DNV·GL

# SERVICE SPECIFICATION

DNVGL-SE-0077 Edition March 2015

# Certification of fire protection systems for wind turbines



DNV GL AS

# 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.



Any comments may be sent by e-mail to *rules@dnvgl.com*

# CHANGES – CURRENT

## General

This is a new document.

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# SECTION 1 GENERAL

## 1.1 Introduction

### 1.1.1 Foreword

During recent years a steady growth of the wind energy industry is observed. This is not only related to the total number of installed wind turbines but also to the individual rating and level of sophistication of the technology. The expansion to offshore regions further drives technology development and increases the level of investment.

With this background the demand for effective and reliable protection of the systems and also the investments have grown significantly. An effective fire protection system forms a substantial part of such risk reduction. Effective and reliable fire protection systems, considering both active and passive measures, contribute to a considerable reduction of the risk of bodily injury and property damage caused by fires in wind turbines. It may even prevent the total loss of a wind turbine.

This DNV GL service specification is intended to define and ensure a high quality model for the design and construction of up to date fire protection systems. The service specification will be revised frequently in accordance with experiences, new findings and future technological developments. It is intended to set up a common basis of understanding for manufacturers of fire protection components as well as of complete fire protection systems with regard to high quality, reliability and effectiveness of their products.

### 1.1.2 Function of document

This service specification specifies DNV GL's services for certification of fire protection systems for defined types of wind turbines.

The document provides:

— a common platform for describing the scope and extent of verification activities for the certification of fire protection systems for wind turbines
— a reference for defining the requirements and the scope of work in accordance with requirements of the applicable certification system.

As a prerequisite for each certification of fire protection components and fire protection systems for wind turbines to be carried out a detailed scope of work for DNV GL's fire protection system certification services is worked out. This is an integral part of the fire protection system certification contract between the manufacturer of the fire protection system and DNV GL.

### 1.1.3 Objective

This document has a dual objective:

It serves as a publicly available description of DNV GL's type certification services for fire protections systems for wind turbines. Secondly it is taken as the contractual basis in the certification contract between the client (typically manufacturer of the fire protection system or wind turbine) and DNV GL.

The document specifies the obligations of the client, when he applies for certification of fire protection components and systems for wind turbines.

The document likewise specifies the obligations of DNV GL and the tasks carried out for certification by DNV GL in a comprehensible way.

### 1.1.4 Scope

This service specification applies to certification of fire protection components and fire protection systems for wind turbines exclusively carried out by DNV GL.

The scope of the verification covers all aspects of the system, i.e. the level of fire safety as well as the planning, design, availability, workmanship and quality are assessed.

Component certification of components such as fire detection and fire-extinguishing systems may be

performed by application of the elements and modules as listed in this service specification and the respective sections of this service specification shall be covered.

**Note:**

Concerning the aspects of occupational health and safety (e.g. escape and rescue routes) these can be taken into account through compliance with the standard EN 50308, see /4/. National requirements shall be observed in all cases. The assessment according to this service specification can optionally be extended by the conformity assessment of occupational safety of personnel aspects according to European or local laws and/or standard /4/.

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### 1.1.5 Structure of document

This document consists of the following sections: Sec.1 provides general information and necessary prerequisites. Sec.2 provides an overview of the certification services of fire protection components and fire protection systems for wind turbines. Sec.3 provides a more detailed service description. Sec.4 contains the list of referenced standards, guidelines or documents.

## 1.2 Definitions

### 1.2.1 Verbal forms

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

### 1.2.2 Terminology

| *Term* | *Definition* |
|---|---|
| *active fire protection* | equipment and systems which are used to control, mitigate and extinguish fires |
| *certification* | assessment and attestation by an independent certifying body, that the subject of the certification, here the fire protection components and fire protection systems for wind turbines, complies with a specific standard or other normative document<br>The term covers all activities of the process which leads to the issuance of a certificate. The scope of work is defined by the certifying body or by a regulatory body. |
| *certification system* | system of rules, procedures and management for conformity assessment to be followed prior to the issuance of a certificate |
| *certification scheme* | certification system related to specified products, to which the same specified requirements, specific rules and procedures apply |
| *control and indicating equipment* | The control and indicating equipment of the fire protection system has the following functions, see [3.2.2.2].<br>— It receives signals from fire detectors and activates the signals fire pre-alarm and fire alarm.<br>— It is able to pass its signals to the control system of the wind turbine and to a manned control room.<br>— It monitors the accurate function of the fire protection system and generates corresponding warning messages. |
| *fire alarm* | The state "fire alarm" is defined by two triggered sensors of a fire protection zone. |
| *fire pre-alarm* | The state "fire pre-alarm" is defined by one triggered sensor of a fire protection zone (where at least two sensors are installed). |
| *fire protection* | Whenever the term "fire protection" is used it refers to both the active and passive fire protection for wind turbines. |
| *fire protection components* | Fire protection components are understood as single parts or devices with fire preventive or protective characteristics which may form part of a complete fire protection system, but which are not able to stand and act alone for fire protection. |

| *Term* | *Definition* |
|---|---|
| *fire protection systems* | Fire protection systems serve the targets of fire prevention, fire detection and, if applicable, firefighting. They are defined by the following information and measures:<br>— protection target, see [3.1.1]<br>— overall protection concept, see [3.1.1]<br>— protection measures (active and passive), see [3.1.2]. |
| *flame retardant* | property of a substance or treatment applied to a material to substantially suppress, reduce or delay the propagation of a flame |
| *optional* | Optional services are services which are not part of the scope which is required in order to obtain statements of compliance and project certificates. |
| *passive fire protection* | Design/engineering measures e.g. coating or cladding arrangement or free-standing system which, in the event of fire, provide thermal protection to restrict the rate at which heat is transmitted to the object or area being protected, see [3.2.3]. |
| *protection class* | The protection class respectively protection level is defined by fire protection measures to be applied in the wind turbine and on the basis of section 4 of CFPA-E No 22:2012 F, see /1/. |
| *protection level* | see protection class |
| *recommendation* | a non-mandatory advice |
| *verification* | refers to the conformation, through the provision of objective evidence, that specified requirements have been fulfilled (ISO 9000, see /14/) |
| *wind turbine* | system which converts kinetic energy in the wind into electrical energy |

### 1.2.3 Abbreviations and symbols

**Table 1-1 Abbreviations of organisations and companies**

| *Abbreviation* | *Description* |
|---|---|
| CFPA-Europe | Confederation of Fire Protection Association Europe |
| VDI | VDI Verein Deutscher Ingenieure e.V. |
| EFSG | The European Fire and Security Group (EFSG) is an association of certification bodies of Europe working in the fire and security sectors. |
| IEC | International Electrotechnical Commission |
| ISO | International Organization for Standardization |
| VdS | VdS Schadenverhütung GmbH - independent testing institution for fire protection and security - is a company of Gesamtverband der Deutschen Versicherungswirtschaft e.V. (GDV – German Insurance Association). |

## 1.3 References

For the evaluation of fire protection systems, this document refers especially to the publication CFPA-E No 22:2012 F, see /1/, in which fire protection targets and protection concepts as well as protection measures are described.

This service specification contains further references to various sources. They are indicated correspondingly and listed in [4].

# SECTION 2 PROCESS OF CERTIFICATION

## 2.1 General conditions for certification

### 2.1.1 General

The aim of this service specification is the assessment of fire protection systems and corresponding measures for wind turbine types as well as the appropriate integration into those wind turbine types.

The diversity of wind turbine designs resulting in different protection areas requires an individual assessment for the appropriate integration into a wind turbine type.

Generally the design of fire protection systems and corresponding measures shall meet the requirements of the state of the art.

For a successful certification according to this service specification the effectiveness and reliability of the fire protection system shall be demonstrated. This evidence shall be provided on the basis of CFPA-E No 22:2012 F, see /1/, or equivalent recognized rules of technology (whereby the requirements of /1/ shall be observed as a minimum requirement).

### 2.1.2 Quality management system

Any fire protection components and fire protection systems in the sense of this service specification which are intended to be certified have to be developed, manufactured and delivered under a controlled quality management system.

An implemented quality management system at the applicant for certification is seen upon as basis for the certification according to this service specification.

DNV GL recognizes one of the following options of an applicant's quality management system for the certification

— Option 1: Certification according to the ISO 9001 (at least ISO 9001:2008, see /7/, certified by an accredited certification body. DNV GL reserves the right to verify the applicant's quality management system by documentation review or audit.
— Option 2: Documented implementation of a quality management system equivalent to ISO 9001 (at least ISO 9001:2008, see /7/. In this case DNV GL performs a documentation review and a verification audit of the applicant's quality management system.

### 2.1.3 Deviations

Deviations from the requirements and from the process of certification of this service specification have to be authorized by DNV GL.

Reasons and considerations leading to any such deviation have to be documented thoroughly. It shall be shown conclusively and in detail how the requirements of this service specification can be met in spite of the deviations. Appropriate documents shall be submitted. Then DNV GL assesses the documents and decides in each individual case whether the deviation is admissible for the purposes of this Service Specification.

In the case of details for which the service specification cannot be used, DNV GL reserves the right to proceed according to the intention of this service specification.

### 2.1.4 Applicable legislation and third party regulations

In individual cases and by request of the customer, the locally valid or country-specific regulations and requirements can be taken into account within the certification.

This service specification shall be observed as the minimum requirement, even if national or regional laws and regulations establish lower requirements.

Observance of this service specification does not provide the assurance that the statutory requirements have been met. Moreover, there may be other requirements that are not covered by this Service

Specification.

**Note:**
The standard EN 13478, see /23/, contains relevant information concerning fire prevention and protection. In Sec.3 corresponding notes refer to the requirements of /23/.

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## 2.1.5 Recognition of third party assessments and certifications

If assessments performed by other bodies are to be recognized for the certification by DNV GL, documents shall be submitted to portray the scope of the assessments by the other bodies in sufficient detail. DNV GL assesses these documents and decides in each individual case to what extent these documents can be recognized.

## 2.1.6 Technical documents to be submitted

For the certification of a fire protection system, the following documents shall be submitted:

a) analysis of possible fire risks in the wind turbine, see [3.1]
b) description of the fire protection concept, see [3.1]
c) documentation of the quality management system, see [2.1.2]
d) description of the fire detectors, sensors, individual systems and, if applicable, the control boxes of the fire protection system (e.g. type designation, set values, set points, time constants), if applicable including the approvals (certificates) of the components, systems, see [2.2.2.1]
e) description of the fire protection system, see [2.2.2.2]
f) documentation of the approved installer(s), see [2.2.2.3]
g) general documentation and type certificate of the wind turbine issued by an accredited certification body, see [2.2.3.2]
h) documentation of escape and rescue routes, see [3.1.2]
i) description of temperature monitoring of main components, bearings, brakes and components protected by the fire protection system, see [3.2.2.6]
j) description of the fire protection system implementation into the wind turbine (sequence of events, behaviour in the event of a malfunction in the fire protection system, behaviour of the wind turbine after triggering of the fire protection system), see [2.2.3.2]
k) general arrangement drawing showing the installation positions of the components and systems for fire protection, including the positions of the sensors and fire-extinguishing appliances, see [2.2.3.2]
l) electrical circuit diagrams, insofar as electrical components form part of the fire protection system, with references to the circuit diagrams of the electrical system of the wind turbine, see [2.2.3.2]
m) piping diagrams, insofar as piping forms part of the system, see [2.2.3.2]
n) description of the passive fire protection, see [3.2.3]
o) other documents needed to describe the fire protection system and not listed here
p) installation, commissioning, operating and maintenance manuals, see [3.3].

The documents shall show that the requirements set out in this service specification are met. The degree of detail shall be so selected that the functional principle of the fire protection system and the behaviour of the wind turbine is adequately defined.

The documentation delivered for assessment and certification shall be written in English language. Relevant excerpts of quoted documents that are not commonly known shall be annexed to the documentation.

Drawings, circuit diagrams and flow charts shall be elaborated in compliance with the applicable national and/or international standards and guidelines.

The documentation delivered for assessment and certification shall be in hardcopy form or in the form of electronic files which cannot be edited, e.g. pdf-files.

## 2.1.7 Trials / tests

If the results of trials/tests are to be taken into account during the certification of the fire protection system,

the trials or tests shall be carried out under the supervision of DNV GL or in an accredited test laboratory by e.g. VdS or a member of EFSG.

The conditions for recognition of these trials / tests shall be agreed upon in beforehand with DNV GL.

Each trial / test to be recognized within the scope of the certification of the fire protection system shall be concluded with a detailed report. This report shall form part of the documentation submitted for the certification. In the report, the following information shall be provided as a minimum:

a) reason for conducting the trial
b) purpose of the trial and standard(s) applied for the trial
c) expected results
d) constraints of the trial
e) description of the trial
f) presentation of the results of the trial
g) evaluation and analysis of the results of the trial
h) deviations from the standard(s) (if any)
i) presentation of compliance with the requirements of this service specification
j) conclusions drawn.

## 2.2 Structure of the certification process

### 2.2.1 General

In general the certification of fire protection systems is divided in the main sections:

— approval of fire protection system
— implementation of the fire protection system in one specified type of wind turbine.

Figure 2-1 shows the certification scheme. In the following it is explained in more detail.

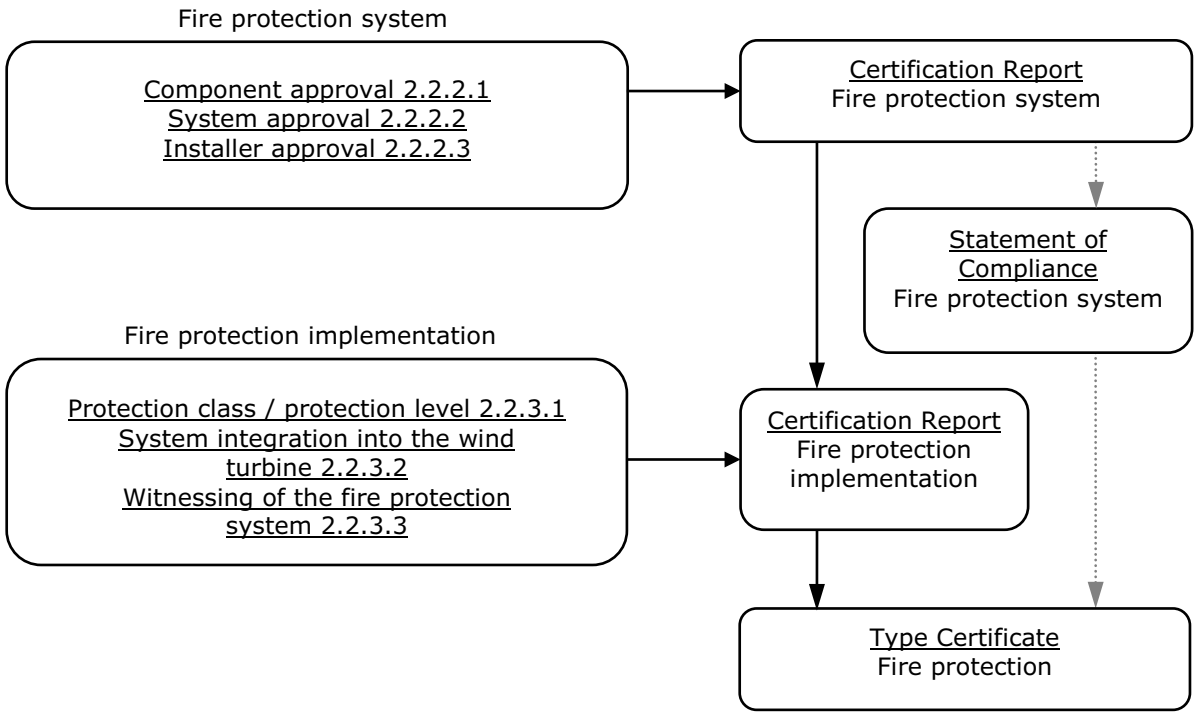


**Figure 2-1 Structure of the certification of the fire protection system by DNV GL**

## 2.2.2 Fire protection system

The first section of the certification process deals with the assessment of the concept for fire protection. Here the selection of single components and their combination in a fire protection system is assessed for suitability for the foreseen configuration and function. This fire protection concept is seen to be independent from any specific type of wind turbine.

### 2.2.2.1 Component approval

Approved components in the sense of this service specification are components of the active fire protection (e.g. extinguishing nozzles, detectors etc.) that possess an approval (component approval) of a certification body accredited according to ISO/IEC 17020, see /11/, ISO/IEC 17025, see /12/, and/or ISO/IEC 17065, see /13/. For example, this may be a VdS component approval.

### 2.2.2.2 System approval

A system for the active fire protection of wind turbines is an arrangement of units and components that can be used, either freely combinable or in fixed configurations, for the construction of fire protection systems and that is intended to produce a coordinated functional interaction in this regard. In addition, such a system includes a planning and installation manual (including protection targets and constraints to be observed) as well as installation, operating and maintenance manuals, see [3.3] "Manuals".

Approved systems in the sense of this service specification are systems that have an approval (defined by a system approval number) for active fire protection with specified application for wind turbines by a certification body accredited according to ISO/IEC 17020, see /11/, ISO /IEC 17025, see /12/, and/or ISO/IEC 17065, see /13/. For example, this may be a VdS-approved CO2 fire-extinguishing system for control cabinets in wind turbines.

[2.1.7] "Trials / tests" shall be observed.

The technical data (e.g. ambient and operating temperature ranges) of the system for the active fire protection shall be defined.

#### 2.2.2.3 Installer approval

An installer in the sense of this service specification is a company that provides one or more of the following services in connection with systems for active fire protection in wind turbines:

a) project conceptualization / planning
b) installation
c) commissioning / handover to operator (including familiarization)
d) maintenance of fire protection systems.

Approved installation companies in the sense of this service specification are companies that possess an approval for the installation of one or more certified fire protection systems by a certification body accredited according to ISO/IEC 17020, see /11/, and/or ISO/IEC 17025, see /12/, or equivalent approval. For example, an approved installer may hold a valid approval by VdS. Approvals of other certification bodies holding a valid accreditation according to ISO/IEC 17065, see /13/, with the respective scope for firefighting systems may be accepted.

### 2.2.3 Fire protection implementation

#### 2.2.3.1 Protection class / protection level

The identification of the protection class respectively protection level which is achieved by the fire protection system under assessment is performed to ascertain whether the approved systems and installers listed in the fire protection concept are suitable for reliable implementation and achievement of the defined fire protection target.

The main part of this step of assessment aims to check the mutual influence of the single systems.

The protection level is defined on the basis of /1/.

#### 2.2.3.2 System integration into the wind turbine

The certification of a fire protection system is performed by DNV GL for a specific certified type of wind turbine (without any ancillary building). This includes installations with various rotor diameters and tower heights. The type certificate of the wind turbine shall be issued according to /2/, /3/ or /9/ by an accredited certification body.

The components and systems for active and passive fire protection of the fire protection concept have to be integrated into the specific wind turbine in a way that:

— The conditions and constraints of the system approval, see [2.2.2.2], are observed.
— The defined protection level, see [2.2.3.1], is fully achieved.
— The control system of the wind turbine is part of the active fire protection, see [3.2.2].
— The certification of the wind turbine is not impaired.

The fire protection system has to be suitably adapted to the external conditions. (E.g. in case of offshore applications concerning corrosion protection requirements can be found in /3/, /5/ and /15/.)

The technical data (e.g. ambient and operating temperature ranges) of the system for the active fire protection shall be in compliance with the wind turbine.

The type certificate of the wind turbine (see [2.1.6] item g) shall show clearly that the wind turbine and its sub-components are protected against lightning according to the state of the art. In case of doubt the corresponding requirements of /2/, /3/, /8/ or /10/ shall be fulfilled, respectively.

#### 2.2.3.3 Witnessing of the fire protection system

On completion of the assessment of the protection level of the fire protection system applied for certification, a function test as well as a visual inspection has to be performed in the presence of two experts from DNV GL in order to cover operational aspects of wind turbines as well as special aspects of fire protection.

This witnessing shall be performed with one of the first fire protection systems of the respective type which is installed in the specific type of wind turbine and put into operation.

The function test is intended to assess the interaction of the fire protection system with the wind turbine, as well as the functionality and conformity of the fire protection system according to the assessed documents.

Selected tests from the commissioning manual [3.3.2], are carried out to verify their practicability.

**Note:**
In case the assessment covers different tower types and the extinguishing agent is located at the tower bottom and has to be transported to hub height in case of its release the witnessing of the fire protection system shall be performed at the wind turbine variant with the highest hub height.

In general if the assessment covers wind turbine variants with e.g. different tower and rotor blade types the configuration of the inspected wind turbine shall be agreed with DNV GL in advance.

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## 2.2.4 Documentation of the certification result

On successful completion of the certification process as described above under items [2.2.2] and [2.2.3] certification reports and certificates confirm the compliance with the requirements of this service specification.

The following reports and certificates are issued:

— Certification report "Fire protection system"
— Statement of compliance "Fire protection system" (optional)
— Certification report "Fire protection implementation"
— Type certificate "Fire protection".

### 2.2.4.1 Certification report "Fire protection system"

The certification report "Fire protection system" summarizes the result of the assessment of the fire protection system in general as explained in item [2.2.2]. It states that the requirements of the following sections of this service specification are fulfilled:

— [2.2.2.1] "Component approval"
— [2.2.2.2] "System approval"
— [2.2.2.3] "Installer approval".

Special remarks and conditions may be imposed in this certification report.

### 2.2.4.2 Statement of compliance

A statement of compliance "Fire protection system" may be issued on request of the applicant. It is based on the certification report "Fire protection system". The technical specifications for the fire protection system together with its key technical data are listed in the appendix to this statement of compliance. The approved installer company is stated in the appendix as well.

### 2.2.4.3 Certification report "Fire protection implementation"

The certification report "Fire protection implementation" confirms that the fire protection system according to the certification report "Fire protection system" complies with the requirements of the following sections of this service specification within the factual and structural conditions of a defined specific type of wind turbine:

— [2.2.3.1] "Protection class / protection level"
— [2.2.3.2] "System integration into the wind turbine"
— [2.2.3.3] "Witnessing of the fire protection system".

### 2.2.4.4 Type certificate

On completion of the certification of the fire protection system, a type certificate "Fire protection" is issued. The validity period of the certificate and the possibility for recertification is given. As an appendix to this certificate, the type of the wind turbine in which the fire protection system is to be used is listed. The key technical data of the fire protection system and the installer company are also stated in the appendix.

**Note:**

A type of a fire protection system for a certain type of a wind turbine is defined by the properties of the fire protection system and by the wind turbine type.

If a fire protection system shall be used for more than one wind turbine type the suitability of the fire protection system has to be assessed for each single wind turbine type. After a successful assessment these wind turbine types shall be listed on the type certificate "Fire protection".

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The validity period of the type certificate for a fire protection system is 5 years. A yearly "Periodical verification" (see [2.3.3]) is to be performed during the validity. After expiry a recertification will be performed on request by the applicant for another validity period of 5 years.

## 2.3 Maintenance of certificates

### 2.3.1 General

The validity of the statement of compliance "Fire protection system" and the type certificate "Fire protection" is limited to 5 years each. During this time the holder of the type certificate is responsible to ensure continued compliance of the fire protection system with this service specification. Therefore the holder of the certificate shall keep the documentation of the fire protection system up to date.

### 2.3.2 Modifications to the fire protection concept, components and system

Modifications of components and sub-systems of the certified fire protection system which were part of the certification or any other kind of modification which affect and change the operating mode of the certified fire protection system in any way, lead to the immediate expiration of the validity of the certificate.

Modification of components and sub-systems of the certified fire protection system, which were not part of the certification have to be recorded together with the reason for the modification in an appropriate way.

Any changes in the fire protection concept, component(s) and system certified according to [2.2.2] as well as modifications in the fire protection system certified according to [2.2.3] have to be communicated to DNV GL in due time.

The holder of the certificate shall submit to DNV GL objective evidence and documents related to these changes. Such information shall include all relevant documentation enabling DNV GL to verify the extent of such modifications and to evaluate their effect on the certificate.

On the basis of these documents DNV GL shall subsequently decide necessary further steps regarding the validity of the certification.

If DNV GL is convinced of the continued compliance of the fire protection system as initially certified, the certificate shall remain valid to the date of expiry as stated.

### 2.3.3 Periodical verification

During the period of validity of the Type Certificate the holder of the certificate shall provide objective evidence of the continued compliance of his system. For this purpose the holder of the certificate shall submit a yearly report to DNV GL. This report shall comprise:

— list of the valid documentation of the fire protection system
— list of all technical modifications to single components and sections of the system which form part of the certification
— list of the fire protection systems already delivered and installed
— list of malfunctions and abnormal operating experience, respectively.

DNV GL checks this report. Depending on the result of the assessment DNV GL reserves the right to request additional measures for verification as well as regarding the continued validity of the certificate.

### 2.3.4 Recertification

The type certificate expires at the end of its period of validity without further notification by DNV GL.

For recertification the holder of the certificate shall submit a written request to DNV GL not later than 3 month in advance of the expiry date of the certificate.

For the recertification, the following documents shall be submitted for assessment by DNV GL:

- list of the valid documents, see [2.1.6]
- list of all technical modifications forming part of the certification
- list of the fire protection systems already delivered and installed
- list of malfunctions and abnormal operating experience, respectively
- valid certificate of the quality management system
- valid certificates of other areas, which were part of the certification process.

In case of insufficient documentation or other kind of questions DNV GL reserves the right to require further documentation or other measures for verification.

Upon satisfactory assessment, performance of a witnessing of a fire protection system and upon closing of all questions DNV GL renews the certificate with a period of validity of 5 years.

### 2.3.5 Withdrawal of certificates

DNV GL reserves the right to withdraw the Type Certificate upon objective evidence and determination that the holder of the certificate has demonstrated a pattern or history of:

- failing to comply with the prerequisites, the applicable requirements and/or conditions, see [2.2]
- substantial deviations from the approved components and/or fire protection system
- substantial modifications to the fire protection components and/or fire protection system without following the procedures laid down in [2.3.2] and [2.3.6] or
- performing the installer's duties and responsibilities in a manner that is insufficient to fulfil the requirements for installer's approval according to [2.2.2.3].

### 2.3.6 Reinstatement of certificates

DNV GL notifies the applicant in writing about the conditions for reinstating the type certificate after withdrawal.

# SECTION 3 DETAILED REQUIREMENTS FOR CERTIFICATION OF FIRE PROTECTION SYSTEMS

## 3.1 Fire protection concept

### 3.1.1 Protection targets and protection concept

Based on a detailed analysis of possible fire risks in the type of wind turbine as a result a fire protection concept shall be prepared in coordination with the manufacturer of the fire protection system, the manufacturer of the wind turbine and the certification body as well as the recognized testing body. Notes, instructions and recommendations on this topic are given in section 4 "Protection targets and protection concept" of /1/.

**Note:**
The level of detail of the analysis of possible fire risks as well as the selection and design of technical fire prevention and protection measures shall be in compliance with the corresponding requirements of /23/.

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The wind turbine- or installation-specific compilation of the required fire protection measures within the scope of a protection concept shall – as shown by way of example in /1/ – be assigned a protection class forming the assessment basis for the certification (see [2.2.3.1] "Protection class / protection level").

The behaviour of the fire protection system and the control system of the wind turbine shall be defined concerning the cases fire pre-alarm and fire alarm.

### 3.1.2 Protection measures

Fire protection measures resulting from a fire protection concept are described in section 5 "Protection measures" of /1/.

Escape and rescue routes shall be described in detail. If applicable the required equipment necessary for the use of the escape routes shall be documented.

## 3.2 Fire protection system

The following technical requirements shall be applied for a fire protection system as a minimum.

### 3.2.1 General

Fire protection systems for wind turbines can be subdivided into active and passive fire protection.

### 3.2.2 Active fire protection

**Note:**
The level of detail of integrated fire detection and firefighting system shall be in compliance with the corresponding requirements of /23/. Because the wind turbine is usually in unmanned operation an automatic discharge extinguishing system shall be used.

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#### 3.2.2.1 Procedural measures

Procedural measures for wind turbine pursue the target of mitigating the risk of overheating for components of the wind turbine. The procedural measures include e.g. the disconnection of the wind turbine from the electrical power supply or the closing of any automatic ventilation flaps. If any procedural measures are taken to mitigate the fire risk, these shall be explained in the description of the fire protection system.

#### 3.2.2.2 Control and indicating equipment

The signals of the fire alarm and extinguishing system shall be processed independently of the wind turbine controller by a control and indicating equipment. The correct function of the processor of the control and indicating equipment shall be monitored according to the state of the art. If more than one processor are used all processors shall be monitored. The performance of the monitoring device(s) shall not be influenced by any program errors. The wind turbine controller might also process these signals in redundancy to the control and indicating equipment, additionally.

The states of the control and indicating equipment listed below shall be indicated optically and acoustically at the control and indicating equipment, at the display of the control system of the wind turbine (e.g. warning message) and also in a manned control room. As an option concerning the following states the information about the affected fire protection zone and indication group can be shown, additionally:

— In case of a fire pre-alarm, see [1.2.2], the control and indicating equipment shall behave according to the specifications of the fire protection concept, see [3.1].
— In case of a fire alarm, see [1.2.2], the control and indicating equipment shall behave according to the specifications of the fire protection concept, see [3.1]. Depending on the specifications of the fire protection concept, see [3.1], in case of a fire alarm the control and indicating equipment shall activate the installed automatic fire-extinguishing system (of the defined fire-extinguishing area). The release of fire extinguishing agent(s) shall be performed according to the fire protection concept, see [3.1], e.g. after a defined delay time.
— Failure of the external power supply (grid loss) with duration of up to 6 hours is regarded as a normal external condition and the function of the control and indicating equipment shall not be influenced negatively during that time. Upon recovery of the grid after a longer grid loss, the control and indicating equipment shall restart and work without problems or changed settings and all log files shall be available.
— The control and indicating equipment shall fulfil the requirements of section 5.2.3 "Fault monitoring" of /1/. Faults (e.g. failure of a feeder line, loss of extinguishing agent, short-circuit or wire break in alarm loops). The fault signals shall be resettable and shall be distinguishable from a fire alarm signal.
— The state "no faults and no alarms" of the fire protection system shall be indicated optically. This state information shall be transmitted to the control system of the wind turbine.

#### 3.2.2.3 Fire alarm system

The activation criteria (device settings) of the fire detectors (e.g. temperature, time delays) shall be specified. In each case, they shall meet at least the requirements set out in section 5.2.1 "Fire detection" of /1/.

Fire detectors shall be proof against deceptive alarms and shall be adapted to the special design situations of wind turbines; faulty triggering should be prevented by the corresponding measures (e.g. interdependency of two detectors / two detector lines). The special design situations include e.g. nacelle temperatures above 50 °C, condensation, vibration and dust. The components that are used shall comply with the current state of the art and be approved, see [2.2.2.1].

In a fire protection zone and in one indication group at least 2 fire or smoke sensors of the same type shall be installed.

Optical and acoustic alarms shall be used in the following areas of wind turbine:

— Where there is a hazard for persons working on the wind turbine through fire itself.
— Where there is a hazard for persons through activation of the fire-extinguishing system.
— Where there is a hazard for persons because the escape routes may be blocked by fire (e.g. working in the hub and fire in the bottom of the tower).

#### 3.2.2.4 Portable fire extinguishers

The requirements for fire extinguishers are the minimum capacities of 5 kg for carbon dioxide and 9 litres for foam.

Independent of the fire protection concept, see [3.1] fire extinguishers shall be provided for fighting incipient fires in the nacelle (at least one with carbon dioxide and one with foam) and in the tower base area (at least one with carbon dioxide) in the near of electrical installations.

Depending on the analysis of possible fire risks, see [3.1.1], a foam fire extinguisher might be provided additionally in the highest tower section (yaw section).

#### 3.2.2.5 Automatic fire-extinguishing appliances and systems

The requirements for automatic fire-extinguishing appliances and systems and for their areas of application shall be derived from the fire protection concept. The verification of their effectiveness and reliability shall

be provided through the system approval of the fire protection system, see [2.2.2.2].

— If the automatic fire-extinguishing appliance or system is triggered by activation elements or fire detectors, their response times and activation criteria (e.g. temperature, pressure) shall be stated. The functional reliability of the activation elements shall be verified, see [2.2.2.1].
— If extinguishing nozzles are used, see [2.2.2.1], their functional reliability – coordinated with the fire extinguishing agent in use – shall be verified.
— A procedure for returning the fire-extinguishing system to service after it has been activated shall be described in the manuals, see [3.3].
— Suitable measures for inspecting and repairing the components (e.g. motors or control cabinets) affected by the fire extinguishing agent shall be described in the manuals (see [3.3]). If an fire extinguishing agent constitutes any hazards for the operating or maintenance personnel these hazards shall be stated and suitable measures and safety instructions shall be provided to protect the personnel containing health warnings related to released fire extinguishing agents (e.g. high pressure, suffocation hazard).
— The fire-extinguishing system shall be fitted with an automatic monitoring arrangement. Malfunction and warning signals shall be provided to the control and indicating equipment, see [3.2.2.2].

Possible hazards or damages caused by the automatic fire-extinguishing appliances and systems (e.g. physical damage of cabinets or sections of wind turbine because of over pressure) shall be considered and corresponding protective measures (e.g. overpressure release devices) shall be stated.

#### 3.2.2.6 Control system of the wind turbine

The control system of the wind turbine constitutes a part of the hazard warning system and regarding certain components it prevents those from high temperatures.

The temperature of the main components, bearings, brakes and components that are protected by the fire protection system shall be monitored and the corresponding description shall be submitted to DNV GL.

If the temperature limits of components (e.g. bearings or brake linings) are exceeded, the control system shall cause a shutdown of the wind turbine and the corresponding error message shall be stored. If in certain cases automatic re-starts take place without manual clearance the corresponding description of the control system of the wind turbine and its parameters as well as the limits of the automatic start-ups shall be submitted to DNV GL for assessment. The malfunction shall be rectified by expert technical personnel after the cause of the malfunction has been determined and removed.

**Note:**
The number of automatic start-ups shall be limited to three times every 24 hours for every component (e.g. gear-box bearing) which has been identified by analysis of possible fire risks, for being able to cause a fire in the wind turbine.

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In case the wind turbine is equipped with ventilation systems (e.g. for cooling purposes) which could influence the fire extinguishing negatively they shall be disabled during the release of fire extinguishing agent(s) and the corresponding description as well as the related parameters shall be submitted to DNV GL.

The behaviour of the control system of the wind turbine in case of a fire pre-alarm signal received from the control and indicating equipment shall be documented according to the fire protection concept, see [3.1].

In case of a fire alarm signal received from the control and indicating equipment an immediate and controlled shutdown of the wind turbine shall be performed without an automatic restart and according to the fire protection concept, see [3.1], a subsequent disconnection from the grid shall be performed, if necessary (e.g. because of fire alarm in high voltage transformer or cable section).

### 3.2.3 Passive fire protection

Design/engineering measures for fire protection help to prevent fires, to limit them in spatial extent and, in case of fire, to secure the availability of the escape and rescue routes. The design/engineering measures include fire stopping (e.g. covers for brake discs to guard against flying sparks), fire-resistant claddings and fire protection coatings. If any design/engineering measures are taken to mitigate the fire risk, these shall be explained in the description of the fire protection system.

**Note:**
The level of detail of design/engineering measures shall be in compliance with the corresponding applicable requirements of /23/.

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The selection of the materials and components with due regard for fire protection shall be considered in the design of the wind turbines. This shall e.g. include the use of flame retardant and self-extinguishing materials for thermal and noise insulation as well as the design of oil collecting arrangements and application of oils which are flame retardant.

It may be necessary to establish different fire protection measures and/or fire zones for various areas of the wind turbine. This shall be considered e.g. concerning the position of the main transformer, control cabinets and/or static converter cabinets in the wind turbine.

The use of non-halogen or flame retardant cables as well as fire stops shall be considered.

**Note:**
Flame tests are described in the standards IEC 60332-1-1, see /38/ and IEC 60332-1-2, see /39/.

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In case the step-up transformer is located in the wind turbine it shall be shown that its design fits to the application and possible risks are considered resulting in corresponding measures.

## 3.3 Manuals

In this chapter principle requirements for manuals are stated. These are necessary for the assessment.

### 3.3.1 Installation manual

#### 3.3.1.1 General

The installation manual describes all working steps to be taken during the installation of the fire protection system into the wind turbine in order to ensure safe operation of the fire protection system. In the case of wind turbines with an integrated fire protection system, this can form part of the installation manual of the wind turbine.

The installation manual is only valid for one type of a fire protection system (precise type designation of the fire protection system, see [2.2.2.2], and its system approval number) in conjunction with one type of a wind turbine (which shall be stated); in some cases, the manual may also be valid for different versions of a type of wind turbine.

#### 3.3.1.2 Format of the installation manual

The format and level of detail of the installation manual shall be such that the technical personnel performing the required tasks are able to understand the documentation.

The installation manual contains the instructions, see [3.3.1.3], and the form sheet of the installation report, see [3.3.1.4], respectively.

In addition, IEC 82079-1, see /6/, shall be observed.

#### 3.3.1.3 Scope of the installation manual

At least the following information shall be contained concerning the type identification:

— manufacturer, supplier or importer and installer of the fire protection system or its subsystems
— precise type designation and the system approval number of the fire protection system or its subsystems, see [2.2.2.2]
— manufacturer, type designation, variant(s) and tower height(s) of the wind turbine.

All prerequisites for proper execution of the installation shall be specified and, if applicable, the maximum allowable wind speed(s) for installation work in the wind turbine shall be stated.

The installation manual shall state which work activities may only be performed by the manufacturer of the fire protection system, by approved installers for the active and passive fire protection systems or by trained personnel. In addition the required qualifications for the technical personnel shall be defined.

All working steps required for the installation and the corresponding components as well as material to be

installed shall be described. The auxiliary devices or tools shall be specified precisely.

All necessary drawings, specifications and instructions shall be contained or referenced and be available.

All required tests and checks as well as the expected results or measured values shall be listed.

Safety instructions and regulations for the prevention of accidents shall be placed in the text in such a way that they appear before the corresponding working step to be carried out. They shall be highlighted in order to be easily recognized as such, e.g.

- Warnings against hazardous situations as well as safety and accident-prevention measures shall be specified. If applicable countermeasures shall be stated.
- All situations that could arise if the installation does not proceed as planned shall be mentioned. The measures to be taken in each case shall be indicated.
- If extinguishing gases are used, the necessary safety rules shall be indicated.

#### 3.3.1.4 Form sheet for the installation report

The installation report is used to document the proper execution of all checks and all important working steps of the installation process. For each check and each important working step, there shall be appropriate fields to be filled in, together with fields for entering the measured values and check results.

All set values and nominal values, as well as expected measured values, shall be specified.

The installation report may consist of various sub-reports (e.g. for various assemblies or installation phases).

The following fields shall be provided as a minimum:

- type designation of the fire protection system (information concerning the type identification, see [3.3.1.3], including the serial number)
- details of the wind turbine (manufacturer, type, serial number and, if applicable, site)
- name of the person(s) carrying out the corresponding working step
- report of the execution of all working steps, tests and checks, see [3.3.1.3]
- extra space for possible remarks or items outstanding
- date and signature of the person(s) responsible for the installation.

## 3.3.2 Commissioning manual

#### 3.3.2.1 General

The commissioning manual describes all working steps which have to be performed during commissioning in order to ensure safe operation of the fire protection system.

The commissioning manual is only valid for one type of a fire protection system (precise type designation of the fire protection system, see [2.2.2.2], and its system approval number) in conjunction with one type of a wind turbine (which shall be stated); in some cases, the manual may also be valid for different versions of a type of wind turbine.

#### 3.3.2.2 Format of the commissioning manual

The format and level of detail of the installation manual shall be such that the technical personnel performing the required tasks are able to understand the documentation.

The commissioning manual contains the instructions, see [3.3.2.3], and the form sheet for the commissioning report, see [3.3.2.3].

In addition, IEC 82079-1, see /6/, shall be observed.

#### 3.3.2.3 Scope of the commissioning manual

At least the following information shall be contained concerning the type identification:

- manufacturer, supplier or importer of the fire protection system or its subsystems
- precise type designation and the system approval number of the fire protection system or its subsystems, see [2.2.2.2]

— manufacturer, type designation, variant(s) and/or tower height(s) of the wind turbine.

All prerequisites for proper execution of the commissioning shall be specified and, if applicable, the maximum allowable wind speed(s) for work in the wind turbine variant(s) shall be stated.

All checks to be carried out prior to the commissioning shall be listed.

The commissioning manual shall state which work activities may only be performed by the manufacturer of the fire protection system, by approved installers for the active and passive fire protection systems or by trained personnel. In addition the required qualifications for the technical personnel shall be defined.

All working steps required for the commissioning shall be described. The auxiliary devices (e.g. multimeter, manometer, equipment for testing smoke detectors) or tools shall be specified precisely.

All necessary drawings, specifications and instructions shall be contained or referenced and be available.

All required tests and checks as well as the expected results or measured values shall be listed. For each function test of the fire protection system the switching values to be set and criteria to be met shall be specified. At least the following tests shall be carried out:

— function of all sensors and switches; function of the fire protection system (without release of fire extinguishing agents)
— plausibility check of the behaviour of the wind turbine after triggering of the fire protection system
— simulation of simple malfunctions.

Safety instructions and regulations for the prevention of accidents shall be placed in the text in such a way that they appear before the corresponding working step to be carried out. They shall be highlighted in order to be easily recognized as such, e.g.

— Warnings against hazardous situations as well as safety and accident-prevention measures shall be specified. If applicable countermeasures shall be stated.
— All situations that could arise if the installation does not proceed as planned shall be mentioned. The measures to be taken in each case shall be indicated.
— If extinguishing gases are used, the necessary safety rules shall be indicated.

#### 3.3.2.4 Form sheet for the commissioning report

The commissioning report is used to document the proper execution of all checks and all important working steps of the commissioning process. For each check and important working step, there shall be appropriate fields to be filled in, together with fields for entering the measured values and check results.

All set values and nominal values, as well as expected measured values, shall be specified.

The commissioning report may consist of various sub-reports.

The following fields shall be provided as a minimum:

— type designation of the fire protection system (information concerning the type identification, see [3.3.2.3], including the serial number)
— details of the wind turbine (manufacturer, type, serial number and site)
— name of the person(s) carrying out the corresponding working step
— confirmation that all checks required before the start of commissioning, see [3.3.2.3], have been completed
— report of the execution of all working steps, tests and checks, see [3.3.2.3]
— extra space for possible remarks or items outstanding
— date and signature of the person(s) responsible for the commissioning.

### 3.3.3 Operating manual

#### 3.3.3.1 General

The operating manual is intended to provide the operator or his representative with the knowledge necessary for proper operation of the fire protection system. It shall be understandable that the operator

is able to initiate the necessary firefighting measures whenever needed.

The operating manual is only valid for one type of a fire protection system (precise type designation of the fire protection system, see [2.2.2.2], and its system approval number) in conjunction with one type of a wind turbine (which shall be stated); in some cases, the manual may also be valid for different versions of a type of wind turbine.

#### 3.3.3.2 Format of the operating manual

The format and level of detail of the operating manual shall be such that qualified personnel with technical training performing the required tasks are able to understand the instructions.

In addition, IEC 82079-1, see /6/, shall be observed.

#### 3.3.3.3 Scope of the operating manual

At least the following information shall be contained concerning the type identification:

— manufacturer, supplier or importer of the fire protection system or its subsystems
— precise type designation and the system approval number of the fire protection system or its subsystems, see [2.2.2.2]
— manufacturer, type designation, variant(s) and/or tower height(s) of the wind turbine.

Notes for users shall be provided and contain at least the information concerning the operation concept, all functions, states of the control and indicating equipment, see [3.2.2.2], if applicable, text messages of the control and indicating equipment and information or reference to the emergency procedure plans of the wind turbine type and the fire protection systems.

Warnings against hazardous situations shall be provided and contain at least the information concerning the danger caused by fire extinguishing agents (e.g. high gas pressure, toxic gases) and accident-prevention regulations.

Safety instructions and regulations for the prevention of accidents shall be so arranged in the text that they appear before the operating action in question. They shall be highlighted in order to be easily recognized as such.

Help with fault-finding shall be possible for the operator using the information provided in the operation manual. The operator should be capable of recognizing the cause of a malfunction and – insofar as it cannot be cleared simply by an operating action – of providing the qualified technical maintenance personnel with useful advance information without carrying out any repairs by themselves.

Checks or test procedures to be performed periodically in addition to the maintenance activities shall be described, if applicable.

For the aspects of occupational safety, please refer to the Note in [1.1.4].

### 3.3.4 Maintenance manual

#### 3.3.4.1 General

The maintenance manual describes all working steps which have to be performed during maintenance in order to ensure safe functioning of the fire protection system; this includes supervising actions, reconditioning, repairing, adjusting and cleaning.

The maintenance manual is only valid for one type of a fire protection system (precise type designation of the fire protection system, see [2.2.2.2], and its system approval number) in conjunction with one type of a wind turbine (which shall be stated); in some cases, the manual may also be valid for different versions of a type of wind turbine.

#### 3.3.4.2 Format of the maintenance manual

The format and level of detail of the maintenance manual shall be such that the technical personnel performing the required tasks are able to understand the documentation.

The maintenance manual contains the instructions, see [3.3.4.3], and the form sheet of the maintenance report, see [3.3.4.4].

In addition, IEC 82079-1, see /6/, shall be observed.

### 3.3.4.3 Scope of the maintenance manual

At least the following information shall be contained concerning the type identification:

- manufacturer, supplier or importer of the fire protection system or its subsystems
- precise type designation and the system approval number of the fire protection system or its subsystems, see [2.2.2.2]
- manufacturer, type designation, variant(s) and/or tower height(s) of the wind turbine.

All prerequisites for proper execution of the maintenance shall be specified (e.g. temperatures) and the maximum allowable maintenance wind speed(s) of the wind turbine variant(s) shall be stated.

The maintenance manual shall state which work activities may only be performed by the manufacturer of the fire protection system, by approved installers for the active and passive fire protection systems or by trained personnel. In addition the required qualifications for the technical personnel shall be defined.

The maintenance intervals which are required as a minimum shall be stated. It is recommendable to compile a maintenance and inspection plan presenting the work required in tabular form and in the appropriate time sequence. The maximum maintenance interval for portable fire extinguishers, see [3.2.2.4], is two years.

All working steps required for the maintenance shall be described. The auxiliary devices (e.g. multimeter, manometer, equipment for testing smoke detectors), tools, spare parts and auxiliary materials to be used shall be specified precisely.

All necessary drawings, specifications and instructions shall be contained or referenced and be available.

All required tests and checks as well as the expected results or measured values shall be listed. For each function test of the fire protection system the switching values to be set and criteria to be met shall be specified. At least the following tests shall be carried out:

- function of all sensors and switches; function of the fire protection system (without release of fire extinguishing agents)
- plausibility check of the behaviour of the wind turbine after triggering of the fire protection system.

Safety instructions and regulations for the prevention of accidents shall be placed in the text in such a way that they appear before the corresponding working step to be carried out. They shall be highlighted in order to be easily recognized as such.

- Warnings against hazardous situations as well as safety and accident-prevention measures shall be specified. If applicable countermeasures shall be stated.
- All situations that could arise if the installation does not proceed as planned shall be mentioned. The measures to be taken in each case shall be indicated.
- If extinguishing gases are used, the necessary safety rules shall be indicated.

If applicable, the investigations of technical experts and authorized persons, as required by the relevant national regulations (e.g. for pressure vessels of the fire-extinguishing systems) shall be included in the maintenance manual, and columns/sections shall be provided in the maintenance report for the confirmation that these investigations have been carried out.

All components and auxiliary materials of the fire protection system that have to be exchanged according to schedule during the operating life (e.g. hoses, gases and pressure vessels) shall be listed and the information about their quality and quantity shall be given. The intervals (operational lifetime) criteria for the exchange (special inspections) shall be specified.

### 3.3.4.4 Form sheet for the maintenance report

The maintenance report shall document the proper execution of all checks and important individual working steps of the maintenance process. For each check and working step, there shall be appropriate fields to be filled in, together with fields for recording measurement values and test results.

All adjustment settings and set values as well as the expected measurement results shall be specified.

The maintenance report may consist of several sub-reports.

The following fields shall be provided as a minimum:

- type designation of the fire protection system (information concerning the type identification, see [3.3.4.3], including the serial number)
- details of the wind turbine (manufacturer, type, serial number and site)
- name of the person(s) carrying out the corresponding working step
- record of the execution of all working steps, tests and checks in the corresponding intervals, see [3.3.4.3]
- parts replaced
- extra space for possible remarks or items outstanding
- date and signature of the person(s) responsible for the maintenance.

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**DNV GL**

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