type testing elements

The type testing elements given in Figure 5 and the duration test shall be carried out by an accredited testing laboratory or the certification body shall verify that the party conducting the testing complies with at least the criteria of ISO/IEC 17025 or ISO/IEC 17020, as applicable. The requirements for the duration test are described in IEC 61400-2.

The certification body shall require that the testing and the test results be documented in a test report. This test report shall be evaluated by the certification body to ensure that the tests have been carried out in accordance with the approved detailed test program and that the test report properly documents the aspects required for certification. The certification body shall verify by inspection that critical personnel safety features have been satisfactorily implemented in the installed wind turbine to be tested.

A satisfactory evaluation is concluded with a conformity statement. The signatories of the conformity statement shall be different from the persons responsible for the test reports, attestation of the tests and accreditation of the test laboratories.

For SWT designed according to 61400-2 the “load measurements” and “blade tests” have to be replaced by the “duration test”.

8.4.2 Safety and function tests

The purpose of safety and function testing is to verify that the wind turbine under test displays the behaviour predicted in the design.

The certification body shall verify satisfactory demonstration of the control and protection system functions with reference to the approved test plan see 8.3.3. The test plan shall at least include testing of the protection functions below. In addition, the dynamic behaviour of the wind turbine at rated wind speed or above shall be verified by testing if this has not been verified within the scope of the load measurements (see 8.4.4).

The protection functions under test shall include functions with a single fault in the control and protection system.

The detailed requirements for testing are given in Annex D.

8.4.3 Power performance measurements

The purpose of power performance measurements is to document a measured power curve and predicted annual energy production for the wind turbine type, in accordance with IEC 61400-12-1.

The certification body shall verify that the measurement procedures conform with IEC 61400-12-1 and that the measurement conditions, instrumentation, calibrations, and analyses are described in a test report, also in accordance with IEC 61400-12-1.

8.4.4 Load measurements

The purpose of load measurements is to validate design calculations and to determine the magnitude of loads under specific conditions.

The certification body shall evaluate load measurements carried out for type certification and review the analysis of measured data, supplied by the applicant.

Measurements and analysis shall be conducted on the basis of the minimum requirements detailed in Annex C.

Measurements shall be made on a wind turbine that is dynamically and structurally similar to, but may differ in detail (such as alternative tower designs) from, the turbine submitted for certification. In case of differences, the applicant shall evaluate the differences, e.g. perform load and dynamic behaviour predictions for the wind turbine under test.

Guidance for test procedures and evaluation of tests may be found in IEC/TS 61400-13.

8.4.5 Blade tests

The purpose of blade tests is to verify blade structural design and to assess the suitability of manufacturing processes. Full-scale structural testing is required for every new type of blade. A type of blade is described not only in terms of its size and shape but also in terms of its internal construction and structure. Fatigue tests as well as static tests are required. Guidance for test procedures and evaluation of the tests may be found in specifications for structural testing of blades within the IEC 61400 series.

Test blades shall be representative for the blade design considered for design evaluation. Deviations shall be subject to approval by the certification body. If the blade design is changed, the certification body shall determine the need and requirements for any new tests, through consultation with the manufacturer. New tests shall be required following any significant changes in blade design. Changes in the following, for example, may be significant:

– the structural system, including the internal stiffening arrangement;
– the aerodynamic profile;
– material for critical load carrying parts; and
– transition zones in the blade root.

8.4.6 Other tests

The certification body may require other tests and/or measurements to be carried out. Other tests may also be requested by an applicant for inclusion in type testing. Such tests may include:

– thermal conditions of main mechanical and electrical components;
– mechanical conditions (vibrations, clearances, response) of main mechanical and electrical components;
– environmental testing of electronic assemblies; and
– electromagnetic compatibility testing.

The type test for a wind turbine equipped with main gearbox(es) shall additionally include a field test for main gearboxes as required in ISO 81400-4[5)].

8.4.7 Test reports

Type test reports shall conform with the requirements of ISO/IEC 17025 and relevant standards used to define the test requirements. In addition, test reports shall include a description of:

– the wind turbine or component, with identification by means of serial number (and control system software revision number(s), where applicable);
– any differences between the wind turbine or component under test with the corresponding part included in the certification; and
– any significant unexpected behaviour.

Attestation by the certification body shall be clearly marked on the final type test report(s).

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5) This standard will be substituted with IEC 61400-4, when available.

8.4.8 Type test conformity statement

The certification body shall issue a conformity statement based on satisfactory evaluation of the test reports. The conformity statement shall specify:

- the tests carried out;
- the test standards applied; and
- identification of the test reports.

Examples of conformity statements are given in Annex B.

8.5 Manufacturing evaluation

8.5.1 General

The purpose of manufacturing evaluation is to assess if a specific wind turbine type is manufactured in conformity with the documentation design verified during the design evaluation. This evaluation shall include the following elements:

- quality system evaluation; and
- manufacturing inspection.

The manufacturing evaluation presupposes that the manufacturer of the wind turbine and the main components operates a quality system. It requires manufacturing of at least one representative specimen of the type under certification.

8.5.2 Quality system evaluation

The requirement for evaluation of the quality system is satisfied if the quality system is certified to be in conformance with ISO 9001. This system certification shall be carried out by an accredited body that operates according to ISO/IEC 17021.

If the quality system is not certified, the certification body shall evaluate the system of the applicant. The following aspects shall be evaluated:

- responsibilities;
- control of documents;
- sub-contracting;
- purchasing;
- process control;
- inspection and testing;
- corrective measures;
- quality recordings;
- training; and
- product identification and traceability.

8.5.3 Manufacturing inspection

It shall be ensured that the requirements identified during the design evaluation with regard to critical components and critical manufacturing processes are observed and implemented in production and assembly. The certification body shall verify by inspection that at least one representative specimen is manufactured according to the design under certification.

The inspection shall comprise:

- verification that design specifications are properly implemented in workshop;
- workshop instructions, purchase specifications and installation instructions;
- evaluation of manufacturer's workshop, if relevant;
- verification of fabrication methods, procedures and qualifications of personnel;
- review of material certificates;
- random checks on effectiveness of procedures for acceptance of purchased components; and
- random checks of fabrication processes.

Inspection of critical components shall take place at the wind turbine manufacturer unless the manufacturer's incoming goods inspection is insufficient to ensure that the requirements identified during the design evaluation are met.

In general, the following components shall be considered for inspection:

- rotor blades;
- rotor hub;
- rotor shaft;
- main, pitch and yaw bearings (pitch and yaw drives);
- main bearing housings;
- gear box;
- locking devices and mechanical brake;
- generator, transformer;
- main frame, generator frame;
- tower;
- sub-structure (optional);
- foundation (optional);
- bolted connections; and
- hub and nacelle assembly (in workshop).

If a critical component is produced by more than one component manufacturer and the components differ significantly in specifications and/or manufacturing processes, all differing components shall be considered for inspection.

Changes in manufacturing processes that influence the component quality or component properties shall be reported to the certification body. In the event of major process changes documentation shall be submitted for renewed evaluation and, if necessary, the inspection shall be repeated.

The manufacturing inspections shall be repeated as part of the renewal of the certificate.

8.5.4 Manufacturing conformity statement

A satisfactory manufacturing conformity evaluation is concluded with a manufacturing conformity statement.

Examples of conformity statements are given in Annex B.

8.6 Foundation design evaluation

The purpose of the optional foundation design evaluation is to enable the inclusion of one or more foundation designs in the type certificate, as selected by the applicant. The certification body shall evaluate whether any turbine foundation included in type certification is designed in accordance with the foundation specifications detailed in the design documentation used in the turbine design evaluation (see 8.3.10) and is in accordance with the agreed applicable standards and codes.

For an offshore wind turbine the scope of foundation design evaluation shall include the sub-structure connecting the foundation to the tower.

The certification body shall, if applicable, require that reinforcement, concrete layout and construction sequence plans be included in the foundation design documentation. These plans shall be in sufficient detail to allow the certification body to verify the adequacy of the foundation design, taking into account the specified construction processes.

The certification body shall issue a conformity statement based on satisfactory evaluation of the foundation design evaluation report. The conformity statement shall include:

- identification of the wind turbine type;
- description of assumed soil and other external conditions;
- identification of tower configuration;
- identification of the sub-structure configuration; and
- identification of the foundation type.

Examples of conformity statements are given in Annex B.

8.7 Foundation manufacturing evaluation

8.7.1 General

The purpose of manufacturing evaluation is to assess if a specific wind turbine foundation type is manufactured in conformity with the documentation design verified during the design evaluation. This evaluation shall include the following elements:

- quality system evaluation; and
- manufacturing inspection.

The manufacturing evaluation presupposes that the manufacturer of the foundation operates a quality system. It requires manufacturing of at least one representative specimen of the type under certification.

For an offshore wind turbine, the foundation manufacturing evaluation shall include manufacturing evaluation of the sub-structure connecting the foundation to the tower.

8.7.2 Quality system evaluation

The requirement for evaluation of the quality system is satisfied if the quality system is certified to be in conformance with ISO 9001. This system certification shall be carried out by an accredited body that operates according to ISO/IEC 17021.

If the quality system is not certified, the certification body shall evaluate the quality system of the applicant. The following aspects shall be evaluated:

- responsibilities;
- control of documents;
- sub-contracting;
- purchasing;
- process control;
- inspection and testing;
- corrective measures;
- quality recordings;
- training; and
- product identification and traceability.

8.7.3 Foundation manufacturing inspection

It shall be ensured that the requirements identified during the design evaluation with regard to critical manufacturing processes are observed and implemented in production. The certification body shall verify by inspection that at least one representative specimen is manufactured according to the design under certification.

The inspection shall comprise:

- verification that design specifications (e.g. reinforcement, concrete layout and construction sequence plans) are properly implemented on site;
- manufacturing instructions, purchase specifications and installation instructions;
- verification of fabrication methods, procedures and qualifications of personnel;
- review of material certificates;
- random checks on effectiveness of procedures for acceptance of purchased components; and
- random checks of fabrication processes.

If a foundation is produced by more than one manufacturer and the foundations differ significantly in specifications and/or manufacturing processes, all differing foundations shall be considered for inspection.

Changes in manufacturing processes, which influence the foundation quality or properties, shall be reported to the certification body. In the event of major process changes, documentation shall be submitted for renewed evaluation and, if necessary, the inspection shall be repeated.

The manufacturing inspections shall be repeated as part of the renewal of the certificate.

8.7.4 Foundation manufacturing conformity statement

A satisfactory manufacturing conformity evaluation is concluded with a manufacturing conformity statement.

Examples of conformity statements are given in Annex B.

8.8 Type characteristics measurements

8.8.1 General

The purpose of type characteristic measurements is to establish performance-related characteristics of the wind turbine type, other than measurement of power performance, which is a mandatory element of type testing (Subclause 8.4.3). These optional measurements may be selected by the applicant and shall conform with the relevant IEC 61400 standards listed in the following subclauses. The type characteristics measurements comprise one or more of the elements:

– power quality tests;
– low voltage ride through tests; and
– acoustic noise measurements

as shown in Figure 6.

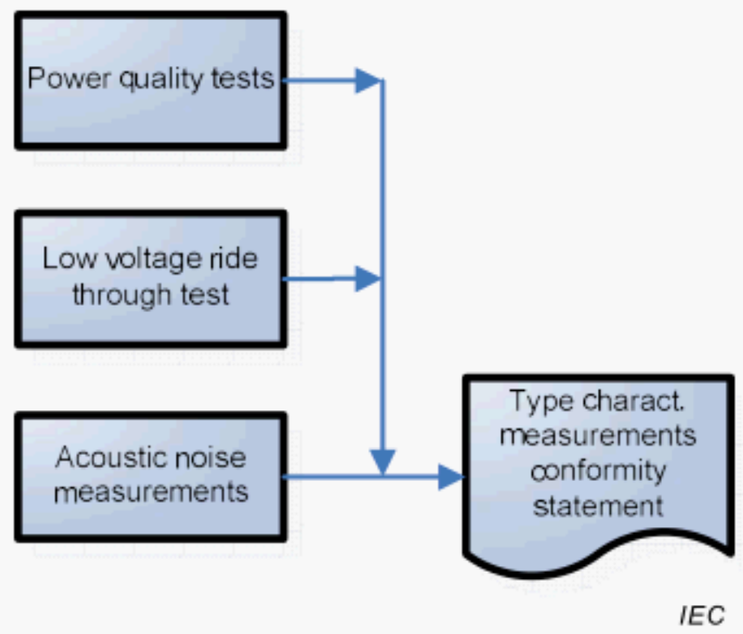

Figure 6 – Type characteristics measurements elements

In cases where applicable IEC standards are not available, the measurement procedure shall be agreed between the applicant and the certification body.

The certification body shall evaluate that measurement of characteristics has been carried out on a turbine representative of the type to be certified. Inspection records shall be completed prior to measurement in order to demonstrate satisfactory conformity of the turbine with design documentation.

The measurements shall be carried out by an accredited test laboratory or the certification body shall verify that the party conducting the testing complies with at least the criteria of ISO/IEC 17025 or ISO/IEC 17020, as applicable.

Measurements and test results shall be documented in a test report evaluated by the certification body. The certification body shall evaluate that the measurements have been carried out in accordance with an approved detailed program and that the report properly documents the characteristics required for certification.

A satisfactory evaluation is concluded with a conformity statement issued by the certification body, attesting that the measurements have been carried out in accordance with the appropriate test procedures and relevant IEC 61400 standards.

Examples of conformity statements are given in Annex B.

8.8.2 Power quality measurements

For type certification in which power quality measurements are included, the certification body shall verify that the measurement procedures conform with IEC 61400-21 and that the measurement conditions, instrumentation, calibrations and analyses are described in a test report, also in accordance with IEC 61400-21. The purpose of these measurements is to document the characteristic quality of the power generated by the wind turbine type.

8.8.3 Low voltage ride through measurement

For type certification in which low voltage ride through (LVRT) measurements are included, the certification body shall verify that the measurement procedures conform with the relevant standards and that the measurement conditions, instrumentation and equipment, calibrations and analyses are described in a test report, also in accordance with the relevant standards.

The relevant standards shall comprise:

– IEC 61400-21; and
– other standards agreed between the certification body and the applicant.

The purpose of these measurements is to document the low voltage ride through capabilities of the wind turbine type.

8.8.4 Acoustic noise measurements

For type certification in which acoustic emission measurements are included, the certification body shall verify that the measurements conform with IEC 61400-11. The purpose of these measurements is to document the acoustic emission characteristics of the wind turbine type. If acoustic emission measurements are included, the certification body shall verify that they, at least, include the:

– apparent sound power level at a wind speed of 8 m/s,
– sound directivity index at the three required positions, and
– tonality of any tones above the minimum threshold

as defined in IEC 61400-11.

The certification body shall also verify that the measurement conditions, instrumentation, calibrations and analyses are described in a test report in accordance with IEC 61400-11.

8.8.5 Test reports

The certification body shall require that type characteristics measurements reports conform with the requirements of ISO/IEC 17025 and relevant standards used to define the test requirements. In addition, descriptions of:

– the test turbine, including serial number and control system software revision number(s);
– any differences between the test turbine and the wind turbine type under certification; and
– any significant unexpected behaviour

shall be required.

Attestation by the certification body shall be clearly marked on the final type characteristics measurements report(s).

8.8.6 Type characteristics measurements conformity statement

The certification body shall issue a conformity statement based on satisfactory evaluation of the test reports. The conformity statement shall specify:

- the measurements carried out;
- the measurement standards applied; and
- identification of the test report(s).

Examples of conformity statements are given in Annex B.

8.9 Final evaluation

The purpose of final evaluation is to provide documentation of the findings of all operating bodies involved in the evaluation of the elements of the type certificate.

The final evaluation report shall consist of:

- a reference list of all supporting product documentation for the type certificate;
- report of whether the detailed documentation is complete and whether the type test results confirm all relevant requirements set out in the design documentation; and
- review of the final product documentation, including drawings, component lists, procurement specifications and manuals (see following paragraph), to confirm that this is consistent with the manufacturing evaluation report and with the supporting design calculations and relevant design assumptions.

The certification body shall attest that the installation, operator's instructions and maintenance manuals are based on the relevant requirements in IEC 61400-1, IEC 61400-2 and IEC 61400-3, for an offshore wind turbine. The manuals shall be reviewed against the corresponding approved processes. The certification body shall establish that

- format and detail are such that a skilled worker with technical training can understand the documentation;
- notes regarding safety and regulations for the prevention of accidents are arranged in the text such that they appear before the operation in question; and
- these notes shall be clearly identified as safety-related items.

The final evaluation report shall be delivered to the applicant and a copy retained in the confidential files of the certification body.

8.10 Type certificate

The certification body shall issue a type certificate based on satisfactory evaluation for completeness and correctness of the final evaluation report. The type certificate shall include the results of the mandatory modules and, when applicable, document the optional foundation design and manufacturing evaluation (see 8.6 and 8.7) and type characteristic measurements (see 8.8).

The type certificate is valid for the wind turbine type specified in the certificate. The specifications may include alternative components and configurations. The allowable combinations of alternatives shall be clearly identified.

The type certificate shall reference in an appropriate way the standards and normative documents used. The type certificate shall include the information given in Annex B.

The certification body shall include requirements in the agreement governing the validity of the certificate, see 6.5.1.

If the applicant does not operate a quality system that is certified according to ISO 9001, the certification body shall verify at least once a year that manufactured wind turbines continue to be in conformance with the certified design. This verification shall follow the elements of 8.5.

An example of a type certificate is given in Annex B.

9 Project certification

9.1 General

Project certification shall confirm for a specific site that type-certified wind turbines and particular foundation designs meet requirements governed by site-specific external conditions and are in conformity with applicable local codes and other requirements relevant to the site. Project certification may also confirm conformity for other installations in relation to the turbine installations. The certification shall confirm that the wind conditions, other environmental and electrical network conditions, and soil properties at the site conform with those defined in the design documentation for the wind turbine type(s) and foundation(s).

Project certification may also confirm that installation and commissioning are in conformity with specific standards and other technical requirements, and that the wind turbines are operated and maintained in conformity with relevant manuals.

Under this standard, the certificate and conformity statements for project certification shall be issued only for wind turbines that are type-certified according to the criteria detailed in Clause 8.

The certification body shall require an applicant to provide documentation that covers all the aspects detailed in this clause. The documentation shall be evaluated for compliance with the technical requirements of this standard, IEC 61400-1, IEC 61400-2 or IEC 61400-3 and additional codes or standards chosen by the designer and agreed with the certification body.

9.2 Site conditions evaluation

9.2.1 General

The purpose of site conditions evaluation is to examine whether the environmental, electrical and soil properties at a site conform to the parameter values defined in the design documentation.

9.2.2 Site conditions evaluation requirements

The certification body shall evaluate whether assessment of the external conditions at the site, as detailed in IEC 61400-1, IEC 61400-2 or IEC 61400-3 for offshore projects, have been adequately undertaken and documented. The site conditions are classified in the following categories:

– wind conditions;
– other environmental conditions;
– earthquake conditions;
– electrical power network conditions; and
– geotechnical conditions.

For offshore sites, these conditions are supplemented by

– marine conditions, and
– weather windows and weather downtime.

Assessment of the site conditions may be based on site-specific measurements supported by hindcasts and/or applicable standards or methods valid for the installation site. Site-specific measurements shall normally be correlated with data from a nearby location for which long term measurements exist. The monitoring period for the site-specific measurements shall be sufficient to obtain reliable data.

The certification body may carry out independent calculations for selected parameters based on the environmental and geotechnical data provided.

Measurements of the external conditions of the site shall be carried out by a testing laboratory accredited to ISO/IEC 17025, or the certification body shall verify the satisfactory quality and reliability of the measurements. The verification shall include evaluation of:

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

The certification body shall require that qualified personnel (meteorologists, engineers or geologists) carry out the data acquisition, analysis and reporting of the external conditions at the site.

The certification body shall evaluate that relevant reports properly document the external conditions as well as the data acquisition, the applied statistical methods and the design parameters for the external conditions.

9.2.3 Site conditions evaluation conformity statement

A satisfactory site conditions evaluation is concluded with a site conditions evaluation conformity statement. The conformity statement shall include identification of the evaluated reports.

Examples of conformity statements are given in Annex B.

9.3 Design basis evaluation

9.3.1 General

The purpose of design basis evaluation is to examine that the design basis is properly documented and sufficient for a safe design and execution of the project.

9.3.2 Design basis requirements

The design basis shall identify and include:

- design parameters for the external conditions;
- design methodologies and principles;
- codes and standards which form the basis for the project;
- other relevant statutory requirements (e.g. embarkation, rescue and decommissioning);
- wind turbine type; main specifications or type certificate with identifications of deviations;
- support structure concept;
- requirements for manufacturing, transportation, installation and commissioning;

- requirements for operation and maintenance;
- requirements for grid connection; and
- other project requirements, e.g. from the owner.

The design basis shall include all relevant overall design aspects and parameters to be applied in the calculations regarding the site external conditions, loads, design load cases, partial safety factors applied on loads and materials, geometric tolerances, corrosion allowance growth, etc.

The design basis shall describe the design principles and methodology, including how the following have been established:

- codes and standards;
- external design parameters;
- wake effects;
- design load cases;
- load factors and load reduction factors;
- duration of simulation as well as number of simulations; and
- extreme and fatigue design loads/response analyses.

The design basis shall include relevant manufacturing, transportation, installation and commissioning requirements such as:

- codes and standards;
- quality management system;
- environmental conditions relevant for installation; and
- requirements for the manufacturing, transportation, installation and commissioning manuals.

The design basis shall include relevant operation and maintenance requirements such as:

- codes and standards;
- quality management system;
- inspection scope and frequency;
- target lifetime of components, systems and structures;
- requirements for service and maintenance manuals;
- requirements for conditioning monitoring systems; and
- requirements with respect to personnel safety.

9.3.3 Design basis conformity statement

A satisfactory design basis evaluation is concluded with a design basis evaluation conformity statement. The conformity statement shall include identification of the evaluated reports.

Examples of conformity statements are given in Annex B.

9.4 Integrated load analysis

9.4.1 General

The purpose of the integrated load analysis is to examine whether the site-specific loads and load effects on the integrated wind turbine structure, including the rotor-nacelle assembly plus the support structure and supporting soils, are derived in conformity with the design basis.

9.4.2 Integrated load analysis requirements

If the conditions and requirements in the design basis regarding loads and load effects are more benign than assumed for the type certification for the wind turbine and the support structure and the wind turbine characteristics are identical, no further load analysis needs to be made.

If further load analyses are to be carried out, the applicant shall perform these calculations taking due account of complete structural dynamics. The applicant shall provide full documentation to the certification body of the load calculations and a comparison with the loads assumed for the type certificate.

The certification body shall evaluate:

- the combinations of external conditions and design situations (e.g. normal, fault, transport, installation);
- the respective partial load safety factors;
- the calculation methods, e.g. simulation procedure, number of simulations and combinations of wind and wave loads, if applicable;
- the design driving load cases defined with reference to the site conditions and the operation and safety system of the wind turbine; and
- any difference between the site-specific loads and the loads assumed for the type certificate.

9.4.3 Integrated load analysis conformity statement

A satisfactory evaluation of the integrated load analysis is concluded with a conformity statement.

Examples of conformity statements are given in Annex B.

9.5 Site-specific wind turbine/RNA design evaluation

9.5.1 General

The design of the site-specific wind turbine shall be evaluated for compliance with the design basis. In the case of a site-specific support structure design, the evaluation shall only comprise the rotor/nacelle assembly (RNA).

In addition to wind and marine conditions, other external conditions can affect the integrity and safety of the site-specific wind turbine, e.g. by thermal, photochemical, corrosive, mechanical, electrical or other physical action.

9.5.2 Site-specific wind turbine design requirements

The wind turbine type certification conditions and limitations shall be compared to the actual site conditions as given in the design basis. This comparison shall be part of the design documentation. The comparison shall in addition to loading conditions include other relevant conditions such as:

- temperature;
- humidity;
- solar radiation;
- rain, hail, snow and ice;
- chemically active substances;
- mechanically active particles;

- salinity;
- electrical conditions; and
- lightning etc.

The action taken with respect to the relevant conditions shall be stated in the design documentation.

Structural, mechanical and electrical components shall be designed for the appropriate site conditions. The corrosion protection systems shall be evaluated for the site-specific environment. Special attention shall be given to the effects of the site-specific conditions on electrical components such as generator, converter, transformer, switch gear and enclosures[6)].

The site-specific loads resulting from the integrated load analysis have to be evaluated with respect to the design loads used in the type certification. Any increases in load level as well as any changes in vibration modes/natural frequencies shall be reported and carefully evaluated. This evaluation shall consider the relevance and validity of load measurements, functional testing and component tests such as blade test. Furthermore, the evaluation shall also identify components that will require reinforcement or modifications.

Design documentation shall be provided for any new, modified or reinforced components and systems that are not fully covered by the type certificate for the wind turbine.

Design documentation for new or modified electrical components and systems shall comply with the design basis and, if relevant, also with the requirements for the type certification.

9.5.3 Site-specific wind turbine design conformity statement

A satisfactory evaluation of the site-specific wind turbine design is concluded with a conformity statement.

Examples of conformity statements are given in Annex B.

9.6 Site-specific support structure design evaluation

9.6.1 General

The site-specific support structure (tower, sub-structure and foundation) design shall be evaluated for compliance with the approved design basis as well as the standards listed therein. In cases where the scope of the design basis does not cover the support structure, reference to a recognized standard or design method can be made by the applicant, provided this is accepted by the certification body. In any event, the resulting safety level shall at least comply with the intended level in the relevant IEC 61400 series standard i.e. IEC 61400-1, IEC 61400-2 or IEC 61400-3.

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6) It shall be verified that the wind turbine electrical system including the wind turbine terminals meets the requirements in the approved design basis with respect to:

- the design of the electrical system ensuring that minimal hazards to people as well as minimal potential damage to the wind turbine and external electrical system during operation and maintenance of the wind turbine under all normal and extreme conditions;
- the design of the electrical system taking into account the fluctuating nature of the power generation from wind turbines;
- provisions made to ensure adequate protection of all electrical components and systems against the effects of corrosion.

9.6.2 Site-specific support structure design evaluation requirements

The design evaluation of the support structure shall at least include:

- evaluation of the design of the support structure with respect to the results of the integrated load analysis;
- calculated support structure stiffness and damping as compared to the assumptions made in the load calculations;
- evaluation of the geotechnical design documentation based on the design basis;
- evaluation of the design documentation for the support structure;
- evaluation of manufacturing plan, transportation plan, installation plan and maintenance plan, however only with respect to the structural integrity of the final installed (permanent) support structure; and
- evaluation of proposed corrosion protection system(s) against design premises specified in the design basis.

The design documentation for the support structure including documentation of the geotechnical aspects shall at least include design drawings, part lists, manufacturing specifications and design calculations, which may be combined with measurement/test reports. The certification body shall require that the documentation clearly identifies the design basis and agreed codes and standards, as well as loads and relevant external conditions.

9.6.3 Support structure design conformity statement

A satisfactory evaluation of the support structure design is concluded with a conformity statement.

Examples of conformity statements are given in Annex B.

9.7 Other installations design evaluation

9.7.1 General

A project may comprise other Installations such as substations, cables etc, the design of which shall be evaluated as required by the client. Such other installations design shall be evaluated for compliance with the standards and other specifications in the approved design basis as well as with site-specific loads and conditions. In cases where the design basis does not do so, reference to a recognized standard or design method can be made by the applicant, provided this is accepted by the certification body. In any event, the resulting safety level shall at least comply with the intended level in the relevant IEC 61400 series standard i.e. IEC 61400-1, IEC 61400-2 or IEC 61400-3.

9.7.2 Other installations design evaluation requirements

For each of the identified other installations requiring design evaluation, the certification body shall develop a scope of work to be agreed with the client. The design evaluation of the other installations shall at least include:

- evaluation of the design documentation;
- evaluation of the design of the other installation with respect to the results of the integrated load analysis, if relevant;
- evaluation of the geotechnical design documentation if relevant based on the design basis; and
- evaluation of proposed corrosion protection system(s) against design premises specified in the design basis.

The design documentation for the other installations shall at least include design drawings, parts lists, documentation of the geotechnical aspects where relevant, manufacturing specifications and design calculations that may be combined with measurement/test reports. The certification body shall require that the documentation clearly identifies the design basis and agreed codes and standards, as well as loads and relevant external conditions.

9.7.3 Other installations design conformity statement

A satisfactory evaluation of the other installations design is concluded with a conformity statement.

Examples of conformity statements are given in Annex B.

9.8 Wind turbine/RNA manufacturing surveillance

9.8.1 General

The type certification of the wind turbine is based on design evaluation, type testing and measurements as well as manufacturing evaluation, including quality system evaluation and manufacturing inspection. The evaluation of quality system mainly relies on the presence of a certified ISO 9001 system. The manufacturing inspection during type certification is based on one specimen only. The project certification will in addition to this include inspection/audit activities (surveillance), in order to verify that the manufacturing of wind turbines for the specific project is carried out according to the approved design and with the intended quality.

9.8.2 Surveillance requirements

The extent of inspection and audits to be carried out for project certification will be evaluated for each single project and wind turbine type.

The certification body will tailor a scope of work for inspection service. This scope will include use of international standards together with input from the design evaluation. Such input from the design evaluation may be:

- critical items/processes identified during the design evaluation;
- test programs/procedures for serial production;
- approved design documentation such as drawings and specifications; and
- details from prototype testing.

The following items will typically influence the detailed scope for the inspection service:

- the manufacturer’s experience with respect to delivery of the specific item to wind turbines;
- the certification body’s experience with the manufacturer;
- time schedule and number of items for the specific delivery;
- number of production plants;
- type of manufacturing process, e.g. hand lay-up or vacuum injection of laminates, manual or automatic welding, etc.;
- type of quality control e.g. NDT or visual inspection, statistical methods or testing each item, etc.;
- appropriateness of the manufacturer’s quality system in relation to the specific manufacturing process and control activities;
- extent of inspection by purchaser, e.g. manufacturer’s inspection on case of sub-supplies;
- availability of certified documents specifying the quality requirements;

- manufacturing codes and standards applied, e.g. national or international;
- availability of relevant quality control documents such as requirements for final manufacturing documentation, test programmes, acceptance test procedures, NDT procedures, weld procedures, corrosion protection, handling, curing, heat treatment, mechanical testing requirements, etc.;
- access to the manufacturing facility's sub-suppliers and manufacturing documents; and
- procedures for handling of deviations to requirements, e.g. waiver procedures.

9.8.3 Wind turbine/RNA manufacturing surveillance conformity statement

The certification body shall issue a conformity statement based on a satisfactory evaluation of verification, inspection and surveillance reports.

Examples of conformity statements are given in Annex B.

9.9 Support structure manufacturing surveillance

9.9.1 General

The following summarizes the work related to survey during manufacture of the support structure.

The project certification shall include inspection/audit activities in order to verify that the manufacture of support structure(s) for the specific project is carried out according to the approved design and with the intended quality.

It is a precondition for the manufacturing surveillance of the support structure that the manufacturer of the support structure or the main parts of the support structure operates a quality system. The inspection/audit activities shall focus on the quality system implemented during manufacture and evaluate that the quality system is appropriate.

9.9.2 Surveillance requirements

The extent of inspections and audits to be carried out for a project certification shall be determined for each project. The following processes may be subject to evaluation, depending on the type of structure:

- manufacture of steel plates;
- manufacture of primary load-carrying steel structure;
- manufacture of secondary steel structure (deck, ladders etc.); and
- build of concrete structures.

For each of these processes, the certification body shall tailor a scope of work for Inspection service. This scope shall include utilisation of international standards together with input from the design evaluation. Such input from the design evaluation may be:

- critical items/processes identified during the verification of final design documentation; and
- approved design documentation such as drawings and specifications.

The following items will also typically influence the detailed scope for the inspection service:

- the manufacturer's experience with respect to delivery of the specific item for incorporation in support structures;
- the certification body's experience with the manufacturer;
- time schedule and number of items for the specific delivery;
- number of production plants;

- type of manufacturing process, e.g. hand lay-up or vacuum injection of laminates, manual or automatic welding, etc.;
- type of quality control, e.g. NDT or visual inspection, statistical methods or testing each item, etc.;
- appropriateness of the manufacturer's quality system in relation to the specific manufacturing process and control activities;
- extent of inspection by purchaser, e.g. manufacturer's inspection on case of sub-supplies;
- availability of certified documents specifying the quality requirements;
- manufacturing codes and standards applied, e.g. national or international;
- availability of relevant quality control documents such as requirements for final manufacturing documentation, test programmes, acceptance test procedures, NDT procedures, weld procedures, corrosion protection, handling, curing, heat treatment, mechanical testing requirements, etc.;
- access to the manufacturing facility's sub-suppliers and manufacturing documents; and
- procedures for handling of deviations to requirements, e.g. waiver procedures.

9.9.3 Support structure manufacturing surveillance conformity statement

The certification body shall issue a conformity statement based on a satisfactory evaluation of verification, inspection and surveillance reports.

Examples of conformity statements are given in Annex B.

9.10 Other installations manufacturing surveillance

9.10.1 General

The project certification shall include inspection/audit activities that serve to verify that the manufacture of other installations for the specific project is carried out according to the approved design and with the intended quality.

It is a precondition for the manufacturing surveillance of the other installations that the manufacturer of the installation or the main parts of the installation operates a quality system. The inspection/audit activities shall focus on the quality system implemented during manufacture and evaluate that the quality system is appropriate.

9.10.2 Surveillance requirements

The extent of inspections and audits to be carried out for other installations (selected equipment or complete installations) during project certification shall be evaluated for each project. The certification body shall develop a scope of work for inspection service to be agreed with the client. This scope will include use of international standards, together with input from the design evaluation. Such input from the design evaluation may be:

- critical items/processes identified during the design evaluation;
- test programs/procedures; and
- approved design documentation such as drawings and specifications.

The following items may influence the detailed scope for the inspection service, depending on the type of equipment or installation:

- the manufacturer's experience with respect to delivery of the specific item to wind turbine projects;
- the certification body's experience with the manufacturer;
- time schedule and number of items for the specific delivery;

- type of quality control, e.g. NDT or visual inspection, statistical methods or testing each item, etc.;
- appropriateness of the manufacturer's quality system in relation to the specific manufacturing process and control activities;
- extent of inspection by purchaser, e.g. manufacturer's inspection on case of sub-supplies;
- availability of certified documents specifying the quality requirements;
- manufacturing codes and standards applied, e.g. national or international;
- availability of relevant quality control documents, such as requirements for final manufacturing documentation, test programs, acceptance test procedures, NDT procedures, weld procedures, corrosion protection, handling, curing, heat treatment, mechanical testing requirements, etc.;
- access to the manufacturing facility's sub-suppliers and manufacturing documents; and
- procedures for handling of deviations to requirements, e.g. waiver procedures.

9.10.3 Other installations manufacturing surveillance conformity statement

The certification body shall issue a conformity statement based on a satisfactory evaluation of verification, inspection and surveillance reports.

Examples of conformity statements are given in Annex B.

9.11 Project characteristics measurements

9.11.1 General

The purpose of project characteristics measurements within project certification is to establish performance-related characteristics of a specific wind turbine or wind turbine project at a specific site, in addition to the measurements done for a single turbine within the type certification. These optional measurements may be selected by the applicant and shall conform to the relevant IEC 61400 series standards. The measurements comprise one or more of the elements:

- grid connection compatibility according to grid codes;
- verification of power performance; and
- verification of acoustic noise emission.

In cases where applicable IEC standards are not available, the measurement procedure shall be agreed between the applicant and the certification body.

The measurements shall be carried out by an accredited test laboratory or the certification body shall verify that the party conducting the testing complies with at least the criteria of ISO/IEC 17020 or ISO/IEC 17025, as applicable.

Measurements and test results shall be documented in a test report evaluated by the certification body. The certification body shall evaluate that the measurements have been carried out in accordance with an approved detailed program and that the report properly documents the characteristics required for certification.

A satisfactory evaluation is concluded with a conformity statement issued by the certification body, attesting that the measurements have been carried out in accordance with the appropriate test procedures and relevant IEC 61400 series standards.

Examples of conformity statements are given in Annex B.

9.11.2 Grid connection compatibility according to grid codes

Grid connection compatibility measurements shall be evaluated by the certification body to verify specified reactions (e.g. during grid fault conditions) defined in the grid codes applicable to the site. For project certification, the certification body shall evaluate grid connection compatibility by comparing the measurements with the electrical network and conditions given in the grid codes. The certification body shall verify that the measurement procedures conform with IEC 61400 series standards and grid codes, and that the measurement conditions, instrumentation and equipment, calibrations and analyses are described in a test report.

The purpose of these measurements is to document the grid connection compatibility of a specific wind turbine or wind turbine project at a specific site.

9.11.3 Verification of power performance

Power performance tests and measurements shall be evaluated by the certification body in order to verify the power production of one or more wind turbines included at the project site. For project certification, the certification body shall evaluate the performance of the wind turbine(s) by comparing the results of the tests and measurements with the reference individual performance of the wind turbines supplied by the customer.

The certification body shall also verify that the measurement procedures conform to the relevant IEC 61400-12 series of standards[7)] and/or customer defined requirements or procedures. The standards or procedures applied and the results of the evaluation shall be clearly referenced and stated in the conformity statement issued by the certification body.

The purpose of these measurements is to document the power performance of a specific wind turbine or of all or some of the wind turbines installed at a specific project.

9.11.4 Verification of acoustic noise emission

Acoustic noise measurements shall be evaluated by the certification body to verify compliance with specific acoustic noise emission criteria established either by the client or by local codes.

The certification body shall verify that the measurement procedures conform, to the extent it is possible, with the relevant IEC 61400 series standards[8)] and with the reference standards and compliance criteria. The reference standards and compliance criteria shall be clearly identified in the conformity statement issued by the certification body.

The purpose of these measurements is to document compliance with respect to acoustic noise emission of a specific wind turbine or the project as a whole installed at a specific site.

9.11.5 Test reports

The certification body shall require that the project characteristics measurement reports conform with the requirements of ISO/IEC 17025 and relevant standards used to define the test requirements (e.g. grid codes). In addition, descriptions of:

– the specific wind turbine or wind turbine project at a specific site, including the test turbine(s), serial number(s) and control system software revision number(s); and
– any significant unexpected behaviour

shall be required.

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7) IEC 61400-12-1 and any future performance assessment related standards

8) IEC 61400-11 and any future acoustic noise related standards

Attestation by the operating body shall be clearly marked on the final project characteristics measurement report(s).

9.11.6 Project characteristics measurement conformity statement

The certification body shall issue a conformity statement based on satisfactory evaluation of the test reports. The conformity statement shall specify:

- the measurements carried out;
- the measurement standards applied; and
- identification of the test report(s).

Examples of conformity statements are given in Annex B.

9.12 Transportation and installation surveillance

9.12.1 General

The purpose of transportation and installation surveillance is to verify conformity with the requirements of the design basis and to verify that the loads on components and subsystems of the wind turbines are not exceeding the design envelope during transportation and installation and that possible transportation and/or handling damages are being detected.

9.12.2 Transportation and installation requirements

If a quality management system is in place for the transportation and installation processes, surveillance may be carried out by auditing. If not, the certification body shall perform the surveillance by inspection.

The certification body shall evaluate from documentation whether the transportation and installation processes of the wind turbine(s) are in conformance with the design basis and the requirements in the relevant IEC 61400 series standard, i.e. IEC 61400-1, IEC 61400-2 or IEC 61400-3.

The certification body shall ensure that components are inspected for damage that may have occurred during transport and handling. This is including, but not limited to, damage to corrosion protection or actual corrosion. After completion of the installation, a final visual inspection of all relevant components shall be made.

For offshore projects, surveillance shall include:

- monitoring of sea-transportation;
- compliance with respect to acceptable weather conditions during transport and installation; and
- compliance with the support structure and wind turbine installation procedures.

Verification, inspection and surveillance activities shall be concluded with reports that describe the activities carried out.

9.12.3 Transportation and installation conformity statement

The certification body shall issue a conformity statement based on a satisfactory evaluation of verification, inspection and surveillance reports.

Examples of conformity statements are given in Annex B.

9.13 Commissioning surveillance

9.13.1 General

The purpose of commissioning surveillance is to verify that the wind turbines installed in a specific project at a specific site are commissioned in conformity with the relevant manuals included in the design documentation (see 8.9).

9.13.2 Commissioning surveillance requirements

The certification body shall evaluate whether the commissioning of the wind turbine(s) is in conformance with the instructions supplied by the manufacturer in accordance with relevant parts of the IEC 61400 series. Other tests to be performed during commissioning in addition to tests in accordance with the general instructions may be agreed with the manufacturer.

This evaluation requires examination of commissioning records. In addition, the certification body shall witness the commissioning of at least one wind turbine and additionally at least one wind turbine per every 50 turbines in the project.

The certification body shall as a minimum verify that:

– the commissioning instructions supplied by the manufacturer are adequate;
– the instructions supplied by the manufacturer are followed during commissioning; and
– the final commissioning reports are complete.

Verification and surveillance activities shall be concluded with reports that describe the activities carried out.

9.13.3 Commissioning surveillance conformity statement

The certification body shall issue a conformity statement based on a satisfactory evaluation of verification and surveillance reports.

Examples of conformity statements are given in Annex B.

9.14 Final evaluation

The purpose of final evaluation is to provide documentation of the findings of all operating bodies involved in the evaluation of the elements of the project certificate.

Following evaluation of the evaluation reports and conformity statements, the final evaluation report shall be prepared, consisting of:

– a reference list of all supporting product and project documentation for the project certificate; and
– report of all conformity statements issued for the project certification modules for outstanding issues.

The final evaluation report shall be delivered to the applicant and a copy retained in the confidential files of the certification body.

9.15 Project certificate

The certification body shall issue a project certificate based on the final evaluation for completeness and correctness of the evaluation reports and conformity statements. The project certificate shall include the results of the mandatory modules and the agreed optional modules.

The project certificate is valid for wind turbine(s) and additional installation(s) as installed at the site specified in the certificate at the date of issue.

The project certificate shall reference in an appropriate way the standards and normative documents used. An example of a project certificate is given in Annex B.

The certification body and the applicant may agree to include operation and maintenance Surveillance in order to confirm the validity of the project certificate at periodic intervals. In this case, major modifications to the site or the wind turbines shall be reported to the certification body without delay. The surveillance shall be carried out according to 9.16.

9.16 Operation and maintenance surveillance

9.16.1 General

The purpose of operation and maintenance surveillance is to establish that a specific wind turbine installation or wind turbine project at a specific site is operated and maintained in conformity with the relevant manuals included in the design documentation (see 8.9).

This surveillance requires examination of operation and maintenance records as well as inspection of turbines and other installations and parts which are covered by the project certificate.

Operation and maintenance surveillance shall be carried out at regular intervals on the basis of an agreement between applicant and certification body. The agreement shall specify the intervals and the extent of the surveillance. An operation and maintenance surveillance conformity statement shall attest compliance under the terms of this agreement.

9.16.2 Operation and maintenance surveillance requirements

The certification body shall evaluate operation and maintenance records and reports. The evaluation shall as a minimum establish that:

– maintenance has been carried out by authorised and qualified personnel in accordance with and at the intervals specified in the maintenance manual;
– the control settings have been checked with regard to conformance with the limiting values specified in the design documentation; and
– all repair, modification and replacement (RMR) has been carried out in accordance with the certificate by reviewing RMR-reports.

In combination with this, the certification body shall inspect the general condition of the turbines and other installations that are covered by the certificate. The extent of the inspection shall be based on:

– the evaluation of operation and maintenance records and reports;
– status of outstanding findings from previous inspections;
– status of outstanding recommendations from previous inspections; and
– status of ongoing RMR-projects.

The operator's instructions, maintenance manuals and maintenance records shall be issued in a language that is understood by relevant personnel. The inspection reports shall be appended to the corresponding maintenance manual. Particular attention shall be paid to repaired and/or modified components to assure that only repairs or modifications compatible with the certificate have been made.

9.16.3 Operation and maintenance conformity statement

A satisfactory operation and maintenance evaluation is concluded with inspection reports and a conformity statement.

Examples of conformity statements are given in Annex B.

Annex A
(informative)

Design documentation (if applicable)

Table A.1 – Design documentation (if applicable)

	Item	Drawings geometrical data	Analysis calculations	Description	Specifications	Data sheet	Schematics	Test data
1	**General turbine description**							
	General turbine characteristics, configurations and layout			√			√	
	Turbine description and general specifications	√		√	√			
	Major component weights and centres of gravity				√			
	Operational limits				√			
	Electrical power system			√			√	
	External conditions and design class			√				
	Codes and standards			√				
	Co-ordinate Systems	√		√				
2	**Design control procedure**							
	Document description and Organisation in compliance with ISO 9001			√				
3	**Control and protection system**							
	Detailed control logic flow chart						√	
	Control and protection philosophy			√				
	Modes of operation			√				
	Control system software			√	√		√	
	Software release and version control			√				
	Set point list				√			
	Remote control/monitoring			√	√		√	
	Protection system logic			√			√	
	Electrical control system (structure, starting and stopping procedures,…)			√			√	
	Fault analysis		√	√				
	Structure of protection system	√		√			√	
	Description of safety concept and component specifications including transducers and sensors (settings, time constants,…)			√	√			
	Braking system (structure, time constants, characteristics, braking torque curve,…)	√	√	√	√		√	
	Electrical and hydraulic circuit diagrams			√			√	
	Condition monitoring			√	√	√	√	
	Safety instructions			√				
	Overspeed sensing				√		√	
	Overpower/current sensing				√		√	
	Vibration sensing				√		√	
	Emergency switching off button			√			√	
	Supervisory wind farm control system (remote control of power output, pitch/yaw control parameters,…)			√				

	Item	Drawings geometrical data	Analysis calculations	Description	Specifications	Data sheet	Schematics	Test data
	Test plan			√				
4	**Loads and load cases**							
	General:							
	Wind farm configuration chart	√					√	
	Site data (e.g. environmental and marine conditions, dynamic viscosity, air density, salinity, soil,...)		√	√				
	Mass distribution, stiffness, natural frequencies and damping factors for all structural components (rotor, blade, drive train, support structure,...)		√		√			
	Cut in/cut off/rated wind speed				√			
	Rotor-/generator speeds				√			
	Mechanical/electrical losses				√			
	Generator data (rated power, synchronous speed, nominal/ maximum slip, relevant time constants)					√		
	Nacelle/rotor data (mass, dimensions, centre of gravity, etc.)	√	√		√			
	General analysis approach (e.g. coordinate system used)	√	√	√				
	System dynamics model description:							
	Degrees of freedom			√			√	
	Mass and stiffness distributions				√			
	Aerodynamic inputs (airfoil tables, blade geometry, lift and drag coefficients,...)		√		√		√	
	Partial safety factors		√		√			
	Validation of calculation models:							
	Analytical		√					
	Comparison with test data		√					√
	Dynamic behaviour of the system and of individual major components:							
	Campbell diagrams		√				√	
	Spectral/frequency plots		√					√
	Mode shapes and frequencies		√					
	Comparisons between predictions and measurements		√					√
	Load cases (from IEC 61400-1/2/3 plus other identified cases):							
	Fatigue loads for several turbine sections (tower sections, main shaft/hub, blade root, blade sections)		√					
	Ultimate loads for several turbine sections (tower sections, main shaft/hub, blade root, blade sections)		√					
	Markov matrices for drive train and blade section loads		√					
	Load duration distribution spectra (LDD) for drive train and pitch bearing loads		√					
	Tower bottom loads		√					
	Maximum blade deflection analysis		√					

	Item	Drawings geometrical data	Analysis calculations	Description	Specifications	Data sheet	Schematics	Test data
	Critical deflection (blade/tower)		√					
	Failure modes		√					
	Turbine controller (e.g. block circuit diagram, input and output signals, etc.)			√			√	
5	**Rotor blades**							
	Structure	√		√	√			
	Blade connection		√		√			
	Data of materials used (fibres, resins, foam, etc.)				√			
	Geometrical data	√			√			√
	Extreme stress analysis		√					
	Fatigue stress analysis		√					
	Modal analysis		√					
	Stability stress analysis		√					
	Production sequence	√			√			
	Root	√	√					
	Blade/hub connection	√	√					
	Aerodynamic brake mechanism	√	√		√			
	Material and blade tests		√					√
6	**Machine and structural components**							
	General:							
	Assembly drawings	√		√				
	Material data		√		√			√
	Gearing and drive train (including generator, brake and couplings, ratio, inertia)		√		√			
	Drive train dynamics	√	√	√	√	√		
	Hydraulic system		√	√	√	√	√	
	Pitch system:							
	Drive	√	√		√	√	√	
	Power supply	√	√		√			
	Bearings	√	√		√			
	Pitch lock	√	√		√			
	Connections	√	√		√			
	Hub:							
	Structure	√	√		√			
	Teeter system	√	√		√			
	Pitch system (including power supply)	√	√		√	√		
	Hub/low speed shaft connection	√	√		√			
	Low speed shaft:							
	Main shaft	√	√		√			
	Main bearing	√	√		√			
	Bearing housing	√	√		√			
	Rotor lock	√	√		√			
	Coupling		√		√			
	Bearing lubricants				√	√		
	Gear box:							
	Gear box	√	√		√			√
	Torsion support	√	√		√			
	Connections to main frame, bearings	√	√		√	√		
	Cooling and heating systems	√	√		√	√		√
	High speed shaft:							
	Mechanical brake	√	√		√			
	Coupling	√	√		√			

	Item	Drawings geometrical data	Analysis calculations	Description	Specifications	Data sheet	Schematics	Test data
	Frame:							
	Main frame	√	√		√			
	Generator frame	√	√		√			
	Connections main frame and main frame to generator frame	√	√		√			
	Yaw system:							
	Drive	√	√		√	√	√	
	Bearings	√	√		√			
	Yaw lock	√	√		√			
	Connections	√	√		√			
	Tower:							
	Structure	√			√			
	Connections	√	√					
	Dynamic analysis of the tower (with turbine)		√					
	Earthquake analysis		√					
	Extreme and fatigue analysis for welded and bolted connections of the tower		√					
	Finite-element-analysis of door frame and other openings	√	√					
	Corrosion protection system				√			
	Cable twist			√	√		√	
	Cable suspension	√			√			
	Ladders, platforms, elevators	√	√		√			
7	**Electrical components**							
	Single line diagram (basic power circuit with safety devices)						√	
	Characteristic parameters of electrical components (positioning drives, generator,…)			√	√			
	Functional descriptions and maintenance instructions			√				
	Power circuit schematic	√					√	
	Data of short-circuit and overcurrent protection gear						√	
	Electrical systems diagrams (incl. auxiliary circuits like cranes, lifts, etc.)	√		√	√		√	
	Part lists (incl. sensors, switches and all important electrical appliances)						√	
	Emergency power system and fire alarm system	√		√			√	
	Charging equipment and storage batteries			√	√	√	√	
	Summary of electrical measuring equipment	√		√			√	
	Records of routine test according to IEC 60034-1			√	√			√
	Power converter	√			√		√	
	High voltage cable	√		√		√		
	Generator			√	√		√	√
	Connections to generator frame	√	√		√			
	Generator bearings	√	√		√			
	Air flow concept, cooling system			√				
	Capacitors			√		√		
	High voltage disconnection device	√		√		√	√	
	Low voltage disconnection device	√		√		√	√	

	Item	Drawings geometrical data	Analysis calculations	Description	Specifications	Data sheet	Schematics	Test data
	Medium voltage transformer	√		√	√		√	
	Type test records of the transformer as per IEC 60076-1			√				√
	Earthing and lightning protection (incl. lightning protection zones, lightning rods and conductors, earth electrodes, location of bonding bars, connection to separate buildings)	√		√	√		√	
8	**Housings**							
	Spinner and nacelle cover	√	√		√			
	Enclosure (materials, design details, general view, etc.)	√	√		√			√
	Extreme analysis (for steel parts, bolts and fibre reinforced plastics, etc.)		√					
9	**Component design evaluation tests**							
	Test report							√
10	**Foundation**							
	Structure	√			√			
	Design parameters			√	√			
	Materials			√	√			
	Detailed presentation of the reinforcement plan	√		√			√	
	Reinforcement (type of steel; diameter, shape, number and position of bars)	√	√	√	√			
	Analysis of tower to foundation joint (embedded steel or anchor bolts)	√	√					
	Extreme and fatigue analysis for all load bearing concrete parts		√					
	Determination of pile forces in case of pile foundations (monopile, tripod, jacket)		√					
	Geotechnical verifications (sliding, settlement, bearing capacity)		√					
	Construction, transport and installation			√				
11	**Manufacturing process**							
	Purchase specifications				√			
	Manufacturing specifications				√			
	Work instructions	√		√			√	
	Quality control procedures				√	√		
	Manufacturing manual	√		√	√	√	√	
12	**Transportation process**							
	Technical specifications				√			
	Limited environmental conditions			√	√			
	Work instructions	√		√			√	
	Quality control procedures				√	√		
	Transportation manual	√		√	√	√	√	
13	**Installation process**							
	Installation specifications				√			
	Work instructions	√		√			√	
	Quality control procedures				√	√		
	Installation manual	√		√	√	√	√	
14	**Maintenance process**							
	Work instructions	√		√			√	

	Item	Drawings geometrical data	Analysis calculations	Description	Specifications	Data sheet	Schematics	Test data
	Quality control procedures				√	√		
	Maintenance manual	√		√	√	√	√	
15	**Personnel safety**							
	Safety instructions			√	√		√	
	Climbing facilities, access ways, passages, platforms, floors, hand rails, fixing points	√	√	√	√			
	Lighting			√	√	√		
	Fire resistance			√	√	√		
	Alternative escape routes			√	√		√	

NOTE 1 Drawings are typically engineering drawings that clearly define dimensions of components or electrical schematics. They can also include material specifications, fabrication instructions or finish specifications when referring to a specific component contained within the drawing.

NOTE 2 Analysis usually refers to engineering calculations such as stress analysis or calculations of structural loads or of electrical loads as well as statistical analysis. Analysis is the basis of specifications for structural, material, electrical and mechanical component requirements. This also includes plots of results and comparisons with test results.

NOTE 3 Descriptions consist of text describing relevant tasks, functions, components etc.

NOTE 4 Specifications are written requirements for certain components of the wind turbine. These could include performance and dimensional specifications for a gear-box, finish requirements for gearing, bearing descriptions, electrical demands for electrical components, dimensional requirements for mechanical components, performance specifications for a hydraulic auxiliary power supply or quality documentation.

NOTE 5 Data sheets are listings of data relevant for the corresponding component, part, detail etc.

NOTE 6 Schematics are data plots, flow charts, diagrams and other illustrations (electric, pneumatics, and hydraulics).

NOTE 7 Test data usually refers to reports of tests and measurements.

NOTE 8 A check mark (√) indicates that corresponding documentation is expected for certification purposes.

Annex B
(informative)

Certificate example format

Type certificate example format

TC – (Number)

Type certificate

This certificate is issued to

XXXX

Street

City

Country

for the wind turbine

XXXX

The certificate attests compliance with IEC 61400-1 class xx (or IEC 61400-2), concerning the design and manufacture. It is based on the following reference documents:

DE-(Number)	:	Design evaluation conformity statement
dated	:	dd.mm.yy
TT-(Number)	:	Type test conformity statement
dated	:	dd.mm.yy
MC-(Number)	:	Manufacturing conformity statement
dated	:	dd.mm.yy
FDE-(Number)	:	Foundation design eval. conformity statement
dated	:	dd.mm.yy
TC-(Number)	:	Type characteristics conformity statement
dated	:	dd.mm.yy
ER-(Number)	:	Final evaluation report
dated	:	dd.mm.yy

The conformity evaluation was carried out according to IEC 61400-22: Wind Turbines – Part 22: Conformity testing and certification.

The wind turbine type is specified on page 2 of this certificate.

Changes in the system design or the manufacturer's quality system are to be approved by (certification body). Without approval, the certificate loses its validity.

This type certificate is valid until: dd.mm.yy.

(Location), dd.mm.yy.

ee/ss

(Certification body)

Signature(s)

TC – (Number)
Type certificate, Page 2

Wind turbine type specification:

Machine parameters:

Model
WT manufacturer and country
IEC WT class
Rated power [kW]
Rated wind speed V_r [m/s]
Rotor diameter [m]
Hub height(s) [m]
Hub height operating wind speed range V_{in} – V_{out} [m/s]
Design life time [y]

Wind conditions:

Characteristic turbulence intensity I15 at V_{hub} = 15 m/s [-]
Annual average wind speed at hub height V_{ave} [m/s]
Reference wind speed V_{ref} [m/s]
Mean flow inclination [deg]
Hub height 50-year extreme wind speed V_{e50} [m/s]

Electrical network conditions:

Normal supply voltage and range [V]
Normal supply frequency and range [Hz]
Voltage imbalance [V]
Maximum duration of electrical power network outages [days]
Number of electrical network outages [1/y]

Other environmental conditions (where taken into account):

Design conditions in case of offshore WT (water depth, wave conditions, etc.)
Normal and extreme temperature ranges [°C]
Relative humidity of the air [%]
Air density [kg/m^3]
Solar radiation [W/m^2]
Description of lightning protection system
Earthquake model and parameters
Salinity [g/m^3]

Major components:

Blade type [-]
Gear box type [-]
Generator type [-]
Tower type [-]

Design evaluation conformity statement example format

DE – (Number)
Design evaluation conformity statement

This conformity statement is issued to

XXXX

Street

City

Country

for the wind turbine

XXXXXX

This conformity statement attests compliance with IEC 61400-1 , Class xx (or IEC 61400-2), concerning the design. It is based on the following evaluation reports:

Evaluation report	:	Control- and protection system
dated	:	dd.mm.yy
prepared by	:	name(s)
Evaluation report	:	Loads and load cases
dated	:	dd.mm.yy
prepared by	:	name(s)
Evaluation report	:	Structural components
dated	:	dd.mm.yy
prepared by	:	name(s)
Evaluation report	:	Mechanical and electrical comp.
dated	:	dd.mm.yy.
prepared by	:	name(s)
.....		

The conformity evaluation was carried out according to IEC 61400-22: Wind Turbines – Part 22: Conformity testing and certification.

Any change in the design is to be approved by (certification body). Without approval, the Statement loses its validity.

The wind turbine type is specified on page 2 of this conformity statement (eee wind turbine specification in Type Certificate).

(Location), dd.mm.yy.

ee/ss (Certification body)

Signature(s)

Type test conformity statement example format

TT – (Number)
Type test conformity statement

This conformity statement is issued to

XXXX
Street
City
Country

for the wind turbine

XXXXXX

The conformity statement attests that the wind turbine has been evaluated by (certification body) concerning type testing. It is based on the following reference documents:

Measurement report	:	Safety and function test
dated	:	dd.mm.yy
issued by	:	test lab.
Measurement report	:	Power performance measurements
dated	:	dd.mm.yy
issued by	:	test lab.
Measurement report	:	Load measurements
dated	:	dd.mm.yy
issued by	:	test lab.
Measurement report	:	Blade test
dated	:	dd.mm.yy
issued by	:	test lab.
(**Measurement report**	:	Other component tests)
(dated	:	dd.mm.yy)
(issued by	:	test lab.)

The conformity evaluation was carried out according to IEC 61400-22: Wind turbines – Part 22: Conformity testing and certification.

The wind turbine type is specified on page 2 of this conformity statement (see specification in Type Certificate). Any change in the design is to be approved by (certification body). Without approval, the statement loses its validity.

(Location), dd.mm.yy.
ee/ss

(Certification body)

Signature(s)

Manufacturing conformity statement example format

MC – (Number)
Manufacturing conformity statement

This conformity statement is issued to

XXXX
Street
City
Country

for the wind turbine

XXXXXX

The certificate attests compliance with IEC 61400-1 class xx (or IEC 61400-2), concerning the manufacturer's quality system. It is based on the following reference documents:

Evaluation report	:	Quality system
dated	:	dd.mm.yy
issued by	:	name
Evaluation report	:	xxx
dated	:	dd.mm.yy
issued by	:	name

The conformity evaluation was carried out according to IEC 61400-22: Wind turbines – Part 22: Conformity testing and certification.

The wind turbine type is specified on page 2 of this statement (see specification in Type Certificate).

Any change in the manufacturer's quality system is to be approved by (certification body). Without approval, the statement loses its validity.

This manufacturing conformity statement is valid until (validity of ISO 9001 certificate or date of next audit ...).

(Location), dd.mm.yy.
ee/ss (Certification body)

Signature(s)

Project certificate example format

PC- (Number)
Project certificate

This certificate is issued to

XXXX
Street
City
Country

for the wind turbine(s) at the site

XXXX
Address
Country

The certificate attests compliance with IEC 61400-XX . It is based on the following reference documents:

TC-(Number)	:	Type certificate
Dated	:	dd.mm.yy
SC-(Number)	:	Site conditions evaluation conformity statement
dated	:	dd.mm.yy
DB-(Number)	:	Design basis evaluation conformity statement
dated	:	dd.mm.yy
ILA-(Number)	:	Integrated load analysis conformity statement
dated	:	dd.mm.yy
	.	
	.	
	.	
CO-(Number)	:	Commissioning conformity statement
dated	:	dd.mm.yy
OMS-(Number)	:	Operation and maintenance surveillance Conformity statement

The conformity evaluation was carried out according to IEC 61400-22: Wind turbines – Part 22: Conformity testing and certification.

The project certificate is valid for wind turbine(s) and additional installation(s) as installed at the site specified in the certificate at the date of issue.

The wind turbine type is specified on page 2 of this certificate (see specification in Type Certificate).

(Location), dd.mm.yy.
ee/ss

(Certification body)

Signature(s)

Site conditions conformity statement example format

SC – (Number)
Site conditions conformity statement

This conformity statement is issued to

XXXX
Street
City
Country

for the wind turbine(s) at the site

XXXX
Address
Country

This conformity statement attests compliance with IEC 61400-XX, concerning site assessment. It is based on the following evaluation reports:

Evaluation report	:	Wind conditions
dated	:	dd.mm.yy
prepared by	:	name(s)
Evaluation report	:	Other environmental conditions
dated	:	dd.mm.yy
prepared by	:	name(s)
Evaluation report	:	Electrical conditions
dated	:	dd.mm.yy
prepared by	:	name(s)
Evaluation report	:	Soil conditions
dated	:	dd.mm.yy.
prepared by	:	name(s)

The conformity evaluation was carried out according to IEC 61400-22: Wind turbines – Part 22: Conformity testing and certification.

The wind turbine type is specified on page 2 of this statement (see specification in Type Certificate).

(Location), dd.mm.yy.
ee/ss

(Certification body)

Signature(s)

Operation and maintenance surveillance conformity statement example format

OMS – (Number)
Operation and maintenance surveillance conformity statement

This conformity statement is issued to

XXXX
Street
City
Country

for the wind turbine(s) at the site

XXXX
Address
Country

The conformity statement attests compliance with IEC 61400-XX, concerning operation and maintenance surveillance. It is based on the following reference documents:

TC – (Number)	:	Type certificate
dated	:	dd.mm.yy
issued by	:	name
Manual	:	Operation and maintenance instructions
dated	:	dd.mm.yy
issued by	:	name
Evaluation report	:	Verification, surveillance and/or audit
dated	:	dd.mm.yy
issued by	:	name

The conformity evaluation was carried out according to IEC 61400-22: Wind turbines – Part 22: Conformity testing and certification.

The wind turbine type is specified on page 2 of this statement (see specification in Type Certificate).

This Conformity Statement is valid until (date of next audit …).

(Location), dd.mm.yy.
ee/ss

(Certification body)

Signature(s)

Component certificate example format

CC – (Number)
Component certificate

This certificate is issued to

XXXX
Street
City
Country

for the wind turbine component

XXXX

The certificate attests compliance with IEC 61400-XX, concerning the design and manufacture. It is based on the following reference documents:

DE-(Number)	:	Design evaluation conformity statement
dated	:	dd.mm.yy
TT-(Number)	:	Type test conformity statement
dated	:	dd.mm.yy
MC-(Number)	:	Manufacturing conformity statement
dated	:	dd.mm.yy
ER-(Number)	:	Final evaluation report
dated	:	dd.mm.yy

The conformity evaluation was carried out according to IEC 61400-22: Wind turbines – Part 22: Conformity testing and certification.

The wind turbine component is specified on page 2 of this certificate.

Changes in the system design or the manufacturer's quality system are to be approved by (certification body). Without approval, the certificate loses its validity.

This component certificate is valid until: dd.mm.yy.

(Location), dd.mm.yy.

ee/ss (Certification body)

Signature(s)

Annex C
(informative)

Minimum requirements for load measurements

C.1 General

The purpose of load measurements for type certification is to validate design calculations and to directly determine loads under specific conditions. The following minimum requirements for these measurements shall be met.

C.2 Load measurement program

The load measurement program shall be based on and consist of measurement load cases that are as close as practically possible to the design load cases defined in IEC 61400-1 or IEC 61400-2. The measurement load cases shall include all normal and critical operating and fault conditions (e.g. loss of grid, emergency shutdowns, protection system faults, etc.), braking performance and yaw behaviour. Testing shall be sufficient to characterise typical operational behaviour throughout the design wind speed range. A statistically significant amount of data for relevant wind speeds and turbulence intensities shall be collected.

C.3 Measured data

Measured data shall at least include loads, meteorological parameters and wind turbine operational data. Loads at critical load path locations in the structure, which will enable valid comparisons with predicted loads and characterise the dynamic behaviour of the WT, shall be measured. These loads may include blade root bending moments (flap-wise and lead-lag), shaft loads (bending and torque) and tower top and base loads (in two directions). Meteorological parameters shall include hub height wind speed, wind direction, and atmospheric pressure and temperature. Relevant wind turbine operational data including rotor speed, electrical power, pitch angle, rotor azimuth, yaw position and turbine status shall be measured.

C.4 Data analysis

The data shall be analysed in such a way that valid comparisons with calculated loads and frequencies are possible. As a minimum the mean, minimum and maximum values, standard deviation, cycles counted, power spectral densities and histograms of the appropriate load data shall be evaluated over the recorded wind speed and turbulence ranges and the relevant data included in the test report.

Annex D
(informative)

Requirements for safety and function tests

D.1 General

The purpose of the safety and function tests element of wind turbine type certification is described in 8.4.2. This annex describes the general requirements for conducting these tests. The requirements are described in the following.

D.2 Definition of protection functions

The protection functions shall be in accordance with IEC 61400-1 and shall be defined in the design documentation. The protection functions are the object of the safety and function tests.

D.3 Test plan

The plan for the safety and function tests shall include the critical functions of the control and protection system that requires test verification, as described in the design documentation. These critical functions shall at least include

- primary protection functions in connection with
  - loss of grid,
  - emergency switching off,
  - turbine over speed, and
  - other critical stop situations revealed during design,
- secondary protection functions in connection with
  - one fault in the primary protection system,
  - loss of grid, and
  - emergency switching off,
- normal operation of the turbine control functions in connection with
  - important design criteria defined in connection with the design i.e. for example pitch position for a pitch regulated turbine.

The certification body shall verify satisfactory demonstration of the control and protection system, focused on the items above.

Further to these tests, it can be relevant in accordance to the design documentation to include one or more of the following situations:

- emergency shutdown during operation with no additional faults;
- operating vibration levels and excessive vibration protection;
- over speed protection at rated wind speed or above;
- start-up and shutdown above rated wind speed;
- yaw control (including cable twist);
- testing the situations described above in the first three bullets for wind speeds above rated power.

The basis for this testing is the design documentations and simulation. The test report may include simulation of the tested event; including the actual conditions (i.e. wind speed, turbulence, wind shear etc.). Each test shall be described in the test plan[9)]. In many cases, several component failure modes or critical events will lead to similar behaviour of the control and protection system and may be covered by a single test.

For each test, the test plan shall detail the physical quantities to be measured, the instrumentation and data acquisition system and the calibration and operational settings for the control system, any required special actuators, solenoids, or electrical switches if necessary, and all external condition requirements associated with the test.

Procedures for conducting each test, including appropriate safety measures, shall be described in the test plan. Also, as part of the test plan, the operating body shall identify the criteria for acceptable wind turbine system behaviour (including dynamic behaviour). This will typically be found in the design documentation. These criteria shall be subject to approval by the certification body and the applicant.

The certification body shall further verify that the descriptions given in the test plan are adequate for successful implementation of the test.

D.4 On-site test activities

The test shall be carried out in accordance with the approved test plan. Any modifications to the test plan, which are found to be necessary during the test, shall be documented and subject to approval.

D.5 Analysis and reporting

A test report conforming to the requirements of 8.4.7 shall be prepared. The data analysis shall also minimally include time series plots of each critical physical quantity measured and either a table of computed values of statistical measures of the data variability (including maximum and minimum values) or suitable statistical graphs such as histograms, exceedance curves or power spectral densities. The analysis shall include identification of the critical overall system natural frequencies displayed in the data. The reported information shall establish that the purpose of the test has been fulfilled and that the agreed acceptance criteria have been met.

D.6 Inspection of personnel safety

The certification body shall inspect the aspects of the personnel safety, described in the design documentation, see 8.3.15. In general, all safety facilities have to be checked for compliance with the design documentation and proper assembling.

The certification body shall at least inspect the following personnel safety aspects.

- Safety instructions
  - Safety instructions shall be available for everybody working or operating on the site or in the wind turbine.
- Climbing facilities
  - Climbing facilities and fixing points shall be checked for proper assembling und fully function.

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9) Some of these tests may alternatively be carried out as part of the load measurements in Annex C (see IEC 61400-13 for guidance).

- Access ways and passages
  - Access ways and passages shall ensure a leaving of the wind turbine at any time.
  - Access ways and passages shall ensure an entry for rescue workers.
- Standing places, platforms and floors
  - Trip hazards shall be avoided or marked clearly.
  - Platforms, floors and walkways shall be equipped with non-slip surfaces.
  - Hatches in the platforms shall be lockable.
- Hand rails and fixing points
  - Hand rails and fixing points shall be proper fixed.
  - Hand rails shall be checked for sharp edges.
- Lighting
  - The existing of suitable lighting shall be checked.
  - The function of the emergency light shall be checked.
- Electrical and earthing system
  - Electrical equipment shall be grounded, well insulated and conform with the design documentation.
  - Conductive components shall be marked clearly.
- Fire resistance
  - The fire prevention and control concept shall be checked.
- Emergency switching off buttons
  - Emergency switching off buttons shall be clearly recognizable, visible and easily approachable.
  - The function of the emergency switching off buttons shall be checked.
- Provision of alternative escape routes
  - Provision of alternative escape routes shall be described and prepared for everybody working or operating on a wind farm if part of the design documentation.
- Provision for emergency stay on an offshore wind turbine for one week
  - Sufficient resources and provisions for an emergency stay for one week shall be available.
- Offshore specific safety equipment for an offshore wind turbine
  - The existing of offshore specific safety equipment shall be checked.

The basis for this inspection is the evaluated design documentation.

The certification body shall verify that the assembled safety facilities are in compliance with the design documentation.

Annex E
(informative)

Condition monitoring systems for wind turbines

E.1 General

With a condition monitoring system (CMS), it is possible to detect changes in the condition of the monitored components of the wind turbine.

The CMS normally measures vibrations at the components of the wind turbines, for example at the components of the drive train and the tower, and collects operational parameters, as for example power output, speed, oil and bearing temperatures. The CMS may also include other systems such as continuous oil condition monitoring e.g. recording metal particles in the oil.

The recorded data will be processed and compared with threshold values. The threshold values will need to be established such that premature damages are detected as early as possible and the numbers of “false” alarms are kept at a reasonable level. The establishment of threshold values will be a continuous process during the lifetime of the wind turbine.

This chapter applies for condition monitoring systems to be installed in already operating turbines, as well as for systems integrated in the wind turbines and in their components.

CMS will be granted a certificate if their documentation could be successfully evaluated, if their development and production comply with the requirements of ISO 9001, and if their operating mode was examined in a test run.

E.2 Scope of the evaluation

The details of the evaluation and the related statement of conformity have to be agreed between applicant and certification body.

For the evaluation of the CMS documentation, the complete documentation has to provide, for example in form of specifications, calculations, drawings, circuit diagrams, part lists and flow charts.

At least following documentation have to be submitted and evaluated for the CMS type: general description; description of the function mode (including circuit diagram); description of the software (including data-storage concept) and description of the setting of threshold values; description of the hardware and data sheets; description of the way in which average values are obtained, which kind of average values are used and how it can be avoided that significant data is lost for interpretation; description of how the threshold values are supervised in wind turbines with variable speed; description of the measures taken for protection against electromagnetic interference caused by the wind turbine or as a result of power failures; manuals (installation instructions, commissioning instructions, operation instructions, maintenance instructions with maintenance plan).

E.3 Requirements on a CMS

Exceeded threshold values shall be forwarded immediately and automatically by the CMS normally as pre-alarm/warning and main alarm.

The drive train with its bearings, as well as the gear toothing are normally the main priorities for the supervision of the wind turbine.

Appropriate frequency ranges shall be chosen for vibration sensors depending on the component to be supervised.

The number of sensors for the supervision of the vibration of the drive train depends on its constructive design.

The number of sensors and their position at the gearbox shall be selected in such a way that all the potential defect frequencies can be measured.

Operational parameters will normally be transferred from the control system of the wind turbine and integrated into the CMS data evaluation.

The commonly applicable rules for handling digital signals (e.g. concerning the sampling rate and anti-aliasing filtering) are to be applied.

In order to be able to consult historical data for evaluating damages and establish/refine threshold values, the relevant characteristic values and spectra should be stored, even if no threshold value was exceeded.

Bibliography

IEC 60034-1, *Rotating electrical machines – Part 1: Rating and performance*

IEC 60076-1, *Power transformers – Part 1: General*

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