

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Wind turbines –
Part 3: Design requirements for offshore wind turbines**

**Eoliennes –
Partie 3: Exigences de conception des éoliennes en pleine mer**

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WIND TURBINES –

Part 3: Design requirements for offshore wind turbines

FOREWORD

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International Standard IEC 61400-3 has been prepared by IEC technical committee 88: Wind turbines.

This part is to be read in conjunction with IEC 61400-1:2005, *Wind turbines – Part 1: Design requirements*.

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

FDIS	Report on voting
88/329/FDIS	88/338/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.

A list of all parts of 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 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

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- withdrawn,
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INTRODUCTION

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

Several different parties may be responsible for undertaking the various elements of the design, manufacture, assembly, installation, erection, commissioning, operation and maintenance of an offshore wind turbine and for ensuring that the requirements of this standard are met. The division of responsibility between these parties is a contractual matter and is outside the scope of this standard.

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

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WIND TURBINES –

Part 3: Design requirements for offshore wind turbines

1 Scope

This part of IEC 61400 specifies additional requirements for assessment of the external conditions at an offshore wind turbine site and it specifies essential design requirements to ensure the engineering integrity of offshore wind turbines. Its purpose is to provide an appropriate level of protection against damage from all hazards during the planned lifetime.

This standard focuses on the engineering integrity of the structural components of an offshore wind turbine but is also concerned with subsystems such as control and protection mechanisms, internal electrical systems and mechanical systems.

A wind turbine shall be considered as an offshore wind turbine if the support structure is subject to hydrodynamic loading. The design requirements specified in this standard are not necessarily sufficient to ensure the engineering integrity of floating offshore wind turbines.

This standard should be used together with the appropriate IEC and ISO standards mentioned in Clause 2. In particular, this standard is fully consistent with the requirements of IEC 61400-1. The safety level of the offshore wind turbine designed according to this standard shall be at or exceed the level inherent in IEC 61400-1. In some clauses, where a comprehensive statement of requirements aids clarity, replication of text from IEC 61400-1 is included.

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 60721-2-1:1982, *Classification of environmental conditions – Part 2-1: Environmental conditions appearing in nature. Temperature and humidity*
Amendment 1:1987

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

IEC 62305-3:2006, *Protection against lightning – Part 3: Physical damage to structures and life hazard*

IEC 62305-4:2006, *Protection against lightning – Part 4: Electrical and electronic systems within structures*

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

ISO 2533:1975, *Standard Atmosphere*

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

ISO 19900:2002, *Petroleum and natural gas industries – General requirements for offshore structures*

ISO 19901-1:2005, *Petroleum and natural gas industries – Specific requirements for offshore structures – Part 1: Metocean design and operating conditions*

ISO 19901-4:2003, *Petroleum and natural gas industries – Specific requirements for offshore structures – Part 4: Geotechnical and foundation design considerations*

ISO 19902, *Petroleum and natural gas industries – Fixed steel offshore structures*

ISO 19903: 2006, *Petroleum and natural gas industries – Fixed concrete offshore structures*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply in addition to those stated in IEC 61400-1.

3.1

co-directional (wind and waves)

acting in the same direction

3.2

current

flow of water past a fixed location usually described in terms of a current speed and direction

3.3

design wave

deterministic wave with a defined height, period and direction, used for the design of an offshore structure. A design wave may be accompanied by a requirement for the use of a particular periodic wave theory

3.4

designer

party or parties responsible for the design of an offshore wind turbine

3.5

environmental conditions

characteristics of the environment (wind, waves, sea currents, water level, sea ice, marine growth, scour and overall seabed movement, etc.) which may affect the wind turbine behaviour

3.6

external conditions (wind turbines)

factors affecting operation of an offshore wind turbine, including the environmental conditions, the electrical network conditions, and other climatic factors (temperature, snow, ice, etc.)

3.7

extreme significant wave height

expected value of the highest significant wave height, averaged over 3 h, with an annual probability of exceedance of $1/N$ ("recurrence period": N years)

3.8

extreme wave height

expected value of the highest individual wave height (generally the zero up-crossing wave height) with an annual probability of exceedance of $1/N$ ("recurrence period": N years)

3.9
fast ice cover
 rigid continuous cover of ice not in motion

3.10
fetch
 distance over which the wind blows constantly over the sea with approximately constant wind speed and direction

3.11
foundation
 part of an offshore wind turbine support structure which transfers the loads acting on the structure into the seabed. Different foundation concepts are shown in Figure 1 together with the other parts of an offshore wind turbine

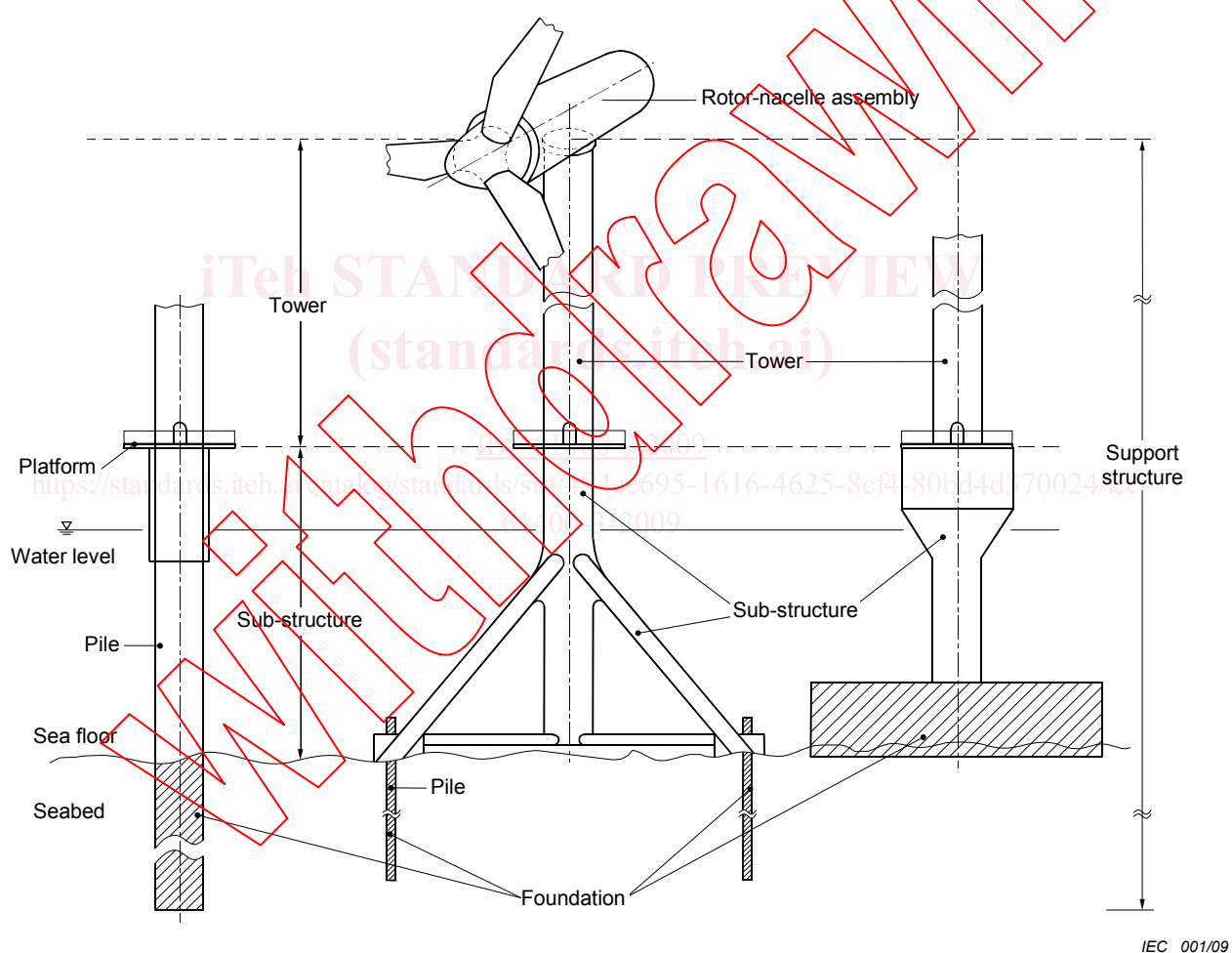


Figure 1 – Parts of an offshore wind turbine

3.12
highest astronomical tide
 highest still water level that can be expected to occur under any combination of astronomical conditions and under average meteorological conditions. Storm surges, which are meteorologically generated and essentially irregular, are superimposed on the tidal variations, so that a total still water level above highest astronomical tide may occur

3.13**hindcasting**

method of simulating historical (metocean) data for a region through numerical modelling

3.14**hub height (wind turbines)**

height of the centre of the swept area of the wind turbine rotor above the mean sea level

3.15**hummocked ice**

crushed ice and ice floes piled up into ridges when large ice floes meet with each other or with a rigid obstacle, for example an offshore wind turbine support structure

3.16**ice floe**

sheet of ice in size from metres to several kilometres, not rigidly frozen to a shore, still or in motion

3.17**icing**

build-up of a cover of ice or frost on parts of an offshore wind turbine that can result in added loads and/or changed properties

3.18**land-locked waters**

waters almost or entirely surrounded by land

3.19**load effect**

effect of a single load or combination of loads on a structural component or system, for example internal force, stress, strain, motion, etc.

3.20**lowest astronomical tide**

lowest still water level that can be expected to occur under any combination of astronomical conditions and under average meteorological conditions. Storm surges, which are meteorologically generated and essentially irregular, are superimposed on the tidal variations, so that a total still water level below lowest astronomical tide may occur

3.21**manufacturer**

party or parties responsible for the manufacture and construction of an offshore wind turbine

3.22**marine conditions**

characteristics of the marine environment (waves, sea currents, water level, sea ice, marine growth, seabed movement and scour, etc.) which may affect the wind turbine behaviour

3.23**marine growth**

surface coating on structural components caused by plants, animals and bacteria

3.24**mean sea level**

average level of the sea over a period of time long enough to remove variations due to waves, tides and storm surges

3.25

mean zero crossing period

average period of the zero-crossing (up or down) waves in a sea state

3.26

metocean

abbreviation of meteorological and oceanographic

3.27

multi-directional (wind and/or wave)

distribution of directions

3.28

offshore wind turbine

wind turbine with a support structure which is subject to hydrodynamic loading

3.29

offshore wind turbine site

the location or intended location of an individual offshore wind turbine either alone or within a wind farm

3.30

pile penetration

vertical distance from the sea floor to the bottom of the pile

3.31

power collection system (wind turbines)

electric system that collects the power from one or more wind turbines. It includes all electrical equipment connected between the wind turbine terminals and the network connection point. For offshore wind farms, the power collection system may include the connection to shore

3.32

reference period

period during which stationarity is assumed for a given stochastic process, for example wind speed, sea elevation or response

3.33

refraction

process by which wave energy is redistributed as a result of changes in the wave propagation velocity due to variations in water depth and/or current velocity

3.34

residual currents

components of a current other than tidal current. The most important is often the storm surge current

3.35

rotor – nacelle assembly

part of an offshore wind turbine carried by the support structure, refer to Figure 1

3.36

sea floor

interface between the sea and the seabed

3.37**sea floor slope**

local gradient of the sea floor, for example associated with a beach

3.38**sea state**

condition of the sea in which its statistics remain stationary

3.39**seabed**

materials below the sea floor in which a support structure is founded

3.40**seabed movement**

movement of the seabed due to natural geological processes

3.41**scour**

removal of seabed soils by currents and waves or caused by structural elements interrupting the natural flow regime above the sea floor

3.42**significant wave height**

statistical measure of the height of waves in a sea state, defined as $4 \times \sigma_\eta$ where σ_η is the standard deviation of the sea surface elevation. In sea states with only a narrow band of wave frequencies, the significant wave height is approximately equal to the mean height of the highest third of the zero up-crossing waves

3.43**splash zone**

external region of support structure that is frequently wetted due to waves and tidal variations. This shall be defined as the zone between

- the highest still water level with a recurrence period of 1 year increased by the crest height of a wave with height equal to the significant wave height with a return period of 1 year, and
- the lowest still water level with a recurrence period of 1 year reduced by the trough depth of a wave with height equal to the significant wave height with a return period of 1 year

3.44**still water level**

abstract water level calculated by including the effects of tides and storm surge but excluding variations due to waves. Still water level can be above, at, or below mean sea level

3.45**storm surge**

irregular movement of the sea brought about by wind and atmospheric pressure variations

3.46**sub-structure**

part of an offshore wind turbine support structure which extends upwards from the seabed and connects the foundation to the tower, refer to Figure 1

3.47**support structure**

part of an offshore wind turbine consisting of the tower, sub-structure and foundation, refer to Figure 1