Certification of lifetime extension of wind turbines
FOREWORD

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

General
This is a new document.
SECTION 1 INTRODUCTION

1.1 General

Wind turbines are generally designed and certified for a specific design lifetime. A significant number of turbines are about to reach their end of the original design lifetime. While this currently applies to onshore wind projects, in the future also offshore wind turbines will face this. Is there an efficient way to operate wind turbines beyond their design lifetime?

DNV GL published its internationally applied ‘Guideline for Continued Operation of Wind Turbines’ in 2009. The guideline provides a general concept how to extend the service life of a turbine. To date the approach described herein has won broad acceptance in the market.

Based on experiences from diverse projects and taking into account the individual needs of operators and manufacturers, DNV GL has continued to develop this approach and to offer tailored solutions to extend turbines’ lifetimes.

This services specification (SE) specifies DNV GL’s services for the certification of wind turbines or wind farms onshore and offshore which shall be operated beyond their (original) design lifetime (lifetime extension).

In order to provide more guidance for possible approaches for lifetime extension and to offer adequate solutions to operators of single wind turbines as well as of large wind farms or even to manufacturers, different methods have been developed. All the methods evaluate the suitability of the turbine for the lifetime extension, and depending on the purpose, a more complex method may be chosen. The method lifetime extension inspection (LEI) reveals whether the turbines in question are suitable for lifetime extension. The methods ‘simplified approach’, ‘detailed approach’ and ‘probabilistic approach’ include quantification of the remaining useful life ("proof of strength and stability") with different procedures. Those 4 methods correspond to different depth of detail. See [2.2] and [2.3].

Appendix A gives an overview about the different methods, the accordant scope and outcome can be found in the DNVGL-ST-0262 Lifetime extension of wind turbines. App.A eases the identification of relevant sections in this service specification. Apart from that, App.C contains examples illustrating how this service specification may be applied.

DNV GL services are performed in compliance with the overall project time schedule of the customer. Final time frames shall be discussed and agreed between the customer and DNV GL before commencement of the work.

1.2 Objectives

This document has a dual objective: It serves as a publicly available description of DNV GL’s services related to the certification of wind turbine lifetime extension and it will be referred to as a contractual document in the certification contract between the customer and DNV GL.

The document specifies the mutual obligations of DNV GL and the customer when a wind turbine or wind farm is certified according to this service specification. The document also specifies the relevant tasks and requirements to be fulfilled for the certification.

The deliverables are listed in [2.3.2] and [2.3.3].

1.3 Scope of application

This service specification applies to onshore and offshore wind turbine lifetime extension certification and related verification and inspection tasks.
1.4 Definitions

1.4.1 Verbal forms

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

<table>
<thead>
<tr>
<th>Term</th>
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<tr>
<td>certification</td>
<td>action by a certifying body, providing written assurance that adequate confidence is provided that the subject of the certification, i.e. the wind turbine, is demonstrably in conformity with a specific standard or other normative document. The term designates all the activities associated with the process leading to the issue of a certificate. The scope of work is defined by the certifying body (i.e. DNV GL) or by a regulatory body.</td>
</tr>
<tr>
<td>certification scheme</td>
<td>certification scheme, i.e. a sequence of phases or modules to be completed prior to the issue of a certificate</td>
</tr>
<tr>
<td>customer</td>
<td>DNV GL’s contractual partner, usually the certificate applicant</td>
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<tr>
<td>(original) design lifetime</td>
<td>the time period that was considered for the strength verification when the device was designed</td>
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<tr>
<td>final certification report</td>
<td>final report, issued as reference document for the certificate or a statement of compliance, and providing documentation of the evaluation of the modules in the certification. The report includes a reference list of all supporting product documentation, an evaluation of whether the detailed documentation is complete and all relevant requirements are confirmed by test results (if applicable), and a review of the final product documentation.</td>
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<tr>
<td>lifetime extension</td>
<td>additional lifetime beyond the (original) design lifetime</td>
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<tr>
<td>operating life/service life</td>
<td>lifetime from commissioning to decommissioning of a component or the wind turbine.</td>
</tr>
<tr>
<td>statement of compliance</td>
<td>a statement signed by a qualified party affirming that, at the time of certification, a product or a service meets specified requirements</td>
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<td>wind turbine</td>
<td>system which converts kinetic energy from the wind into electrical energy</td>
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1.4.3 Acronyms

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<thead>
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<th>Acronym</th>
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<tr>
<td>IEC</td>
<td>International Electrotechnical Commission</td>
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<tr>
<td>LEI</td>
<td>lifetime extension inspection</td>
</tr>
<tr>
<td>SCADA</td>
<td>supervisory control and data acquisition</td>
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<tr>
<td>SoC</td>
<td>statement of compliance</td>
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<tr>
<td>WF</td>
<td>wind farm</td>
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<tr>
<td>WT</td>
<td>wind turbine</td>
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1.5 References

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

1.5.2 DNV GL publications

<table>
<thead>
<tr>
<th>Reference</th>
<th>Title</th>
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<tbody>
<tr>
<td>DNVGL-SE-0074</td>
<td>Type and component certification of wind turbines according to IEC 61400-22</td>
</tr>
<tr>
<td>DNVGL-SE-0073</td>
<td>Project certification of wind farms according to IEC 61400-22</td>
</tr>
<tr>
<td>DNVGL-SE-0190</td>
<td>Project certification of wind power plants</td>
</tr>
<tr>
<td>DNVGL-ST-0262</td>
<td>Lifetime extension of wind turbines</td>
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1.5.3 IEC publications

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<tbody>
<tr>
<td>IEC 61400-1</td>
<td>Wind turbines – Part 1: Design requirements</td>
</tr>
<tr>
<td>IEC 61400-3</td>
<td>Wind turbines – Part 3: Design requirements for offshore wind turbines</td>
</tr>
<tr>
<td>IEC 61400-22</td>
<td>Wind turbines – Part 22: Conformity testing and certification</td>
</tr>
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1.5.4 ISO publications

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<tr>
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<tbody>
<tr>
<td>ISO 9000</td>
<td>Quality management systems - Fundamentals and vocabulary</td>
</tr>
<tr>
<td>ISO 9001</td>
<td>Quality management systems – Requirements</td>
</tr>
<tr>
<td>ISO/IEC 17025</td>
<td>General requirements for the competence of testing and calibration laboratories</td>
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1.6 Procedural requirements

1.6.1 Certification requirements
In general the lifetime extension certification is performed for wind turbines with a valid or expired type certificate. In addition the respective wind farm may have a valid or expired project certificate. These type and project certificates are completely independent of the lifetime extension certification process and associated DNV GL deliverables as reports, statements and certificates. In particular the validity of any type or project certificate is neither extended nor prolonged by any lifetime extension certification activity.

Guidance note 1:
DNV GL’s activities on lifetime extension certification may run in parallel to other activities at customers’ wind turbines. For example lifetime extension inspections may be performed at wind turbines, at which also inspections for “periodic monitoring” or “Wiederkehrende Prüfung” are performed in regular intervals. In such cases it is advisable to combine the tasks to as few as possible activities.

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The quality management system of the customer shall fulfil the requirements of ISO 9001 covering all aspects of the product under certification. In particular the customer shall show quality relevant procedures
to DNV GL for all relevant processes or submit a valid ISO 9001 certificate of an accredited certification body.

Guidance note:
The customer does not need to explicitly operate a quality management system (e.g. in case of small projects like single wind turbines). If necessary for the certification task DNV GL may require explanations how documents were written and under which quality related measures.

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The set of documents submitted to DNV GL for certification may contain test and/or measurement reports. Such test and measurement reports shall be prepared by accredited test or measurement institutes that meet the requirements of ISO/IEC 17025. If tests or measurements shall be carried out by non-accredited institutes, DNV GL will witness these tests or measurements.

1.6.2 Documentation requirements
The documentation submitted for the certification process shall be complete and self-explanatory. The content shall meet the requirements of the applied standards. All relevant documentation shall be subject oriented and in a logical sequence to facilitate cross checking between documents (e.g. design basis, design, manufacturing, transport, installation, commissioning etc.). Each document shall be named explicit by e.g. title, report no., page no., date and a revision description table.

The documentation shall be prepared in English language, unless otherwise agreed between DNV GL and the customer.

All documentation for certification may be forwarded to DNV GL in electronic form, as unprotected pdf-files.

1.6.3 Standards, codes and additional requirements
At least the following shall be listed in the design basis and/or the contractual agreement:

— standards, codes and requirements which form the basis for the services described here,
— relevant statutory requirements for the site in question; these requirements could be safety related issues such as requirements for embarkation, rescue and decommissioning and
— additional documentation which may be requested by DNV GL to cover issues essential to the certification process and not covered by the standards in question.

1.6.4 Combination of standards
The certification process according to internationally recognized standards shall follow the principles described in this service specification. Wherever combinations of standards and external criteria are used, the exact terms of reference and documents to be issued shall be agreed at the beginning of the project.

1.6.5 Inspection requirements
The contractual agreement shall contain the national and local health and safety requirements for personnel. Additional the agreement shall contain applicable requirements from any asset owner, manufacturer, or fabrication workshop operator. The customer shall ensure that the requirements are being known and met and that DNV GL staff is able to work under a safe environment whenever they do any workshop or site visit.
SECTION 2 SERVICE OVERVIEW

2.1 General
The objective of this section is to provide an overview of the certification activities related to wind turbines or wind farms which shall be operated beyond their design lifetime.

2.2 Methods for lifetime extension
In order to structure the work on lifetime extension certification and in order to allow for different scopes of work, four methods are introduced.
An overview on the methods is given in App.A.

Method LEI
The lifetime extension inspection is an inspection of the wind turbine(s) and evaluates if the turbine(s) is/are fit for life time extension.

Method simplified approach
The simplified approach consists of an analytical part and a practical part. It can be performed without access to the wind turbine design documentation as the analytical part can be carried out with a generic turbine model.

Method detailed approach
The detailed approach consists of an analytical part, a practical part and possibly design optimisation. It requires access to the wind turbine design documentation as the analytical part shall be performed with the specific turbine model. The analytical part may be divided into turbine type specific analysis and wind farm specific analysis.

Method probabilistic approach
The probabilistic approach consists of an analytical part, a practical part and possibly design optimisation. Access to the wind turbine design documentation is recommended. The analytical part may be divided into turbine type specific analysis and wind farm specific analysis.

2.3 Certification Scheme

2.3.1 General
A certification activity is concluded by issuing a certification report.

Upon successful completion of a certification module, a statement of compliance is issued, too.

Following the successful completion of all mandatory certification modules, a DNV GL certificate shall be issued. A final certification report shall be issued to the customer as a reference document for the DNV GL certificate.
2.3.2 Deliverables
During the certification of documentation DNV GL provides written review comments to the customer e.g. in electronic form by e-mail.

For any lifetime extension inspection carried out by DNV GL during the certification process, DNV GL will report to the customer critical findings immediately after the inspection and shall then issue the LEI report. The report will describe the extent of the LEI including findings, non-conformities and possible recommendations.

For the lifetime extension certification the reports, statements of compliance and certificates are available as shown in below [2.3.3] to [2.3.4]. The deliverables shall be defined in the certification contract with the customer. Deliverables are relevant report(s), statement(s) and/or certificate(s) issued by DNV GL.

In the event that full compliance is not achieved for all technical issues and aspects, the deliverables will depend on the character of the lack of compliance. Three options for deliverable are possible:

— No outstanding items.
  The deliverables will be issued.
— Non-safety critical outstanding items.
  Provisional statement(s) of compliance shall be issued with the outstanding items listed in the statement. A provisional certificate may be issued on request, which also shall list the outstanding items. Specific description of the outstanding items shall be given in the certification reports. As outstanding issues become closed, updated deliverables can be issued.
— Safety critical outstanding items.
  Statement(s) of compliance and certificate(s) shall not be issued. DNV GL shall deliver the certification reports without the statement(s) of compliance and certificate(s). Specific description of the outstanding items shall be given in the certification reports. As outstanding issues become closed, updated deliverables and relevant statements and certificates shall be issued.

2.3.3 Deliverable method - lifetime extension inspection

Report:
2.3.4 Deliverables methods - simplified, detailed and probabilistic approaches

*)Remark:
For methods 'Detailed approach' and 'Probabilistic approach' the analytical part may be performed in two steps:
Step 1: Wind turbine type specific, performed e.g. by the wind turbine manufacturer.
Step 2: Wind farm site specific, performed e.g. by the wind farm operator.

2.4 Validity and maintenance of statements and certificates

2.4.1 Period of validity
The period of validity of any statement of compliance and any certificate for lifetime extension is given on the document.
Provisional statements and certificates have a maximum period of validity of 1 year.

2.4.2 Conditions to the validity
The validity of statements and certificates may depend on conditions to maintain this validity. Such conditions are mentioned on the statements and certificates and are explained in detail in one of the related certification reports. These conditions may consist of the availability of valid underlying quality management certificates, on site inspections, reporting to DNV GL or others. After certification of relevant documentation DNV GL shall in each case declare fulfilment of such conditions in writing and thus state the prolonged validity of the statement or certificate.

Any changes or modifications to the certified design require certification by DNV GL. Otherwise the validity of statements and certificates shall expire immediately.

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

2.4.3 Reporting during the validity of statements and certificates

Once an accident or failure with implications for the integrity or safety of the certified wind turbine comes to the customer’s knowledge, the customer shall report this accident or failure to DNV GL. Such accidents or failures may result in a request by DNV GL for corrective actions to be taken by the customer in order to maintain the validity of the statement or certificate. Based on an evaluation of the accident or failure and, if relevant, an evaluation of the corrective actions, DNV GL shall decide if the statement or certificate shall be suspended until a satisfactory corrective action is implemented. A suspension implies that the wind turbine may not be operated with reference to the suspended statement or certificate. On special agreement with DNV GL a restricted operation may be possible in such cases. The statement or certificate may be suspended up to maximum of one year provided that a plan for corrective action by the customer is agreed with DNV GL.

If no satisfactory corrective action is taken, the statement or certificate in question will be withdrawn. Certification documents issued by DNV GL shall upon withdrawal or suspension be returned to DNV GL.

Any planned major modifications (modification that can influence former certification work) to the certified wind turbines shall be reported to DNV GL without delay and in sufficient time to allow for evaluation by DNV GL before implementation and to enable the update of the statement and/or certificate.

A yearly report shall be submitted to DNV GL during the validity period of the certificate. The yearly report shall contain:

— description of abnormal or deviant operating experience or operating failures
— description of minor modifications
— reporting on the wind farm operation (e.g. availability, energy production figures).
SECTION 3 DETAILED SERVICE DESCRIPTION

3.1 General
This section provides details of DNV GL’s certification activities for each of the modules described in Sec.2. [2.3.3] and [2.3.4] provide the graphical overviews of the modules.
The certification shall be performed on the basis of DNVGL-ST-0262 Lifetime extension of wind turbines or other standards or guidelines specified in the contract with the customer.

3.2 Method lifetime extension inspection
See also [2.3], [2.3.3] and App.A.
Each wind turbine shall be inspected. The scope of the LEIs and the tests during the inspections shall be specified in the LEI plan and shall fulfil the requirements stated in DNVGL-ST-0262.
The LEI plan shall be approved by DNV GL before any inspection commences.
After the LEI the LEI report “lifetime extension inspection” shall be issued. It contains the documentation of the inspection as well as the results of the review of the maintenance/repair/exchange records, records of former inspections and the SCADA data.
Wind turbine type related experiences (e.g. known weak points of that type of turbine) shall be considered in the scope of the LEI and the conclusions concerning these in the LEI report.
The LEI report shall also contain a recommendation whether the wind turbine is suitable for lifetime extension (fitness of the wind turbine).
One LEI report per wind turbine shall be issued.
All LEI reports shall be submitted to DNV GL for assessment. For the assessment the reports shall be reviewed. Additionally assessment LEIs on site will be performed or LEIs of the customer shall be witnessed. It shall be agreed in the contract with the customer how many LEIs shall be performed and/or witnessed by DNV GL.

3.3 Method simplified approach
See also [2.2], [2.3.4] and App.A.

3.3.1 Analytical part simplified approach
Load calculations shall be performed following the requirements given in DNVGL-ST-0262.
From the results of these calculations and under consideration of the SCADA data of the wind turbines the conclusions for possible lifetime extensions shall be drawn.
Documentation on this shall be submitted to DNV GL for certification.
Upon completion of the analytical part the certification report “Analytical part simplified approach” shall be issued. It shall contain the report of the certification activities including the outcome and the conclusions, and – if necessary – conditions for lifetime extension. Also the recommendation on the LEI frequency as well a calculated length of the lifetime extension shall be given.
At least one certification report per wind farm will be issued.

3.3.2 Statement of compliance - analytical part lifetime extension simplified approach
When the certification report ‘analytical part simplified approach’ is available the statement of compliance “Analytical part lifetime extension simplified approach” shall be issued.
It shall contain:
— a detailed description of the type of wind turbine with characteristic main data
— a brief description of the wind farm including its address/position
— or the assumptions made if the statement is not related to a specific wind farm
— if necessary, conditions for the lifetime extension
— number of years of calculated lifetime extension.

The validity is limited by the end of the operating life of the related wind turbine.

### 3.3.3 Lifetime extension inspection simplified approach

Each wind turbine shall be inspected. The scope of these inspections shall correspond to the needs of the wind farm and the results of the analytical part. It might vary from wind turbine to wind turbine.

These scopes and the tests during the inspections shall be specified in the LEI plan and shall fulfil the requirements stated in DNVGL-ST-0262.

The LEI plan shall among others consider the respective results of the analytical part. The statement of compliance ‘analytical part lifetime extension simplified approach’ should preferably be available before this plan is prepared. In addition it shall be analysed, if any gained wind turbine operation experience after the date of issue of this statement of compliance need consideration in the LEI plan.

The LEI plan shall be approved by DNV GL before any inspection commences.

After the LEI the LEI report “Lifetime extension inspection simplified approach” shall be issued. It contains the documentation of the inspection as well as the results of the review of the maintenance/repair/exchange records and records of former inspections.

Wind turbine type related experiences (e.g. known weak points of that type of turbine) shall be considered in the scope of the LEI and the conclusions in the LEI report.

The LEI report shall also contain a recommendation whether the wind turbine is suitable for lifetime extension (fitness of the wind turbine). Also the recommended date of the next LEI shall be given. The LEI interval shall not exceed two years.

One LEI report per wind turbine shall be issued.

All LEI reports shall be submitted to DNV GL for assessment. For the assessment the reports shall be reviewed. Additional assessment LEIs on site shall be performed or LEIs of the customer shall be witnessed. It shall be agreed in the contract with the customer how many LEIs shall be performed and/or witnessed by DNV GL.

### 3.3.4 Final certification simplified approach

The final certification summarises the modules of the certification. It shall address whether the documentation is complete and whether the LEI results confirm the relevant assumptions.

The certification report “Final certification simplified approach” shall be issued if the valid statement of compliance ‘analytical part lifetime extension simplified approach’ and all LEI reports ‘lifetime extension inspection simplified approach’ are available.

The certification report ‘final certification simplified approach’ shall contain a reference list of all supporting documentation. It shall contain an evaluation if the detailed documentation is complete. It shall also contain an evaluation if the LEI results confirm that all relevant requirements and assumptions are being met.

At least one certification report per wind farm shall be issued.

### 3.3.5 Certificate - lifetime extension simplified approach

Upon availability of the following documents the certificate ‘lifetime extension simplified approach’ shall be issued:

— statement of compliance ‘analytical part lifetime extension simplified approach’
—and
— certification report ‘final certification simplified approach’.
It shall contain:

— a detailed description of the type of wind turbine with characteristic main data
— a brief description of the wind farm including its location
— if necessary, conditions for the lifetime extension
— the date of expiry.

The certificate expires at the end of the operating life of the related wind turbines (decommissioning of the last wind turbine of the wind farm).

If the statement of compliance ‘analytical part lifetime extension simplified approach’ expires in this period it shall be renewed. Else the certificate loses its validity.

Further requirements for the maintenance of the certificate are given in [2.4]. DNV GL shall issue a written confirmation of the results of the assessment related to the maintenance of the certificate.

3.4 Method detailed approach
See also [2.2], [2.3.4] and App.A.

3.4.1 Analytical part detailed approach
Load calculations and possibly load measurements shall be performed following the requirements stated in DNVGL-ST-0262.

The conclusions for a possible lifetime extension shall be derived from:

— the results of these calculations and measurements
— the analysis of relevant SCADA data
— the operation experiences of the type of wind turbine and the relevant wind farm
— possible design optimisations e.g. in the controller and the maintenance concept
— calculations on fatigue strength reserve.

This investigation shall be carried out for each load transferring component of the wind turbine.

Documentation on this shall be submitted to DNV GL for certification.

Upon completion of the analytical part the certification report "Analytical part detailed approach" shall be issued. It shall contain the report of the certification activities including the outcome and the conclusions, and – if necessary – conditions for lifetime extension. Also the recommendation on the LEI frequency as well a calculated length of the lifetime extension shall be given.

These activities shall be performed for a specific type of wind turbine. If they are not related to a specific wind farm, assumptions for site specific conditions shall be applied where necessary.

At least one certification report per wind farm shall be issued.

This analytical part may be performed in two steps:

— Step 1: Wind turbine type specific, performed e.g. by the wind turbine manufacturer
— Step 2: Wind farm site specific, performed e.g. be the wind farm operator

If this option is chosen at least two certification reports are issued.

3.4.2 Statement of compliance - analytical part lifetime extension detailed approach

When the certification report ‘analytical part detailed approach’ is available the statement of compliance "Analytical part lifetime extension detailed approach" shall be issued.

It shall contain:

— a detailed description of the type of wind turbine with characteristic main data
— a brief description of the wind farm including its location
— or the assumptions made if the statement is not related to a specific wind farm
— if necessary, conditions for the lifetime extension
— amount of years of calculated lifetime extension.

The validity is limited by the end of the operating life of the related wind turbine.

In case the analytical part is performed in two steps, two statements of compliance are issued, one each for each step.

3.4.3 Lifetime extension inspection detailed approach

Each wind turbine shall be inspected. The scope of these inspections shall correspond to the needs of the wind farm and the results of the analytical part. It might vary from wind turbine to wind turbine.

These scopes and the tests during the inspections shall be specified in the LEI plan and shall fulfil the requirements stated in DNVGL-ST-0262.

The LEI plan shall among others consider the respective results of the analytical part. The statement of compliance ‘analytical part lifetime extension detailed approach’ should preferably be available before this plan is prepared. In addition it shall be analysed, if any gained wind turbine operation experience after the date of issue of this statement of compliance need consideration in the LEI plan.

The LEI plan shall be approved by DNV GL before any inspection commences.

The LEI report also contains a recommendation whether the wind turbine is suitable for lifetime extension (fitness of the wind turbine). Also the recommended date of the next LEI shall be given. The LEI interval shall not exceed three years.

One LEI report per wind turbine shall be issued.

All LEI reports shall be submitted to DNV GL for assessment. For the assessment the reports shall be reviewed. Additional assessment LEIs on site shall be performed or LEIs of the customer shall be witnessed. It shall be agreed in the contract with the customer how many LEIs shall be performed and/or witnessed by DNV GL.

3.4.4 Final certification detailed approach

The final certification summarises the modules of the certification. It shall address whether the documentation is complete and whether the LEI results confirm the relevant assumptions.

The certification report “Final certification detailed approach” shall be issued if the valid statement of compliance (or the valid statements of compliance) ‘analytical part lifetime extension detailed approach’ and all LEI reports ‘lifetime extension inspection detailed approach’ are available.

The certification report ‘final certification detailed approach’ shall contain a reference list of all supporting documentation. It shall contain an evaluation if the detailed documentation is complete. It shall also contain an evaluation if the LEI results confirm that all relevant requirements and assumptions are being met.

At least one certification report per wind farm shall be issued.

3.4.5 Certificate - lifetime extension detailed approach

Upon availability of the following documents the certificate “Lifetime extension detailed approach” shall be issued:

— statement of compliance (or the statements of compliance) ‘analytical part lifetime extension detailed approach’
— certification report ‘final certification detailed approach’.
It shall contain:

— a detailed description of the type of wind turbine with characteristic main data
— a brief description of the wind farm including its location
— if necessary, conditions for the lifetime extension
— the date of expiry.

The certificate expires at the end of the operating life of the related wind turbines (decommissioning of the last wind turbine of the wind farm).

If one of the statements of compliance ‘analytical part lifetime extension detailed approach’ expires in this period it shall be renewed. Else the certificate loses its validity.

Further requirements for the maintenance of the certificate are given in [2.4]. DNV GL shall issue a written confirmation of the results of the assessment related to the maintenance of the certificate.

3.5 Method probabilistic approach

See also [2.2], [2.3.4] and App.A.

3.5.1 Analytical part probabilistic approach

Load calculations and possibly load measurements shall be performed following the requirements stated in DNVGL-ST-0262.

The conclusions for a possible lifetime extension shall be derived from:

— the results of these calculations and measurements
— the analysis of relevant SCADA data
— the operation experiences of the type of wind turbine and – if available – the relevant wind farm
— possible design optimisations e.g. in the controller and the maintenance concept
— calculations on fatigue strength reserve and/or
— structural reliability analysis.

This investigation shall be carried out for each load transferring component of the wind turbine.

Documentation on this shall be submitted to DNV GL for certification.

Upon completion of the analytical part the certification report “Analytical part probabilistic approach” shall be issued. It shall contain the report of the certification activities including the outcome and the conclusions, and – if necessary – conditions for the lifetime extension. Also the recommendation on the LEI frequency as well a calculated length of the lifetime extension shall be given.

These activities shall be performed for a specific type of wind turbine. If they are not related to a specific wind farm, assumptions for site specific conditions shall be applied where necessary.

At least one certification report per type of wind farm shall be issued.

This analytical part may be performed in two steps:

— Step 1: Wind turbine type specific, performed e.g. by the wind turbine manufacturer
— Step 2: Wind farm site specific, performed e.g. be the wind farm operator

If this option is chosen at least two certification reports are issued.

3.5.2 Statement of compliance - analytical part lifetime extension probabilistic approach

When the certification report ‘analytical part probabilistic approach’ is available the statement of compliance “Analytical part lifetime extension probabilistic approach” shall be issued.
It shall contain:

— a detailed description of the type of wind turbine with characteristic main data
— a brief description of the wind farm including its address/position
— or the assumptions made if the statement is not related to a specific wind farm
— if necessary, conditions for the lifetime extension
— amount of years of calculated lifetime extension at the given probability of failure.

The validity is limited by the end of the operating life of the related wind turbine.

In case the analytical part is performed in two steps, two statements of compliance are issued, one for each step.

3.5.3 Lifetime extension inspection probabilistic approach

Each wind turbine shall be inspected. The scope of these inspections shall correspond to the needs of the wind farm and the results of the analytical part. It might vary from wind turbine to wind turbine.

These scopes and the tests during the inspections shall be specified in the LEI plan and shall fulfil the requirements stated in DNVGL-ST-0262.

The LEI plan shall among others consider the respective results from the analytical part. The statement of compliance ‘analytical part lifetime extension probabilistic approach’ should preferably be available before this plan is prepared. In addition it shall be analysed, if any gained wind turbine operation experience after the date of issue of this statement of compliance need consideration in the LEI plan.

The LEI plan shall be approved by DNV GL before any inspection commences.

After the LEI the LEI report “Lifetime extension inspection probabilistic approach” shall be issued. It contains the documentation of the inspections as well as the results of the review of the maintenance/repair/exchange records and records of former inspections.

The LEI report shall also contain a recommendation whether the wind turbine is suitable for lifetime extension (fitness of the wind turbine). Also the recommended date of the next LEI shall be given. The LEI interval shall not exceed three years.

One LEI report per wind turbine shall be issued.

All LEI reports shall be submitted to DNV GL for assessment. This assessment shall be carried out by reviewing the reports. Additionally assessment LEIs on site shall be performed or LEIs of the customer shall be witnessed. It shall be agreed on in the contract with the customer how many LEIs shall be performed and/or witnessed by DNV GL.

3.5.4 Final certification probabilistic approach

The final certification summarises the modules of the certification. It shall address whether the documentation is complete and whether the LEI results confirm the relevant assumptions.

The certification report “Final certification probabilistic approach” shall be issued when the valid statement of compliance (or the valid statements of compliance) ‘analytical part lifetime extension probabilistic approach’ and all LEI reports ‘lifetime extension inspection probabilistic approach’ are available.

The certification report ‘final certification probabilistic approach’ shall contain a reference list of all supporting documentation. It shall contain an evaluation of whether the detailed documentation is complete. It will also contain an evaluation if the LEI results confirm that all relevant requirements and assumptions are being met.

At least one certification report per wind farm shall be issued.
3.5.5 Certificate - lifetime extension probabilistic approach

Upon availability of the following documents the certificate 'lifetime extension probabilistic approach' shall be issued:

— statement of compliance (or the statements of compliance) ‘analytical part lifetime extension probabilistic approach’
— certification report ‘final certification probabilistic approach’.

It shall contain:

— a detailed description of the type of wind turbine with characteristic main data
— a brief description of the wind farm including its location
— if necessary, conditions for the lifetime extension
— the date of expiry.

The certificate expires at the end of the operating life of the related wind turbines (decommissioning of the last wind turbine of the wind farm).

If one of the statements of compliance ‘analytical part lifetime extension probabilistic approach’ expires during this period it shall be renewed. Else the certificate loses its validity.

Further requirements for the maintenance of the certificate are given in [2.4]. DNV GL shall issue a written confirmation of the results of the assessment related to the maintenance of the certificate.
SECTION 4 RULES FOR THE USE OF THE CERTIFICATE

The certificate shall not be used in such a manner as to bring DNV GL into disrepute. Furthermore, misleading or unauthorized statements regarding the certificate are not allowed.

The certification mark may only be used on or with a reference to the certified product.

The certification mark shall not be used in such a way that it may mislead or give the impression that another product than the certified product is covered by the certificate.

When the certification mark is used in brochures, letters and other printed material, a distinct reference to the certified product shall be stated.

Any claims regarding the certificate shall be promoted with reference to a specific item in the scope for the certification.
## APPENDIX A  OVERVIEW - METHODS FOR LIFETIME EXTENSION

### Table A-1  Methods for lifetime extension assessment

<table>
<thead>
<tr>
<th>Method</th>
<th>Service</th>
<th>Main deliverables</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lifetime extension inspection (LEI)</td>
<td>Lifetime extension inspection (LEI)</td>
<td>Report &quot;Lifetime extension inspection&quot;</td>
<td></td>
</tr>
<tr>
<td>Simplified approach for lifetime extension</td>
<td>Analytical part</td>
<td>Statement of compliance &quot;Analytical part lifetime extension, simplified approach&quot;</td>
<td>Suitable for lifetime extension</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Certificate &quot;Lifetime extension, simplified approach&quot;</td>
<td></td>
</tr>
<tr>
<td>Detailed approach for lifetime extension</td>
<td>Analytical part *)</td>
<td>Statement of compliance &quot;Analytical part lifetime extension, detailed approach&quot;</td>
<td>Proof of strength and stability</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Certificate &quot;Lifetime extension, detailed approach&quot;</td>
<td></td>
</tr>
<tr>
<td>Probabilistic approach for lifetime extension</td>
<td>Analytical part *)</td>
<td>Statement of compliance &quot;Analytical part lifetime extension, probabilistic approach&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Certificate &quot;Lifetime extension, probabilistic approach&quot;</td>
<td></td>
</tr>
</tbody>
</table>

*) Remark:
The analytical part may be performed in two steps:
Step 1: Wind turbine type specific, performed e.g. by the wind turbine manufacturer
Step 2: Wind farm site specific, performed e.g. be the wind farm operator
APPENDIX B  OVERVIEW - VALIDITY PERIODS

This overview of the validity periods is informational only.
The text in this service specification above is binding.

**Method LEI (2.3.3, 3.2)**
Report "lifetime extension inspection"  
No limitation of validity

**Methods simplified, detailed and probabilistic approaches" (2.3.4, 3.3, 3.4, 3.5)**

Statement of Compliance "Analytical part lifetime extension xxxx approach”  
Validity ends at end of the operating life

Certificate  
“Lifetime extension xxxx approach”  
Validity depends on  
- yearly maintenance  
- validity of SoC  
"Analytical part lifetime extension xxx approach".  
Validity ends at the end of the operating life.
APPENDIX C  EXAMPLES FOR THE CERTIFICATION OF WIND TURBINES FOR LIFETIME EXTENSION

The following four examples are case studies for the certification of lifetime extension. They are meant to explain possible scenarios and are given for information to the reader to assist easy understanding. Requirements for certification of lifetime extension are given in the sections above and not in this Appendix C.

C.1 Example: Single wind turbine at the end of its design lifetime

The DNV GL customer is operator of one wind turbine. The certification method **lifetime extension inspection** (LEI) shall be performed by DNV GL. In the report DNV GL confirms the opinion of the operator, that the wind turbine is suitable for life time extension. This helps the customer in his decision making process and the negotiations with the insurance company.

C.2 Example: Wind farm with 5 wind turbines at the end of its design lifetime

The DNV GL customer is operator of a wind farm with 5 wind turbines. The certification method **simplified approach for lifetime extension** is contracted in two steps.

**Step 1**  Analytical part simplified approach

Four years¹ before the design lifetime ends the customer collects SCADA data and performs wind measurements to establish the wind and turbulence reports. These reports are used for a generic (not all turbine specific data are available) load simulation of the wind turbine at one of the locations. Two load simulations are performed, one for the IEC wind class conditions and one for the site specific conditions. The result of the simulations and their comparison is a calculated possible lifetime extension of 6 years¹.

DNV GL performs a certification of the related reports and issues the certification report ‘analytical part simplified approach’ and the statement of compliance ‘analytical part lifetime extension simplified approach’.

**Step 2**  Lifetime extension inspection simplified approach

Half a year¹ before the end of the design lifetime the operator agrees with DNV GL on the inspection plan (LEI plan) and thereafter performs the LEI inspections at each wind turbine. DNV GL certifies the LEI reports and performs some own certification inspections. The certification report “final certification simplified approach” and the certificate “Lifetime extension simplified approach” are issued.

¹ As an example

This DNV GL certificate helps the customer for his decision making process and the negotiations with the insurance company and the building authority.

C.3 Example: The first installations of a type of wind turbine are at the end of their design lifetime

There are several DNV GL customers, as the wind turbine original equipment manufacturer (OEM) and the operators of the wind farms. The certification method **detailed approach** is contracted in three steps.

**Step 1**  Analytical part detailed approach for the type of wind turbine

This step is performed by the OEM and DNV GL.

Four years² before the design lifetime of the first installations of the type of wind turbine ends the OEM collects typical site specific data of the wind farms at which the type of wind turbine is installed.

These data are used for a wind turbine type specific load simulation of wind turbines at three typical locations in the relevant wind farms. The components of the wind turbine type are...
reassessed with regard to the site specific loads.

From the results of these calculations and the operational experiences with this type of wind turbine, conclusions are derived with regard to:

— the turbine type specific LEI plan
— possible calculated life time extension for each of the main components (limiting component in this example is the main shaft: possible calculated life time extension of the main shaft is 8 years²)
— specific measures with regard to maintenance and/or operation.

DNV GL performs an evaluation of the related reports and issues the certification report “Analytical part detailed approach” for the type of wind turbine and the statement of compliance “Analytical part lifetime extension detailed approach” for the type of wind turbine.

Step 2 Analytical part detailed approach for the wind farm

This step is performed by one of the wind farm operators and DNV GL.

Four years² before the design lifetime of his wind farms ends the operator of the wind farm collects SCADA data and performs wind measurements to establish the wind and turbulence reports.

The OEM submits all relevant reports of step 1 ‘analytical part detailed approach’ for the type of wind turbine to the operator.

These reports and other data of the wind farm are used for the comparison between wind farm site specific data and the results of step 1. Outcome of this comparison is the confirmation of calculated possible lifetime extension of 8 years² for this wind farm.

DNV GL performs a certification of the related reports and issues the certification report “Analytical part detailed approach” for the wind farm and the statement of compliance “Analytical part lifetime extension detailed approach” for the wind farm.

Step 3 Lifetime extension inspection detailed approach

This step is performed by the wind farm operator and DNV GL.

Half a year² before the end of the design lifetime the operator agrees with DNV GL on the inspection plan (LEI plan) and thereafter performs the LEI inspections at each wind turbine. DNV GL evaluates the LEI reports and performs some own inspections. The certification report “Lifetime extension inspection detailed approach”.

DNV GL performs the final certification. Then the certification report “Final certification detailed approach” and the certificate “Lifetime extension detailed approach” are issued.

² As an example

The DNV GL statement “Analytical part lifetime extension detailed approach” for the type of wind turbine (step 1) helps the OEM to support his customers in the topic lifetime extension.

The DNV GL certificate “Lifetime extension detailed approach” is value addition to the wind farm and helps for the negotiations between the operator and the insurance company and the building authorities.

C.4 Example: Wind farm with 90 wind turbines at the end of its Design Lifetime

There are two DNV GL customers, the wind turbine original equipment manufacturer (OEM) and the operator of the wind farm. The certification method probabilistic approach is contracted in three steps.

Step 1: Analytical part probabilistic approach for the type of wind turbine

This step is performed by the OEM and DNV GL.

Seven years² before the design lifetime ends, the OEM collects SCADA data (wind data of the operation) and performs wind measurements to establish the wind and turbulence reports.

The data are used for a wind farm specific load simulation of wind turbines at three locations in the wind farm.
To further improve the data, load measurements at wind turbines are performed. Also statistical analysis of operational experiences is derived from the operational records and the SCADA data. From the results of this load simulation and the other investigations, conclusions are derived with regard to:

- the wind turbine specific LEI plan
- reliability analysis of the main components
- possible calculated life time extension for each of the main components (limiting component in this example is the bolted connection of the blade: possible calculated life time extension of the connection is 12 years at a given probability of failure)
- specific measures with regard to maintenance and/or operation
- specific modifications of the control software.

DNV GL performs an evaluation of the related reports and issues the certification report "Analytical part probabilistic approach" and the statement of compliance "Analytical part lifetime extension probabilistic approach" for the type of wind turbine.

**Step 2:** Analytical part probabilistic approach for the wind farm

This step is performed by the wind farm operator and DNV GL.

Four years before the design lifetime of his wind farms ends, the operator of the wind farm starts to collect SCADA data of wind and turbine performance to establish the wind data and turbine operation reports.

The OEM submits all relevant reports from step 1 'analytical part probabilistic approach' for the type of wind turbine to the operator.

These reports and other data of the wind farm are used for the comparison between wind farm data and the results of step 1. Outcome of this comparison is the confirmation of calculated possible lifetime extension of 12 years at the given probability of failure.

DNV GL performs an evaluation of the related reports and issues the certification report "Analytical part probabilistic approach" and the statement of compliance "Analytical part lifetime extension probabilistic approach" for the wind farm.

**Step 3:** Lifetime extension inspection (LEI) probabilistic approach

This step is performed by the wind farm operator and DNV GL.

One year before the end of the design lifetime, the operator agrees with DNV GL on the inspection plan (LEI plan) and thereafter performs the LEI inspections at each wind turbine. DNV GL evaluates the LEI reports and performs some own inspections. The certification report "Lifetime extension inspection probabilistic approach" is issued.

DNV GL performs the final certification. Then the certification report "Final certification probabilistic approach" and the certificate "Lifetime extension probabilistic approach" are issued.

3 As an example

The DNV GL statement "Analytical part lifetime extension probabilistic approach" for the type of wind turbine (step 1) helps the OEM to support his customers in the topic lifetime extension.

The DNV GL certificate "Lifetime extension probabilistic approach" is a value addition to the wind farm and helps for the negotiations between the operator and the insurance company and the building authorities.
APPENDIX D  EXAMPLE STATEMENT/CERTIFICATES

D.1 Statement of compliance “Analytical part lifetime extension detailed approach”

STATEMENT OF COMPLIANCE

Issued for:
Analytical part lifetime extension detailed approach of
<Wind Farm>
Comprising:
<Wind Turbines>
Specified in Annex 1

Issued to:
<Wind Farm Developer>
<Address line>
<Address line>

Certified according to:
DNVGL-SE-0263:20xx-yy Certification of lifetime extension of wind turbines

Based on the documents:
CRD-DNVGL-SE-0263-[ID]-[rev.] Analytical part detailed approach Certification Report, dated yyyy-mm-dd

Changes of the certified wind farm are to be approved by DNV GL.

Place, yyyy-mm-dd
For DNV GL Renewables Certification

[Name of person for “Cert. decision”]
[Function]

DNV GL Renewables Certification is the trading name of DNV GL’s certification business in the renewable energy industry.

The accredited certification body is Germanischer Lloyd Industrial Services GmbH, Bokloobrücke 18, 20457 Hamburg.
D.2 Certificate “Lifetime extension detailed approach”

LIFETIME EXTENSION CERTIFICATE

Certificate No.: CD-DNVGL-SE-0263-[ID with 5 digits]-[rev.]
Issued: [YYYY]-[MM]-[DD]
Valid until: [YYYY]-[MM]-[DD]

Issued for:
Lifetime extension detailed approach of
<Wind Farm>

Comprising:
<Wind Farm> with <Wind Turbines>
Specified in Annex 1

Issued to:
<Wind Farm Developer>
< Address line >
< Address line >

According to:
DNVGL-SE-0263:20xx-yy Certification of lifetime extension of wind turbines

Based on the documents:
SD1-DNVGL-SE-0263-[ID]-[rev.] Analytical part lifetime extension detailed approach
Statement of Compliance, dated yyyy-mm-dd
PCR-DNVGL-SE-0263-[ID]-[rev.] Final Certification Report, dated yyyy-mm-dd

Conditions:
- Annual reporting covering the certified wind farm, including abnormal or deviant operating
  experience or operating failures as well as minor modifications
- Wind farm is maintained or repaired according to the maintenance manuals
- Validity of SD1-DNVGL-SE-0263-[ID]-[rev.] is maintained
- Safety relevant incidents or major modifications shall be reported without delay

Changes of the certified wind farm are to be approved by DNV GL.

Place, yyyy-mm-dd
For DNV GL Renewables Certification

[Name of SLL for “Cert. decision”]
[Function]

By DAKK\textsuperscript{S} according to DIN EN ISO 17025:1994
accredited Certification body for products. The accreditation is valid for the fields of certification
listed in the certificate.

[Name of PW "doing it”]
[Function]

The accredited certification body is Germanischer Lloyd Industrial Services GmbH, Brooktorkai 18, 20457 Hamburg.
DNV GL Renewables Certification is the trading name of DNV GL’s certification business in the renewable energy industry.
D.3 Certificate "Lifetime extension probabilistic approach"

LIFETIME EXTENSION CERTIFICATE

Certificate No.: CP-DNVGL-SE-0263-[ID with 5 digits]-[rev.]
Issued: [YYYY]-[MM]-[DD]
Valid until: [YYYY]-[MM]-[DD]

Issued for:
Lifetime extension probabilistic approach of <Wind Farm>
Comprising:
<Wind Turbines>
Specified in Annex 1

Issued to:
<Wind Farm Developer>
< Address line >
< Address line >

According to:
DNVGL-SE-0263:20xx-yy Certification of lifetime extension of wind turbines

Based on the documents:
SP1-DNVGL-SE-0263-[ID]-[rev.] Analytical part lifetime extension probabilistic approach
Statement of Compliance, dated yyyy-mm-dd
FCR-DNVGL-SE-0263-[ID]-[rev.] Final Certification Report, dated yyyy-mm-dd

Conditions:
- Annual reporting covering the certified wind farm, including abnormal or deviant operating
  experience or operating failures as well as minor modifications
- Wind farm is maintained or repaired according to the maintenance manuals
- Validity of FL4-DNVGL-SE-0263-[ID]-[rev.] is maintained
- Safety relevant incidents or major modifications shall be reported without delay

Changes of the certified wind farm are to be approved by DNV GL.

Place, yyyy-mm-dd
For DNV GL Renewables Certification

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

[Name of PM "doing it"]
Function

The accredited certification body is Deutsche Lloyd Industrial Services GmbH, Brooktorkai 18, 20457 Hamburg,
DNV GL Renewables Certification is the trading name of DNV GL’s certification business in the renewable energy industry.
Driven by our purpose of safeguarding life, property and the environment, DNV GL enables organizations to advance the safety and sustainability of their business. We provide classification and technical assurance along with software and independent expert advisory services to the maritime, oil and gas, and energy industries. We also provide certification services to customers across a wide range of industries. Operating in more than 100 countries, our 16 000 professionals are dedicated to helping our customers make the world safer, smarter and greener.