INTERNATIONAL STANDARD

IEC 61400-2

Second edition
2006-03

Wind turbines –

Part 2: Design requirements for small wind turbines

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International Electrotechnical Commission, 3, rue de Varembé, PO Box 131, CH-1211 Geneva 20, Switzerland
Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: inmail@iec.ch Web: www.iec.ch

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WIND TURBINES –

Part 2: Design requirements for small wind turbines

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 61400-2 has been prepared by IEC technical committee 88: Wind turbines.

This second edition cancels and replaces the first edition published in 1996. This edition constitutes a technical revision. Numerous substantive changes have been made. The most significant of these are:

– revised simplified equations based upon recent test and research results;
– several parameters in the simplified equations shall now be based upon test results;
– added option for use of aeroelastic models instead of simplified equations;
– expanded testing requirements.

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

FDIS	Report on voting
88/254/FDIS	88/259/RVD

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

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

IEC 61400 consists of the following parts, under the general title *Wind turbines*:

Part 1: Design requirements
Part 2: Design requirements for small wind turbines
Part 3: Design requirements for offshore wind turbines[1]
Part 11: Acoustic noise measurement techniques
Part 12: Wind turbine power performance testing
Part 12-1: Power performance measurements of electricity producing wind turbines
Part 13: Measurement of mechanical loads
Part 14: Declaration of apparent sound power level and tonality values
Part 21: Measurement and assessment of power quality characteristics of grid connected wind turbines
Part 23: Full-scale structural testing of rotor blades
Part 24: Lightning protection
Part 25-1: Communications for monitoring and control of wind power plants – Overall description of principles and models[1]
Part 25-2: Communications for monitoring and control of wind power plants – Information models[1]
Part 25-3: Communications for monitoring and control of wind power plants – Information exchange models[1]
Part 25-4: Communications for monitoring and control of wind power plants – Mapping to XML based communication profile[1]
Part 25-5: Communications for monitoring and control of wind power plants – Conformance testing[1]

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

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

[1] Under consideration.

WIND TURBINES –

Part 2: Design requirements for small wind turbines

1 Scope

This part of IEC 61400 deals with safety philosophy, quality assurance, and engineering integrity and specifies requirements for the safety of Small Wind Turbines (SWTs) including design, installation, maintenance and operation under specified external conditions. Its purpose is to provide the appropriate level of protection against damage from hazards from these systems during their planned lifetime.

This part of IEC 61400 is concerned with all subsystems of SWT such as protection mechanisms, internal electrical systems, mechanical systems, support structures, foundations and the electrical interconnection with the load.

While this part of IEC 61400 is similar to IEC 61400-1, it does simplify and make significant changes in order to be applicable to small turbines.

This part of IEC 61400 applies to wind turbines with a rotor swept area smaller than 200 m^2, generating at a voltage below 1 000 V a.c. or 1 500 V d.c.

This part of IEC 61400 should be used together with the appropriate IEC and ISO standards (see Clause 2).

2 Normative references

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

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

IEC 60034-2, *Rotating electrical machines – Part 2: Methods for determining losses and efficiency of rotating electrical machinery from tests (excluding machines for traction vehicles)*

IEC 60034-5, *Rotating electrical machines – Part 5: Degrees of protection provided by the integral design of rotating electrical machines (IP code) – Classification*

IEC 60034-8, *Rotating electrical machines – Part 8: Terminal markings and direction of rotation*

IEC 60038:1983, *IEC standard voltages*
Amendment 1 (1994)
Amendment 2 (1997)

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

IEC 60364-5-54, *Electrical installations of buildings – Part 5-54: Selection and erection of electrical equipment – Earthing arrangements, protective conductors and protective bonding conductors*

IEC 60721-2-1, *Classification of environmental conditions – Part 2-1: Environmental conditions appearing in nature – Temperature and humidity*

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

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

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

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

IEC 61643-1, *Low-voltage surge protective devices – Part 1: Surge protective devices connected to low-voltage power distribution systems – Requirements and tests*

ISO/IEC 17025:2005, *General requirements for the competence of testing and calibration laboratories*

ISO 2394, *General principles on reliability for structures*

3 Terms and definitions

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

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 The averaging time interval shall be an integer number of years to average out non-stationary effects such as seasonality.

3.2
annual average wind speed
wind speed averaged according to the definition of annual average

3.3
auto-reclosing cycles
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
brake (for wind turbines)
device capable of reducing the rotor speed or stopping rotation

3.5
catastrophic failure (for wind turbines)
disintegration or collapse of a component or structure, that results in loss of vital function which impairs safety

3.6
characteristic value (of a material property)
value having a prescribed probability of not being attained in a hypothetical unlimited test series

3.7
control system (for wind turbines)
sub-system that receives information about the condition of the wind turbine and/or its environment and adjusts the turbine in order to maintain it within its operating limits

3.8
cut-in wind speed
V_{in}
lowest mean wind speed at hub height at which the wind turbine produces power

3.9
cut-out wind speed
V_{out}
highest mean wind speed at hub height at which the wind turbine is designed to produce power

3.10
design limits
maximum or minimum values used in a design

3.11
design situation
possible mode of wind turbine operation, for example power production, parking, etc.

3.12
design wind speed
wind speed used as input for the simple design equations (equal to 1,4 V_{ave})

3.13
downwind
in the main wind direction

3.14
emergency shutdown (for wind turbines)
rapid shutdown of the wind turbine triggered by a protection system or by manual intervention

3.15
environmental conditions
characteristics of the environment (altitude, temperature, humidity, etc.) which may affect the turbine system behaviour

3.16
external conditions (for wind turbines)
factors affecting the operation of a wind turbine including the wind regime, other climatic factors (snow, ice, etc.), earthquake and power network conditions

3.17
extreme wind speed
highest average wind speed, averaged over t seconds, that is likely to be experienced within a specified time period (recurrence period) of T years

NOTE Recurrence periods of T = 50 years and T = 1 year and averaging time interval of t = 3 s and t = 10 min are used in a number of standards. In popular language, the less precise term "survival wind speed" is often used. In practice, however, the wind turbine generator system is designed using the extreme wind speed for design load cases.

3.18
fail-safe
design property of an item which prevents its failures from resulting in critical faults

3.19
furling
a passive overspeed control mechanism by means of reducing the projected swept area

3.20
gust
sudden and brief increase of the wind speed over its mean value.

NOTE A gust can be characterized by its rise-time, its amplitude and its duration.

3.21
horizontal axis wind turbine
wind turbine whose rotor axis is substantially parallel to the wind flow

3.22
hub (for wind turbines)
fixture for attaching the blades or blade assembly to the rotor shaft

3.23
hub height (for wind turbines)
height of the centre of the wind turbine rotor above the terrain surface. For a vertical axis wind turbine, the hub height is the height of the equator plane

3.24
idling (for wind turbines)
condition of a wind turbine that is rotating slowly and not producing power

3.25
limit state
state of a structure and the loads acting upon it beyond which the structure no longer satisfies the design requirement

[ISO 2394, 2.2.9, modified]

NOTE The purpose of design calculations (i.e. the design requirement for the limit state) is to keep the probability of a limit state being reached below a certain value prescribed for the type of structure in question (ISO 2394).

3.26
load case
combination of a design situation and an external condition which results in structural loading

3.27
logarithmic wind shear law
a mathematical law which expresses wind speed variations as a logarithmic function of height above ground

3.28
mean wind speed
statistical mean of the instantaneous value of the wind speed averaged over a given time period which can vary from a few seconds to many years

3.29
nacelle
housing which contains the drive-train and other elements on top of a horizontal axis wind turbine tower

3.30
normal shutdown (for wind turbines)
shutdown in which all stages are under the control of the control system

3.31
operating limits
set of conditions defined by the SWT designer that govern the activation of the control and protection system

3.32
parked wind turbine
depending on the construction of the wind turbine, parked refers to the turbine being either in a stand-still or an idling condition

3.33
parking
situation to which a wind turbine returns after a normal shutdown

3.34
power law for wind shear
a mathematical law which expresses wind speed variations as a power law function of height above ground

3.35
power output
power delivered by a device in a specific form and for a specific purpose

NOTE For wind turbines, this is the electric power delivered by a wind turbine.

3.36
protection system (wind turbine)
system which ensures that a wind turbine generator system remains within the design limits

3.37
Rayleigh distribution
a probability distribution function often used for wind speeds. The distribution depends on one adjustable parameter – the scale parameter, which controls the average wind speed

NOTE The Rayleigh distribution is identical to a Weibull distribution (see 3.55) with shape parameter 2.

3.38
reference wind speed
V_{ref}
basic parameter for wind speed used for defining SWT classes. Other design related climatic parameters are derived from the reference wind speed and other basic SWT class parameters

NOTE A turbine designed for a SWT class with a reference wind speed, V_{ref}, is designed to withstand climates for which the extreme 10 min average wind speed with a recurrence period of 50 years at turbine hub height is lower than or equal to V_{ref} (see 3.17).

3.39
resonance
phenomenon appearing in an oscillating system, in which the period of a forced oscillation is very close to that of free oscillation

3.40
rotor speed (for wind turbines)
rotational speed of a wind turbine rotor about its axis

3.41
roughness length
extrapolated height at which the mean wind speed becomes zero if the vertical wind profile is assumed to have a logarithmic variation with height

3.42
safe life
prescribed service life with a declared probability of catastrophic failure

3.43
scheduled maintenance
preventive maintenance carried out in accordance with an established time schedule

3.44
shutdown (for wind turbines)
transitional state of a wind turbine between power production and standstill or idling

3.45
standstill
condition of a wind turbine generator system that is stopped

3.46
support structure (for wind turbines)
part of a wind turbine comprising the tower and foundation

3.47
survival wind speed (deprecated)
a popular name for the maximum wind speed that a construction is designed to withstand

NOTE This term is not used in the IEC 61400 series; the design conditions instead refer to extreme wind speed (see 3.17).