



**SLOVENSKI STANDARD  
SIST EN IEC 61004-5:2020**

**01-oktober-2020**

---

**Sistemi za proizvodnjo energije na veter - 5. del: Rotorski listi vetrnih turbin (IEC 61400-5:2020)**

Wind energy generation systems - Part 5: Wind turbine blades (IEC 61400-5:2020)

Windenergieanlagen - Teil 5: Rotorblätter von Windenergieanlagen (IEC 61400-5:2020)

Systèmes de génération d'énergie éolienne - Partie 5: Pales d'éoliennes (IEC 61400-5:2020)

**ITeH STANDARD PREVIEW  
(standards.iteh.ai)**

**Ta slovenski standard je istoveten z: EN IEC 61400-5:2020**

SIST EN IEC 61004-5:2020  
<https://standards.iteh.ai/catalog/standards/sist/2e5591c3-2c39-42ea-982e-acb9359ed19c/sist-en-iec-61004-5-2020>

**ICS:**

27.180

Vetrne elektrarne

Wind turbine energy systems

**SIST EN IEC 61004-5:2020**

**en**

**iTeh STANDARD PREVIEW**  
**(standards.iteh.ai)**

[SIST EN IEC 61004-5:2020](#)

<https://standards.iteh.ai/catalog/standards/sist/2e5591c3-2c39-42ea-982e-acb9359ed19c/sist-en-iec-61004-5-2020>

EUROPEAN STANDARD

EN IEC 61400-5

NORME EUROPÉENNE

EUROPÄISCHE NORM

August 2020

ICS 27.180

English Version

## Wind energy generation systems - Part 5: Wind turbine blades (IEC 61400-5:2020)

Systèmes de génération d'énergie éolienne - Partie 5:  
Pales d'éoliennes  
(IEC 61400-5:2020)

Windenergieanlagen - Teil 5: Rotorblätter von  
Windenergieanlagen  
(IEC 61400-5:2020)

This European Standard was approved by CENELEC on 2020-07-21. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

(standards.iteh.ai)

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.



European Committee for Electrotechnical Standardization  
Comité Européen de Normalisation Electrotechnique  
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

**EN IEC 61400-5:2020 (E)****European foreword**

The text of document 88/759/FDIS, future edition 1 of IEC 61400-5, prepared by IEC/TC 88 "Wind energy generation systems" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 61400-5:2020.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2021-04-21
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2023-07-21

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

**iTeh STANDARD PREVIEW**  
**Endorsement notice**  
**(standards.iteh.ai)**

The text of the International Standard IEC 61400-5:2020 was approved by CENELEC as a European Standard without any modification.

## Annex ZA (normative)

### Normative references to international publications with their corresponding European publications

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: [www.cenelec.eu](http://www.cenelec.eu).

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60050-415	-	International Electrotechnical Vocabulary - Part 415: Wind turbine generator systems	-	-
IEC 61400-1	-	Wind energy generation systems - Part 1: Design requirements	EN IEC 61400-1	-
IEC 61400-2	-	Wind turbines - Part 2: Small wind turbines	EN 61400-2	-
IEC 61400-3-1	-	Wind energy generation systems - Part 3-1: Design requirements for fixed offshore wind turbines	EN IEC 61400-3-1	-
IEC 61400-3-2	-	Wind energy generation systems - Part 3-2: Design requirements for floating offshore wind turbines	-	-
IEC 61400-23	-	Wind turbines - Part 23: Full-scale structural testing of rotor blades	EN 61400-23	-
IEC 61400-24	-	Wind energy generation systems - Part 24: Lightning protection	EN IEC 61400-24	-
ISO/IEC 17021-1	-	Conformity assessment - Requirements for bodies providing audit and certification of management systems - Part 1: Requirements	EN ISO/IEC 17021-1	-
ISO 10474	-	Steel and steel products - Inspection documents	-	-
ISO 2394	-	General principles on reliability for structures	-	-
ISO 9000	-	Quality management systems - Fundamentals and vocabulary	EN ISO 9000	-

**EN IEC 61400-5:2020 (E)**

ISO 9001	-	Quality management systems - Requirements	-	EN ISO 9001	-
-	-	Metallic products - Types of inspection documents	-	EN 10204	-
ISO 16269-6	-	Statistical interpretation of data - Part 6: Determination of statistical tolerance intervals	-	-	-

## iTeh STANDARD PREVIEW (standards.iteh.ai)

[SIST EN IEC 61004-5:2020](https://standards.iteh.ai/catalog/standards/sist/2e5591c3-2c39-42ea-982e-acb9359ed19c/sist-en-iec-61004-5-2020)

<https://standards.iteh.ai/catalog/standards/sist/2e5591c3-2c39-42ea-982e-acb9359ed19c/sist-en-iec-61004-5-2020>



IEC 61400-5

Edition 1.0 2020-06

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE



Wind energy generation systems –  
Part 5: Wind turbine blades

Systemes de génération d'énergie éolienne –  
Partie 5: Pales d'éoliennes

STANDARD PREVIEW  
(standards.iteh.ai)

SIST EN IEC 61004-5:2020  
https://standards.iteh.ai/catalog/standards/sist/2e5591c3-2c39-42ea-982e-  
acb9359ed19c/sist-en-iec-61004-5-2020

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

COMMISSION  
ELECTROTECHNIQUE  
INTERNATIONALE

ICS 27.180

ISBN 978-2-8322-8335-6

**Warning! Make sure that you obtained this publication from an authorized distributor.**  
**Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

## CONTENTS

FOREWORD.....	4
INTRODUCTION.....	6
1 Scope.....	7
2 Normative references .....	7
3 Terms and definitions .....	8
4 Notation.....	10
4.1 Symbols.....	10
4.2 Greek symbols.....	11
4.3 Subscripts.....	11
4.4 Coordinate systems .....	11
5 Design environmental conditions .....	12
6 Design.....	13
6.1 Structural design process.....	13
6.1.1 General requirements .....	13
6.1.2 Building block approach for composite structural design .....	13
6.1.3 General blade design process .....	14
6.1.4 Design loads.....	17
6.2 Blade characteristics.....	18
6.2.1 Blade properties .....	18
6.2.2 Functional design tolerances .....	18
6.3 Aerodynamic design.....	19
6.3.1 General .....	19
6.3.2 Aerodynamic characteristics .....	19
6.3.3 Power performance characterisation (informative) .....	20
6.3.4 Airfoil noise (informative).....	20
6.4 Material requirements .....	20
6.4.1 General .....	20
6.4.2 Material properties for blade design .....	20
6.4.3 Qualification of materials for manufacture .....	24
6.5 Design for manufacturing .....	25
6.5.1 General .....	25
6.5.2 Requirement for manufacturing tolerances.....	25
6.6 Structural design.....	26
6.6.1 General design approach.....	26
6.6.2 Structural analysis .....	27
6.6.3 Verification requirements .....	29
6.6.4 Partial safety factors for materials .....	30
6.6.5 Structural design verification.....	34
6.6.6 Additional failure modes .....	47
7 Manufacturing requirements .....	48
7.1 Manufacturing process .....	48
7.2 Workshop requirements .....	48
7.2.1 General .....	48
7.2.2 Workshop facilities .....	49
7.2.3 Material handling and storage facilities .....	49
7.2.4 Tools and equipment .....	50



7.2.5	Personnel .....	51
7.3	Quality management system requirements .....	52
7.4	Manufacturing process requirements .....	52
7.4.1	General manufacturing requirements .....	52
7.4.2	Gelcoat application to the mould .....	52
7.4.3	Building up the laminate .....	53
7.4.4	Adhesive bonding process .....	54
7.4.5	Curing .....	55
7.4.6	Demoulding .....	55
7.4.7	Trimming, cutting, and grinding .....	55
7.4.8	Surface finish .....	56
7.4.9	Sealing .....	56
7.4.10	Additional component assembly processes .....	56
7.4.11	Mass and balance .....	57
7.4.12	Manufacturing and assembly processes outside controlled environment .....	57
7.5	Manufacture of natural fiber-reinforced rotor blades .....	57
7.6	Other manufacturing processes .....	58
7.7	Quality control process .....	58
7.7.1	Manufacturing quality plan .....	58
7.7.2	Incoming inspection .....	58
7.7.3	Manufacturing and quality control records .....	58
7.7.4	Non-conformity process .....	59
7.7.5	In manufacture corrective action processes .....	59
7.7.6	Final manufacturing inspection and conformity review .....	60
7.7.7	Documentation .....	60
7.8	Requirements for manufacturing evaluation .....	61
8	Blade Installation, operation and maintenance .....	62
8.1	General .....	62
8.2	Transportation, handling and installation .....	62
8.3	Maintenance .....	63
8.3.1	General .....	63
8.3.2	Scheduled inspections .....	63
	Figure 1 – Chordwise (flatwise, edgewise) coordinate system .....	11
	Figure 2 – Rotor (flapwise, lead-lag) coordinate system .....	12
	Figure 3 – The building block approach .....	13
	Figure 4 – Typical process for design and analytical evaluation of blade .....	15
	Figure 5 – Application of limit states design approach for blade verification .....	16
	Table 1 – Typical manufacturing effects .....	33

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**WIND ENERGY GENERATION SYSTEMS –****Part 5: Wind turbine blades****FOREWORD**

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 61400-5 has been prepared by IEC technical committee 88: Wind energy generation systems.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
88/759/FDIS	88/767/RVD

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

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

Future standards in this series will carry the new general title as cited above. Titles of existing standards in this series will be updated at the time of the next edition.

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

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

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

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

## iTeh STANDARD PREVIEW (standards.iteh.ai)

[SIST EN IEC 61004-5:2020](https://standards.iteh.ai/catalog/standards/sist/2e5591c3-2c39-42ea-982e-acb9359ed19c/sist-en-iec-61004-5-2020)

<https://standards.iteh.ai/catalog/standards/sist/2e5591c3-2c39-42ea-982e-acb9359ed19c/sist-en-iec-61004-5-2020>

## INTRODUCTION

The blades of a wind turbine rotor are generally regarded as one of the most critical components of the wind turbine system. In this International Standard, a minimum set of requirements for the design and manufacturing of wind turbine blades are defined.

An approach to a structural design process for the blade is set forth in the general areas of blade characteristics, aerodynamic design, material requirements and structural design. Furthermore, in order to efficiently facilitate the transfer of a blade design to the production environment, this document includes demands for designing for manufacturing.

The requirements for structural design of the wind turbine blade have been developed in a manner to reward innovation, validation, quality and testing. Specifically, the designer will be able claim lower partial safety factors based on, among other items, the diligence of the validation of models and the correlation to testing results.

To ensure a production environment that can facilitate the manufacturing of a blade in accordance with the design, the manufacturing requirements included in this document provide a minimum basis for a quality management system and workshop requirements. In addition, requirements for blade handling, operation and maintenance are described in the close of this document.

## **iTeh STANDARD PREVIEW** **(standards.iteh.ai)**

SIST EN IEC 61004-5:2020

<https://standards.iteh.ai/catalog/standards/sist/2e5591c3-2c39-42ea-982e-acb9359ed19c/sist-en-iec-61004-5-2020>

## WIND ENERGY GENERATION SYSTEMS –

### Part 5: Wind turbine blades

#### 1 Scope

This part of IEC 61400 specifies requirements to ensure the engineering integrity of wind turbine blades as well as an appropriate level of operational safety throughout the design lifetime. It includes requirements for:

- aerodynamic and structural design,
- material selection, evaluation and testing,
- manufacture (including associated quality management),
- transportation, installation, operation and maintenance of the blades.

The purpose of this document is to provide a technical reference for designers, manufacturers, purchasers, operators, third party organizations and material suppliers, as well as to define requirements for certification.

With respect to certification, this document provides the detailed basis for fulfilling the current requirements of the IECRE system, as well as other IEC standards relevant to wind turbine blades. When used for certification, the applicability of each portion of this document should be determined based on the extent of certification, and associated certification modules per the IECRE system.

SIST EN IEC 61004-5:2020

The rotor blade is defined as all components integrated in the blade design, excluding removable bolts in the blade root connection and support structures for installation.

This document is intended to be applied to rotor blades for all wind turbines. For rotor blades used on small wind turbines according to IEC 61400-2, the requirements in that document are applicable.

At the time this document was written, most blades were produced for horizontal axis wind turbines. The blades were mostly made of fiber reinforced plastics. However, most principles given in this document would be applicable to any rotor blade configuration, size and material.

#### 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

IEC 61400-1, *Wind energy generation systems – Part 1: Design requirements*

IEC 61400-2, *Wind turbines – Part 2: Small wind turbines*

IEC 61400-3-1, *Wind energy generation systems – Part 3-1: Design requirements for fixed offshore wind turbines*

IEC 61400-3-2, *Wind energy generation systems – Part 3-2: Design requirements for floating offshore wind turbines*

IEC 61400-23, *Wind turbines – Part 23: Full-scale structural testing of rotor blades*

IEC 61400-24, *Wind energy generation systems – Part 24: Lightning protection*

ISO/IEC 17021-1, *Conformity assessment – Requirements for bodies providing audit and certification of management systems – Part 1: Requirements*

ISO 10474, *Steel and steel products – Inspection documents*

ISO 2394, *General principles on reliability for structures*

ISO 9000, *Quality management systems – Fundamentals and vocabulary*

ISO 9001, *Quality management systems – Requirements*

EN 10204, *Metallic products – Types of inspection documents*

ISO 16269-6, *Statistical interpretation of data – Part 6: Determination of statistical tolerance intervals*

## iTeh STANDARD PREVIEW

### 3 Terms and definitions (standards.iteh.ai)

For the purposes of this document, the terms and definitions given in IEC 60050-415 and the following apply.

<https://standards.iteh.ai/catalog/standards/sist/2e5591c3-2c39-42ea-982e-ach9359ed19c/sist-en-iec-61004-5-2020>

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

#### 3.1

##### **blade root**

that part of the rotor blade that is connected to the hub/pitch-bearing of the rotor

#### 3.2

##### **blade subsystem**

integrated set of items that accomplish a defined objective or function within the blade (e.g., lightning protection subsystem, aerodynamic braking subsystem, monitoring subsystem, aerodynamic control subsystem, etc.)

#### 3.3

##### **buckling**

instability characterized by a non-linear increase in out of plane deflection with a change in local compressive load

#### 3.4

##### **characteristic value**

value having a prescribed probability of not being attained (i.e. an exceedance probability of less than or equal to a prescribed amount)

**3.5****chord**

length of a reference straight line that joins the leading and trailing edges of a blade aerofoil cross-section at a given spanwise location

**3.6****creep**

time-dependant increase in strain under a sustained load

**3.7****design limits**

maximum or minimum values used in a design

**3.8****design loads**

loads the blade is designed to withstand, including appropriate partial safety factors

**3.9****design properties**

material and geometric properties (including design limits)

**3.10****edgewise**

direction that is parallel to the local chord

**3.11****environmental conditions**

characteristics of the environment (wind, altitude, temperature, humidity, etc.) which may affect the wind turbine blade behaviour

**3.12****flapwise**

direction that is perpendicular to the surface swept by the undeformed rotor blade axis

**3.13****flatwise**

direction that is perpendicular to the local chord, and spanwise blade axis

**3.14****inboard**

towards the blade root

**3.15****lead-lag**

direction that is parallel to the plane of the swept surface and perpendicular to the longitudinal axis of the undeformed rotor blade

**3.16****limit state**

state of a structure and the loads acting upon it, beyond which the structure no longer satisfies the design requirement

**3.17****load envelope**

collection of maximum design loads in all directions and spanwise positions

ITeH STANDARD PREVIEW  
(standards.iteh.ai)

SIST EN IEC 61004-5:2020  
<https://standards.iteh.ai/catalog/standards/sist/2e5591c3-2c39-42ea-982e-acb9359ed19c/sist-en-iec-61004-5-2020>