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Edition 3.1 2014-04

CONSOLIDATED VERSION

colour inside

Wind turbines –
Part 1: Design requirements

IEC 61400-1:2005-08+AMD1:2010-10 CSV(en)

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IEC 61400-1:2005-08+AMD1:2010-10 CSV(en)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FOREWORD

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This Consolidated version of IEC 61400-1 bears the edition number 3.1. It consists of the third edition (2005-08) [documents 88/228/FDIS and 88/232/RVD] and its amendment 1 (2010-10) [documents 88/374/FDIS and 88/378/RVD]. The technical content is identical to the base edition and its amendment.

In this Redline version, a vertical line in the margin shows where the technical content is modified by amendment 1. Additions and deletions are displayed in red, with deletions being struck through. A separate Final version with all changes accepted is available in this publication.

This publication has been prepared for user convenience.

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

The main changes with respect to the previous edition are listed below:

– the title has been changed to “Design requirements” in order to reflect that the standard presents safety requirements rather than requirements for safety or protection of personnel;
– wind turbine class designations have been adjusted and now refer to reference wind speed and expected value of turbulence intensities only;
– turbulence models have been expanded and include an extreme turbulence model;
– gust models have been adjusted and simplified;
– design load cases have been rearranged and amended;
– the inclusion of turbulence simulations in the load calculations is emphasised and a scheme for extreme load extrapolation has been specified;
– the partial safety factors for loads have been adjusted and simplified;
– the partial safety factors for materials have been amended and specified in terms of material types and component classes;
– the requirements for the control and protection system have been amended and clarified in terms of functional characteristics;
– a new clause on assessment of structural and electrical compatibility has been introduced with detailed requirements for assessment, including information on complex terrain, earthquakes and wind farm wake effects.

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

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

The committee has decided that the contents of the base publication and its amendment will remain unchanged until the stability 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.

The contents of the corrigendum of February 2016 have been included in this copy.

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 publication 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 standard 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 standard does not relieve any person, organization, or corporation from the responsibility of observing other applicable regulations.

The standard is not intended to give requirements for wind turbines installed offshore, in particular for the support structure. A future document dealing with offshore installations is under consideration.

WIND TURBINES –

Part 1: Design requirements

1 Scope

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

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

This standard applies to wind turbines of all sizes. For small wind turbines IEC 61400-2 may be applied.

This standard should be used together with the appropriate IEC and ISO standards mentioned in 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 60204-1~~:1997~~, *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 a.c. or 1 500 V d.c. and not exceeding 36 kV*

IEC 60364 (all parts), *Low-voltage electrical installations ~~of buildings~~*

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~~:1982~~, *Classification of environmental conditions – Part 2: Environmental conditions appearing in nature. Temperature and humidity*

IEC 61000-6-1~~:1997~~, *Electromagnetic compatibility (EMC) – Part 6-1: Generic standards – ~~Section 1:~~ Immunity for residential, commercial and light-industrial environments*

IEC 61000-6-2~~:1999~~, *Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – ~~Section 2:~~ Immunity for industrial environments*

IEC 61000-6-4~~:1997~~, *Electromagnetic compatibility (EMC) – Part 6-4: Generic standards – ~~Section 4:~~ Emission standard for industrial environments*

~~IEC 61024-1:1990, *Protection of structures against lightning – Part 1: General principles*~~

~~IEC 61312-1:1995, *Protection against lightning electromagnetic impulse – Part 1: General principle*~~

IEC 61400-2, *Wind turbines – Part 2: Design requirements for small wind turbines*

IEC 61400-21~~:2001~~, *Wind turbines ~~generator systems~~ – Part 21: Measurement and assessment of power quality characteristics of grid connected wind turbines*

IEC 61400-24~~: 2002~~, *Wind turbines ~~generator systems~~ – Part 24: Lightning protection*

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*

ISO 76:~~1987~~ 2006, *Rolling bearings – Static load ratings*

ISO 281~~:1990~~, *Rolling bearings – Dynamic load ratings and rating life*

ISO 2394:1998, *General principles on reliability for structures*

ISO 2533:1975, S*tandard Atmosphere*

ISO 4354:1997, *Wind actions on structures*

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

~~ISO 9001:2000, *Quality management systems – Requirements*~~

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

ISO 81400-4, *Wind turbines – Part 4: Design and specification of gearboxes*

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. The averaging time interval should be a whole number of years 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 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 and protection 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

3.9
cut-in wind speed
V_{in}
lowest wind speed at hub height at which the wind turbine starts to produce power in the case of steady wind without turbulence

3.10
cut-out wind speed
V_{out}
highest wind speed at hub height at which the wind turbine is designed to produce power in the case of steady wind without turbulence

3.11
design limits
maximum or minimum values used in a design

3.12
dormant failure
failure of a component or system which remains undetected during normal operation

3.13
downwind
in the direction of the main wind vector

3.14
electrical power network
particular installations, substations, lines or cables for the transmission and distribution of electricity