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INTERNATIONAL STANDARD

colour inside

Wind turbines –
Part 23: Full-scale structural testing of rotor blades

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WIND TURBINES –

Part 23: Full-scale structural testing of rotor blades

FOREWORD

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International Standard IEC 61400-23 has been prepared by IEC technical committee 88: Wind turbines.

This first edition cancels and replaces IEC TS 61400-23, published in 2001. It constitutes a technical revision.

This edition includes the following significant technical changes with respect to IEC TS 61400-23:

a) description of load based testing only;

b) condensation to describe the general principles and demands.

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

CDV	Report on voting
88/420/CDV	88/448/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.

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

The committee has decided that the contents of this publication 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- withdrawn,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.

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

The blades of a wind turbine rotor are generally regarded as one of the most critical components of the wind turbine system. In this standard, the demands for full-scale structural testing related to certification are defined as well as the interpretation and evaluation of test results.

Specific testing methods or set-ups for testing are not demanded or included as full-scale blade testing methods historically have developed independently in different countries and laboratories.

Furthermore, demands for tests determining blade properties are included in this standard in order to validate some vital design assumptions used as inputs for the design load calculations.

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.

The standard is based on IEC TS 61400-23 published in 2001. Compared to the TS, this standard only describes load based testing and is condensed to describe the general principles and demands.

WIND TURBINES –

Part 23: Full-scale structural testing of rotor blades

1 Scope

This part of IEC 61400 defines the requirements for full-scale structural testing of wind turbine blades and for the interpretation and evaluation of achieved test results. The standard focuses on aspects of testing related to an evaluation of the integrity of the blade, for use by manufacturers and third party investigators.

The following tests are considered in this standard:

- static load tests;
- fatigue tests;
- static load tests after fatigue tests;
- tests determining other blade properties.

The purpose of the tests is to confirm to an acceptable level of probability that the whole population of a blade type fulfils the design assumptions.

It is assumed that the data required to define the parameters of the tests are available and based on the standard for design requirements for wind turbines such as IEC 61400-1 or equivalent. Design loads and blade material data are considered starting points for establishing and evaluating the test loads. The evaluation of the design loads with respect to the actual loads on the wind turbines is outside the scope of this standard.

At the time this standard was written, full-scale tests were carried out on blades of horizontal axis wind turbines. The blades were mostly made of fibre reinforced plastics and wood/epoxy. However, most principles would be applicable to any wind turbine configuration, size and material.

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 60050-415:1999, *International Electrotechnical Vocabulary – Part 415: Wind turbine generator systems*

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

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

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

3 Terms and definitions

For the purposes of this document, the terms and definitions related to wind turbines or wind energy given in IEC 60050-415 and the following apply.

3.1
actuator
device that can be controlled to apply a constant or varying force and displacement

3.2
blade root
that part of the rotor blade that is connected to the hub of the rotor

3.3
blade subsystem
integrated set of items that accomplishes a defined objective or function within the blade (e.g., lightning protection subsystem, aerodynamic braking subsystem, monitoring subsystem, aerodynamic control subsystem, etc.)

3.4
buckling
instability characterized by a non-linear increase in out of plane deflection with a change in local compressive load

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
constant amplitude loading
during a fatigue test, the application of load cycles with a constant amplitude and mean value

3.7
creep
time-dependant increase in strain under a sustained load

3.8
design loads
loads the blade is designed to withstand, including appropriate partial safety factors

3.9
edgewise
direction that is parallel to the local chord

SEE: 4.4.

3.10
elastic axis
the line, lengthwise of the blade, along which transverse loads are applied in order to produce bending only, with no torsion at any section

Note 1 to entry: Strictly speaking, no such line exists except for a few conditions of loading. Usually the elastic axis is assumed to be the line that passes through the elastic center of every section. This definition is not applicable for blades with bend-twist coupling.

3.11
fatigue formulation
methodology by which the fatigue life is estimated

3.12
fatigue test
test in which a cyclic load of constant or varying amplitude is applied to the test specimen

3.13
fixture
component or device to introduce loads or to support the test specimen

3.14
flapwise
direction that is perpendicular to the surface swept by the undeformed rotor blade axis

SEE: 4.4.

3.15
flatwise
direction that is perpendicular to the local chord, and spanwise blade axis

SEE: 4.4.

3.16
full-scale test
test carried out on the actual blade or part thereof

3.17
inboard
towards the blade root

3.18
lead-lag
direction that is parallel to the plane of the swept surface and perpendicular to the longitudinal axis of the undeformed rotor blade

SEE 4.4.

3.19
load envelope
collection of maximum design loads in all directions and spanwise positions

3.20
natural frequency
eigen frequency
frequency at which a structure will vibrate when perturbed and allowed to vibrate freely

3.21
partial safety factors
factors that are applied to loads and material strengths to account for uncertainties in the representative (characteristic) values

3.22
prebend
blade curvature in the flapwise plane in the unloaded condition

3.23
R-value
ratio between minimum and maximum value during a load cycle