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WIND TURBINES –

Part 13: Measurement of mechanical loads

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This International Standard IEC 61400-13 has been prepared by IEC technical committee 88: Wind turbines.

This standard replaces IEC TS 61400-13 published in 2001. This first edition constitutes a technical revision and transition from technical specification to International Standard.

This first edition includes the following changes with respect to the technical specification:

- a) scope of the document focused to load measurements for the purpose of model validation;
- b) number of measurement load cases to match the new scope reduced;
- c) capture matrix requirements to match the new scope reduced;
- d) requirements to address the state of the art technology updated.

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

CDV	Report on voting
88/511/CDV	88/554/RVC

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.

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INTRODUCTION

In the process of structural design of a wind turbine, thorough understanding about, and accurate quantification of, the loading is of utmost importance.

In the design stage, loads can be predicted with aeroelastic models and codes. However, such models have their shortcomings and uncertainties, and they always need to be validated by measurement.

Mechanical load measurements can be used both as the basis for design and as the basis for certification. Design aspects for wind turbines are covered by IEC 61400-1 whilst certification procedures are described in IEC 61400-22. This standard is aimed at the test institute, the turbine manufacturer and the certifying body and clearly defines the minimum requirements for a mechanical loads test resulting in consistent, high quality reproducible test results.

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WIND TURBINES –

Part 13: Measurement of mechanical loads

1 Scope

This part of the IEC 61400 describes the measurement of fundamental structural loads on wind turbines for the purpose of the load simulation model validation. The standard prescribes the requirements and recommendations for site selection, signal selection, data acquisition, calibration, data verification, measurement load cases, capture matrix, post-processing, uncertainty determination and reporting. Informative annexes are also provided to improve understanding of testing methods.

The methods described in this document can also be used for mechanical loads measurements for other purposes such as obtaining a measured statistical representation of loads, direct measurements of the design loads, safety and function testing, or measurement of component loads. If these methods are used for an alternative objective or used for an unconventional wind turbine design, the required signals, measurement load cases, capture matrix, and post processing methods should be evaluated and if needed adjusted to fit the objective.

These methods are intended for onshore electricity-generating, horizontal-axis wind turbines (HAWTs) with rotor swept areas of larger than 200 m². However, the methods described may be applicable to other wind turbines (for example, small wind turbines, ducted wind turbines, vertical axis wind turbines).

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2 Normative references

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

IEC 60050 (all parts), *International Electrotechnical Vocabulary* (available at <<http://www.electropedia.org/>>)

IEC 61400-1:2005, *Wind turbines – Part 1: Design requirements*

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

ISO/IEC Guide 98-3, *Uncertainty of measurement – Part 3: Guide to the expression of uncertainty in measurement*

3 Terms and definitions

For the purposes of this document, the terms and definitions related to wind turbine systems or wind energy in general of IEC 60050-415 as well as the following apply.

3.1

blade

rotating aerodynamically active part of the rotor

3.2**blade root**

that part of the blade that is connected to the hub of the rotor

3.3**brake status**

status indicating if the brake is applied or not

3.4**calibration**

determination of the transfer function and its coefficients from sensor output to the physical value

3.5**capture matrix**

organization of the measured time series according to their mean wind speeds and turbulence intensities

3.6**chord line**

imaginary straight line that joins the leading and trailing edges of a blade airfoil cross-section

3.7**cut-in wind speed**

lowest wind speed at hub height at which the wind turbine starts to produce power in the case of steady wind without turbulence

3.8**cut-out wind speed**

highest wind speed at hub height at which the wind turbine is designed to produce power in the case of steady wind without turbulence

3.9**design loads**

loads that the turbine is designed to withstand

Note 1 to entry: They are obtained by applying the appropriate partial load factors to the characteristic values.

3.10**edgewise**

direction that is parallel to the local chord

Note 1 to entry: In contrast, lead lag is the direction that is parallel to the plane of the swept surface and perpendicular to the longitudinal axis of the undeformed rotor blade.

3.11**flatwise**

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

Note 1 to entry: In contrast, flapwise is the direction that is perpendicular to the surface swept by the undeformed rotor blade axis.

3.12**hub**

fixture for attaching the blades or blade assembly to the main shaft

3.13**nacelle**

housing which contains the drive train and other equipment on the top of a HAWT tower

3.14
natural frequency
eigenfrequency

frequency at which a structure will choose to vibrate when perturbed and allowed to vibrate freely

3.15
outboard

towards the blade tip

3.16
parked wind turbine

depending on the design of the wind turbine, parked refers to the turbine being either in a standstill or an idling condition

3.17
rated power

quantity of power assigned, generally by a manufacturer, for a specified operating condition of a component, device or equipment

Note 1 to entry: Maximum continuous electrical power output which a wind turbine is designed to achieve under normal operating and external conditions.

3.18
rated wind speed

minimum wind speed at hub height at which a wind turbine's rated power is achieved in the case of steady wind without turbulence

3.19
reference wind speed

basic parameter for wind speed used for defining wind turbine classes

Note 1 to entry: Other design related climatic parameters are derived from the reference wind speed and other basic wind turbine class parameters.

Note 2 to entry: A turbine designed for a wind turbine 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} .

3.20
rotor centre

point on the main shaft in the plane perpendicular to the main shaft that contains the blade co-ordinate origin of the reference blade

3.21
rotor plane

plane perpendicular to the main shaft and which includes the rotor centre

3.22
steady-state operation

state of operation of the turbine during which it remains in a steady state such as during power production, power production + fault condition and when parked and for which the external conditions remain essentially steady

3.23
transient event

event during which the state of operation of the wind turbine changes, such as during shutdown