

# INTERNATIONAL STANDARD



**Wind energy generation systems –  
Part 1: Design requirements**



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## Wind energy generation systems – Part 1: Design requirements

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# INTERNATIONAL ELECTROTECHNICAL COMMISSION

## WIND ENERGY GENERATION SYSTEMS –

### Part 1: Design requirements

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International Standard IEC 61400-1 has been prepared by IEC technical committee 88: Wind energy generation systems.

This fourth edition cancels and replaces the third edition published in 2005 and Amendment 1:2010. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) general update and clarification of references and requirements;
- b) extension of wind turbine classes to allow for tropical cyclones and high turbulence;
- c) Weibull distribution of turbulence standard deviation for normal turbulence model (NTM);
- d) updated design load cases (DLCs), in particular DLC 2.1 and 2.2;
- e) revision of partial safety factor specifications;
- f) major revision of Clauses 8, 10 and 11;

- g) introduction of cold climate requirements, Clause 14;
- h) new Annex B on design load cases for site-specific or special class S wind turbine design or site suitability assessment;
- i) new Annex J on prediction of the extreme wind speed of tropical cyclones by using Monte Carlo simulation method;
- j) new Annex K on calibration of structural material safety factors and structural design assisted by testing;
- k) new Annex L on assessment and effects of icing climate;
- l) new Annex M on medium wind turbines.

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

| FDIS        | Report on voting |
|-------------|------------------|
| 88/696/FDIS | 88/701/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.

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

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.

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.

A bilingual version of this publication may be issued at a later date.

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

## INTRODUCTION

This part of IEC 61400 outlines minimum design requirements for wind turbines and is not intended for use as a complete design specification or instruction manual.

Any of the requirements of this document may be altered if it can be suitably demonstrated that the safety of the system is not compromised. This provision, however, does not apply to the classification and the associated definitions of external conditions in Clause 6. Compliance with this document does not relieve any person, organization, or corporation from the responsibility of observing other applicable regulations.

This document is not intended to give requirements for wind turbines installed offshore, in particular for the support structure. For offshore installations, reference is made to the IEC 61400-3 series.

## WIND ENERGY GENERATION SYSTEMS –

### Part 1: Design requirements

#### 1 Scope

This part of IEC 61400 specifies essential design requirements to ensure the structural integrity of wind turbines. Its purpose is to provide an appropriate level of protection against damage from all hazards during the planned lifetime.

This document is concerned with all subsystems of wind turbines such as control and protection functions, internal electrical systems, mechanical systems and support structures.

This document applies to wind turbines of all sizes. For small wind turbines, IEC 61400-2 can be applied. IEC 61400-3-1 provides additional requirements to offshore wind turbine installations.

This document is intended to be used together with the appropriate IEC and ISO standards mentioned in Clause 2.

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

IEC 60038, *IEC standard voltages*

IEC 60071-1, *Insulation co-ordination – Part 1: Definitions, principles and rules*

IEC 60071-2, *Insulation co-ordination – Part 2: Application guidelines*

IEC 60076 (all parts), *Power transformers*

IEC 60204-1, *Safety of machinery – Electrical equipment of machines – Part 1: General requirements*

IEC 60204-11:2000, *Safety of machinery – Electrical equipment of machines – Part 11: Requirements for HV equipment for voltages above 1 000 V AC or 1 500 V DC and not exceeding 36 kV*

IEC 60364 (all parts), *Low voltage electrical installations*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 60664-1, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

IEC 60664-3, *Insulation coordination for equipment within low-voltage systems – Part 3: Use of coating, potting or moulding for protection against pollution*

IEC 60721 (all parts), *Classification of environmental conditions*

IEC 61000-6-2, *Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity standard for industrial environments*

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

IEC 61400-4, *Wind Turbines – Part 4: Design requirements for wind turbine gearboxes*

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

IEC 61439 (all parts), *Low-voltage switchgear and controlgear assemblies*

IEC 61800-4, *Adjustable speed electrical power drive systems – Part 4: General requirements – Rating specifications for AC power drive systems above 1 000 V AC and not exceeding 35 kV*

IEC 61800-5-1, *Adjustable speed electrical power drive systems – Part 5-1: Safety requirements – Electrical, thermal and energy*

IEC 62271 (all parts), *High-voltage switchgear and controlgear*

IEC 62305-3, *Protection against lightning – Part 3: Physical damage to structures and life hazard*

IEC 62305-4, *Protection against lightning – Part 4: Electrical and electronic systems within structures*

IEC 62477-1:2012, *Safety requirements for power electronic converter systems and equipment – Part 1: General*

ISO 76, *Rolling bearings – Static load ratings*

ISO 281, *Rolling bearings – Dynamic load ratings and rating life*

ISO 2394, *General principles on reliability for structures*

ISO 2533, *Standard Atmosphere*

ISO 4354, *Wind actions on structures*

ISO 6336-2, *Calculation of load capacity of spur and helical gears – Part 2: Calculation of surface durability (pitting)*

ISO 6336-3:2006, *Calculation of load capacity of spur and helical gears – Part 3: Calculation of tooth bending strength*

ISO 12494:2001, *Atmospheric icing on structures*

ISO 13850, *Safety of machinery – Emergency stop function – Principles for design*



ISO/TS 16281, *Rolling bearings – Methods for calculating the modified reference rating life for universally loaded bearings*

### 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

##### **annual average**

mean value of a set of measured data of sufficient size and duration to serve as an estimate of the expected value of the quantity

Note 1 to entry: The averaging time interval should be a whole number of years (e.g. 10) to average out non-stationary effects such as seasonality.

#### 3.2

##### **annual average wind speed**

$V_{ave}$

wind speed averaged according to the definition of annual average

#### 3.3

##### **auto-reclosing cycle**

event with a time period, varying from approximately 0,01 s to a few seconds, during which a breaker released after a grid fault is automatically reclosed and the line is reconnected to the network

#### 3.4

##### **blocking**

<wind turbines> use of a mechanical pin or other device (other than the ordinary mechanical brake) that cannot be released accidentally to prevent movement, for instance of the rotor shaft or yaw mechanism

#### 3.5

##### **brake**

<wind turbines> device capable of reducing the rotor speed or stopping rotation

Note 1 to entry: The brake may operate on, for example, aerodynamic, mechanical or electrical principles.

#### 3.6

##### **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)

#### 3.7

##### **complex terrain**

surrounding terrain that features significant variations in topography and terrain obstacles that may cause flow distortion

#### 3.8

##### **control functions**

<wind turbines> functions of the control system that, based on information about the condition of the wind turbine and/or its environment, adjust the turbine in order to maintain it within its operating limits