



NSAI
Standards

Irish Standard
I.S. EN 61400-3:2009

Wind turbines -- Part 3: Design requirements for offshore wind turbines (IEC 61400-3:2009 (EQV))

© NSAI 2009 No copying without NSAI permission except as permitted by copyright law.

I.S. EN 61400-3:2009

Incorporating amendments/corrigenda issued since publication:

This document replaces:

*This document is based on:
EN 61400-3:2009*

*Published:
24 April, 2009*

This document was published
under the authority of the NSAI and
comes into effect on:

25 September, 2009

*ICS number:
27.180*

NSAI
1 Swift Square,
Northwood, Santry
Dublin 9

T +353 1 807 3800
F +353 1 807 3838
E standards@nsai.ie
W **NSAI.ie**

Sales:
T +353 1 857 6730
F +353 1 857 6729
W standards.ie

Price Code:
AC

Údarás um Chaighdeáin Náisiúnta na hÉireann

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 61400-3

April 2009

ICS 27.180

English version

**Wind turbines -
Part 3: Design requirements
for offshore wind turbines
(IEC 61400-3:2009)**

Eoliennes -
Partie 3: Exigences de conception
des éoliennes en pleine mer
(CEI 61400-3:2009)

Windenergieanlagen -
Teil 3: Auslegungsanforderungen
für Windenergieanlagen auf offener See
(IEC 61400-3:2009)

This European Standard was approved by CENELEC on 2009-04-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: avenue Marnix 17, B - 1000 Brussels

Foreword

The text of document 88/329/FDIS, future edition 1 of IEC 61400-3, prepared by IEC TC 88, Wind turbines, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 61400-3 on 2009-04-01.

This European Standard is to be read in conjunction with EN 61400-1:2005.

The following dates were fixed:

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2010-01-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 2012-04-01

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 61400-3:2009 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60034	NOTE Harmonized in EN 60034 series (partially modified).
IEC 60038	NOTE Harmonized as HD 472 S1:1989 (modified), with the following title " <i>Nominal voltages for low-voltage public electricity supply systems</i> ".
IEC 60146	NOTE Harmonized in EN 60146 series (not modified).
IEC 60204-1	NOTE Harmonized as EN 60204-1:2006 (modified).
IEC 60204-11	NOTE Harmonized as EN 60204-11:2000 (not modified).
IEC 60227	NOTE Is related to HD 21 series (not equivalent).
IEC 60245	NOTE Is related to HD 22 series (not equivalent).
IEC 60269	NOTE Harmonized in EN 60269 series (modified).
IEC 60364	NOTE Harmonized in HD 384/HD 60364 series (modified).
IEC 60439	NOTE Harmonized in EN 60439 series (partially modified).
IEC 60446	NOTE Harmonized as EN 60446:1999 (not modified).
IEC 60529	NOTE Harmonized as EN 60529:1991 (not modified).
IEC 61000-6-1	NOTE Harmonized as EN 61000-6-1:2007 (not modified).
IEC 61000-6-2	NOTE Harmonized as EN 61000-6-2:2005 (not modified).
IEC 61000-6-4	NOTE Harmonized as EN 61000-6-4:2007 (not modified).
IEC 61310-1	NOTE Harmonized as EN 61310-1:1995 (not modified).
IEC 61310-2	NOTE Harmonized as EN 61310-2:1995 (not modified).
IEC 61400-21	NOTE Harmonized as EN 61400-21:2002 (not modified).

Annex ZA

(normative)

Normative references to international publications with their corresponding European publications

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.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60721-2-1 + A1	1982 1987	Classification of environmental conditions - Part 2-1: Environmental conditions appearing in nature - Temperature and humidity	HD 478.2.1 S1	1989
IEC 61400-1	2005	Wind turbines - Part 1: Design requirements	EN 61400-1	2005
IEC 62305-3 (mod)	2006	Protection against lightning - Part 3: Physical damage to structures and life hazard	EN 62305-3 + corr. September + A11	2006 2008 2009
IEC 62305-4	2006	Protection against lightning - Part 4: Electrical and electronic systems within structures	EN 62305-4 + corr. November	2006 2006
ISO 2394	1998	General principles on reliability for structures	-	-
ISO 2533	1975	Standard atmosphere	-	-
ISO 9001	2000	Quality management systems - Requirements	EN ISO 9001	2000
ISO 19900	2002	Petroleum and natural gas industries - General requirements for offshore structures	EN ISO 19900	2002
ISO 19901-1	2005	Petroleum and natural gas industries - Specific requirements for offshore structures - Part 1: Metocean design and operating considerations	EN ISO 19901-1	2005
ISO 19901-4	2003	Petroleum and natural gas industries - Specific requirements for offshore structures - Part 4: Geotechnical and foundation design considerations	EN ISO 19901-4	2003
ISO 19902	- ¹⁾	Petroleum and natural gas industries - Fixed steel offshore structures	EN ISO 19902	2007 ²⁾
ISO 19903	2006	Petroleum and natural gas industries - Fixed concrete offshore structures	EN ISO 19903	2006

¹⁾ Undated reference.

²⁾ Valid edition at date of issue.

CONTENTS

FOREWORD.....	5
INTRODUCTION.....	7
1 Scope.....	8
2 Normative references.....	8
3 Terms and definitions	9
4 Symbols and abbreviated terms	15
4.1 Symbols and units	15
4.2 Abbreviations.....	16
5 Principal elements	17
5.1 General	17
5.2 Design methods.....	17
5.3 Safety classes	19
5.4 Quality assurance.....	19
5.5 Rotor – nacelle assembly markings.....	20
6 External conditions	20
6.1 General	20
6.2 Wind turbine classes	21
6.3 Wind conditions	21
6.4 Marine conditions	22
6.5 Other environmental conditions.....	31
6.6 Electrical power network conditions.....	32
7 Structural design.....	33
7.1 General	33
7.2 Design methodology	33
7.3 Loads	33
7.4 Design situations and load cases	34
7.5 Load and load effect calculations	51
7.6 Ultimate limit state analysis.....	54
8 Control and protection system.....	57
9 Mechanical systems.....	57
10 Electrical system.....	58
11 Foundation design	58
12 Assessment of the external conditions at an offshore wind turbine site	59
12.1 General	59
12.2 The metocean database.....	59
12.3 Assessment of wind conditions.....	60
12.4 Assessment of waves	62
12.5 Assessment of currents.....	63
12.6 Assessment of water level, tides and storm surges.....	63
12.7 Assessment of sea ice	63
12.8 Assessment of marine growth	64
12.9 Assessment of seabed movement and scour.....	64
12.10 Assessment of wake effects from neighbouring wind turbines	65
12.11 Assessment of other environmental conditions	65

12.12	Assessment of earthquake conditions	65
12.13	Assessment of weather windows and weather downtime.....	65
12.14	Assessment of electrical network conditions.....	65
12.15	Assessment of soil conditions	66
13	Assembly, installation and erection	67
13.1	General	67
13.2	Planning	68
13.3	Installation conditions.....	68
13.4	Site access	68
13.5	Environmental conditions	68
13.6	Documentation.....	69
13.7	Receiving, handling and storage.....	69
13.8	Foundation/anchor systems.....	69
13.9	Assembly of offshore wind turbine	69
13.10	Erection of offshore wind turbine	69
13.11	Fasteners and attachments	69
13.12	Cranes, hoists and lifting equipment.....	70
14	Commissioning, operation and maintenance	70
14.1	General	70
14.2	Design requirements for safe operation, inspection and maintenance	70
14.3	Instructions concerning commissioning	71
14.4	Operator's instruction manual	72
14.5	Maintenance manual.....	74
Annex A (informative)	Key design parameters for an offshore wind turbine.....	76
Annex B (informative)	Wave spectrum formulations	79
Annex C (informative)	Shallow water hydrodynamics and breaking waves	84
Annex D (informative)	Guidance on calculation of hydrodynamic loads.....	92
Annex E (informative)	Recommendations for design of offshore wind turbine support structures with respect to ice loads.....	105
Annex F (informative)	Offshore wind turbine foundation design	116
Annex G (informative)	Statistical extrapolation of operational metocean parameters for ultimate strength analysis	117
Annex H (informative)	Corrosion protection	123
Bibliography	127	
Figure 1 – Parts of an offshore wind turbine.....	10	
Figure 2 – Design process for an offshore wind turbine.....	19	
Figure 3 – Definition of water levels.....	29	
Figure 4 – The two approaches to calculate the design load effect	55	
Figure B.1 – PM spectrum	80	
Figure B.2 – Jonswap and PM spectrums for typical North Sea storm sea state	81	
Figure C.1 – Regular wave theory selection diagram.....	84	
Figure D.1 – Breaking wave and cylinder parameters.....	96	
Figure D.2 – Oblique inflow parameters	96	
Figure D.3 – Distribution over height of the maximum impact line force ($\gamma=0^\circ$)	98	

Figure D.4 – Response of model and full-scale cylinder in-line and cross-flow (from reference document 4)	100
Figure E.1 – Ice force coefficients for plastic limit analysis (from reference document 6).....	110
Figure E.2 – Serrated load profile ($T_{0,1} = 1/f_N$ or $1/f_b$)	113
Figure G.1 – Example of the construction of the 50-year environmental contour for a 3-hour sea state duration.	118
Table 1 – Design load cases	36
Table 2 – Design load cases for sea ice	50
Table 3 – Partial safety factors for loads γ_f	56
Table 4 – Conversion between extreme wind speeds of different averaging periods	61
Table C.1 – Constants h_1 and h_2 and normalised wave heights $h_{x\%}$ as a function of H_{tr}	87
Table C.2 – Breaking wave type	90

INTERNATIONAL ELECTROTECHNICAL COMMISSION

WIND TURBINES –

Part 3: Design requirements for offshore 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.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

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

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

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.

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*



This is a free preview. Purchase the entire publication at the link below:

[Product Page](#)

-
- ④ Looking for additional Standards? Visit Intertek Inform Infostore
 - ④ Learn about LexConnect, All Jurisdictions, Standards referenced in Australian legislation
-