



IEC 61400-1

Edition 4.0 2019-02

# INTERNATIONAL STANDARD



---

## Wind energy generation systems – Part 1: Design requirements

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

ICS 27.180

ISBN 978-2-8322-6253-5

**Warning! Make sure that you obtained this publication from an authorized distributor.**

# INTERNATIONAL ELECTROTECHNICAL COMMISSION

---

## IEC 61400-1 Edition 4.0 2019-02

### WIND ENERGY GENERATION SYSTEMS –

#### Part 1: Design requirements

### INTERPRETATION SHEET 1

This interpretation sheet has been prepared by IEC technical committee 88: Wind energy generation systems.

The text of this interpretation sheet is based on the following documents:

DISH	Report on voting
88/1065/DISH	88/1078/RVDISH

Full information on the voting for the approval of this interpretation sheet can be found in the report on voting indicated in the above table.

---

#### Question 1:

Subclause 6.4.2 mentions normal other environmental conditions that shall be taken into account and, specifically speaking, an ambient temperature range of  $-10\text{ °C}$  to  $+40\text{ °C}$ . Does this mean that the wind turbines shall be designed to operate at rated power up to  $40\text{ °C}$  on the maximum limit, or does it mean that the wind turbine can be designed to operate at any maximum temperature limit below  $40\text{ °C}$ , let's assume  $35\text{ °C}$  or  $32\text{ °C}$ , etc. ?

#### Answer 1:

The standard requires that turbines designed to one of the design classes stated in Table 1 in Subclause 6.2 be capable of operating and generating at temperatures up to  $+40\text{ °C}$ . There is no requirement that the turbine shall generate maximum rated power at  $+40\text{ °C}$ .

## CONTENTS

FOREWORD.....	10
INTRODUCTION.....	12
1 Scope.....	13
2 Normative references .....	13
3 Terms and definitions .....	15
4 Symbols and abbreviated terms.....	23
4.1 Symbols and units.....	23
4.2 Abbreviated terms.....	26
5 Principal elements .....	27
5.1 General.....	27
5.2 Design methods .....	27
5.3 Safety classes .....	27
5.4 Quality assurance .....	27
5.5 Wind turbine markings .....	27
6 External conditions .....	28
6.1 General.....	28
6.2 Wind turbine classes.....	28
6.3 Wind conditions .....	30
6.3.1 General .....	30
6.3.2 Normal wind conditions.....	31
6.3.3 Extreme wind conditions .....	33
6.4 Other environmental conditions.....	38
6.4.1 General .....	38
6.4.2 Normal other environmental conditions .....	39
6.4.3 Extreme other environmental conditions .....	39
6.5 Electrical power network conditions .....	39
7 Structural design .....	40
7.1 General.....	40
7.2 Design methodology .....	40
7.3 Loads.....	40
7.3.1 General .....	40
7.3.2 Gravitational and inertial loads .....	41
7.3.3 Aerodynamic loads .....	41
7.3.4 Actuation loads.....	41
7.3.5 Other loads.....	41
7.4 Design situations and load cases .....	41
7.4.1 General .....	41
7.4.2 Power production (DLC 1.1 to 1.5).....	44
7.4.3 Power production plus occurrence of fault or loss of electrical network connection (DLC 2.1 to 2.5).....	45
7.4.4 Start-up (DLC 3.1 to 3.3) .....	47
7.4.5 Normal shutdown (DLC 4.1 to 4.2).....	47
7.4.6 Emergency stop (DLC 5.1).....	48
7.4.7 Parked (standstill or idling) (DLC 6.1 to 6.4) .....	48
7.4.8 Parked plus fault conditions (DLC 7.1).....	49
7.4.9 Transport, assembly, maintenance and repair (DLC 8.1 and 8.2).....	49

7.5	Load calculations .....	49
7.6	Ultimate limit state analysis.....	50
7.6.1	Method .....	50
7.6.2	Ultimate strength analysis.....	53
7.6.3	Fatigue failure .....	56
7.6.4	Stability .....	57
7.6.5	Critical deflection analysis .....	57
7.6.6	Special partial safety factors.....	58
8	Control system .....	58
8.1	General.....	58
8.2	Control functions.....	58
8.3	Protection functions .....	59
8.4	Control system failure analysis .....	59
8.4.1	General .....	59
8.4.2	Independence and common-cause failures .....	60
8.4.3	Fault exclusions.....	60
8.4.4	Failure mode return periods.....	60
8.4.5	Systematic failures .....	60
8.5	Manual operation .....	60
8.6	Emergency stop button function .....	60
8.7	Manual, automatic, and remote restart .....	61
8.8	Braking system .....	62
9	Mechanical systems .....	62
9.1	General.....	62
9.2	Errors of fitting.....	63
9.3	Hydraulic or pneumatic systems.....	63
9.4	Main gearbox .....	63
9.5	Yaw system .....	63
9.6	Pitch system .....	64
9.7	Protection function mechanical brakes .....	64
9.8	Rolling element bearings.....	64
9.8.1	General .....	64
9.8.2	Main shaft bearings .....	64
9.8.3	Generator bearings.....	64
9.8.4	Pitch and yaw bearings.....	65
10	Electrical system .....	65
10.1	General.....	65
10.2	General requirements for the electrical system .....	65
10.3	Internal environmental conditions.....	65
10.4	Protective devices.....	67
10.5	Disconnection from supply sources .....	67
10.6	Earth system.....	67
10.7	Lightning protection .....	67
10.8	Electrical cables.....	68
10.9	Self-excitation .....	68
10.10	Protection against lightning electromagnetic impulse .....	68
10.11	Power quality .....	68
10.12	Electromagnetic compatibility.....	69
10.13	Power electronic converter systems and equipment .....	69

10.14	Twist/drip loop .....	69
10.15	Slip rings .....	69
10.16	Vertical power transmission conductors and components .....	70
10.17	Motor drives and converters .....	70
10.18	Electrical machines .....	71
10.19	Power transformers .....	71
10.20	Low voltage switchgear and controlgear .....	71
10.21	High voltage switchgear .....	71
10.22	Hubs .....	72
11	Assessment of a wind turbine for site-specific conditions .....	72
11.1	General .....	72
11.2	Assessment of the topographical complexity of the site and its effect on turbulence .....	72
11.2.1	Assessment of the topographical complexity .....	72
11.2.2	Assessment of turbulence structure at the site .....	75
11.3	Wind conditions required for assessment .....	76
11.3.1	General .....	76
11.3.2	Wind condition parameters .....	76
11.3.3	Measurement setup .....	77
11.3.4	Data evaluation .....	78
11.4	Assessment of wake effects from neighbouring wind turbines .....	78
11.5	Assessment of other environmental conditions .....	78
11.6	Assessment of earthquake conditions .....	79
11.7	Assessment of electrical network conditions .....	80
11.8	Assessment of soil conditions .....	80
11.9	Assessment of structural integrity by reference to wind data .....	80
11.9.1	General .....	80
11.9.2	Assessment of the fatigue load suitability by reference to wind data .....	80
11.9.3	Assessment of the ultimate load suitability by reference to wind data .....	82
11.10	Assessment of structural integrity by load calculations with reference to site- specific conditions .....	82
12	Assembly, installation and erection .....	83
12.1	General .....	83
12.2	Planning .....	84
12.3	Installation conditions .....	84
12.4	Site access .....	84
12.5	Environmental conditions .....	84
12.6	Documentation .....	84
12.7	Receiving, handling and storage .....	85
12.8	Foundation/anchor systems .....	85
12.9	Assembly of wind turbine .....	85
12.10	Erection of wind turbine .....	85
12.11	Fasteners and attachments .....	85
12.12	Cranes, hoists and lifting equipment .....	85
13	Commissioning, operation and maintenance .....	86
13.1	General .....	86
13.2	Design requirements for safe operation, inspection and maintenance .....	86
13.3	Instructions concerning commissioning .....	87
13.3.1	General .....	87

13.3.2	Energization .....	87
13.3.3	Commissioning tests .....	87
13.3.4	Records .....	87
13.3.5	Post commissioning activities .....	87
13.4	Operator's instruction manual .....	87
13.4.1	General .....	87
13.4.2	Instructions for operations and maintenance records .....	88
13.4.3	Instructions for unscheduled automatic shutdown .....	88
13.4.4	Instructions for diminished reliability .....	88
13.4.5	Work procedures plan .....	88
13.4.6	Emergency procedures plan .....	89
13.5	Maintenance manual .....	89
14	Cold climate .....	90
14.1	General .....	90
14.2	Low temperature and icing climate .....	90
14.3	External conditions for cold climate .....	90
14.3.1	General .....	90
14.3.2	Wind turbine class for cold climate .....	90
14.4	Structural design .....	91
14.5	Design situations and load cases .....	91
14.5.1	General .....	91
14.5.2	Load calculations .....	91
14.5.3	Selection of suitable materials .....	91
14.6	Control systems .....	92
14.7	Mechanical systems .....	92
14.8	Electrical systems .....	92
Annex A	(normative) Design parameters for external conditions .....	93
A.1	Design parameters for describing wind turbine class S .....	93
A.1.1	General .....	93
A.1.2	Machine parameters .....	93
A.1.3	Wind conditions .....	93
A.1.4	Electrical network conditions .....	93
A.1.5	Other environmental conditions (where taken into account) .....	94
A.2	Additional design parameters for describing cold climate wind turbine class S (CC-S) .....	94
Annex B	(informative) Design load cases for special class S wind turbine design or site suitability assessment .....	96
B.1	General .....	96
B.2	Power production (DLC 1.1 to 1.9) .....	96
Annex C	(informative) Turbulence models .....	100
C.1	General .....	100
C.2	Mann [3] uniform shear turbulence model .....	100
C.3	Kaimal [1] spectrum and exponential coherence model .....	103
C.4	Reference documents .....	105
Annex D	(informative) Assessment of earthquake loading .....	106
D.1	General .....	106
D.2	Design response spectrum .....	106
D.3	Structure model .....	107
D.4	Seismic load evaluation .....	108

D.5	Additional load .....	109
D.6	Reference documents .....	110
Annex E (informative)	Wake and wind farm turbulence .....	111
E.1	Added wake turbulence method .....	111
E.2	Dynamic wake meandering model.....	113
E.2.1	General .....	113
E.2.2	Wake deficit.....	114
E.2.3	Meandering .....	115
E.2.4	Wake induced turbulence.....	116
E.2.5	Wake superposition .....	116
E.2.6	Model synthesis.....	117
E.3	Reference documents .....	117
Annex F (informative)	Prediction of wind distribution for wind turbine sites by measure-correlate-predict (MCP) methods.....	118
F.1	General.....	118
F.2	Measure-correlate-predict (MCP) .....	118
F.3	Application to annual mean wind speed and distribution.....	118
F.4	Application to extreme wind speed.....	118
F.5	Reference documents .....	119
Annex G (informative)	Statistical extrapolation of loads for ultimate strength analysis.....	120
G.1	General.....	120
G.2	Data extraction for extrapolation .....	120
G.3	Load extrapolation methods .....	121
G.3.1	General .....	121
G.3.2	Global extremes .....	121
G.3.3	Local extremes .....	123
G.3.4	Long-term empirical distributions .....	123
G.4	Convergence criteria.....	124
G.4.1	General .....	124
G.4.2	Load fractile estimate .....	124
G.4.3	Confidence bounds.....	125
G.4.4	Confidence intervals based on bootstrapping.....	125
G.4.5	Confidence intervals based on the binomial distribution.....	125
G.5	Inverse first-order reliability method (IFORM).....	126
G.6	Reference documents .....	128
Annex H (informative)	Fatigue analysis using Miner's rule with load extrapolation.....	130
H.1	Fatigue analysis.....	130
H.2	Reference documents .....	133
Annex I (informative)	Contemporaneous loads .....	135
I.1	General.....	135
I.2	Scaling .....	136
I.3	Averaging .....	136
Annex J (informative)	Prediction of the extreme wind speed of tropical cyclones by using Monte Carlo simulation method .....	137
J.1	General.....	137
J.2	Prediction of tropical cyclone induced extreme wind speeds .....	137
J.2.1	General .....	137
J.2.2	Evaluation of tropical cyclone parameters.....	137
J.2.3	Generation of synthetic tropical cyclones.....	138

J.2.4	Prediction of wind speeds in the tropical cyclone boundary.....	138
J.3	Prediction of extreme wind speed in mixed climate regions .....	139
J.3.1	General .....	139
J.3.2	Extreme wind distributions of extratropical cyclones by the MCP method.....	139
J.3.3	Extreme wind distributions of tropical cyclones by the MCS method.....	140
J.3.4	Determination of extreme wind speed in a mixed climate region .....	140
J.4	Reference documents .....	140
Annex K (informative)	Calibration of structural material safety factors and structural design assisted by testing .....	142
K.1	Overview and field of application.....	142
K.2	Target reliability level.....	142
K.3	Safety formats .....	142
K.4	Reliability-based calibration .....	144
K.5	Calibration using the design value format.....	145
K.6	Partial safety factors for fatigue for welded details in steel structures.....	145
K.7	Types of tests for materials .....	147
K.8	Planning of tests .....	147
K.8.1	General .....	147
K.8.2	Objectives and scope .....	147
K.8.3	Prediction of test results .....	147
K.8.4	Specification of test specimen and sampling.....	148
K.8.5	Loading specifications .....	148
K.8.6	Testing arrangement.....	148
K.8.7	Measurements.....	149
K.8.8	Evaluation and reporting the test .....	149
K.9	General principles for statistical evaluations .....	149
K.10	Derivation of characteristic values.....	150
K.11	Statistical determination of characteristic value for a single property.....	150
K.12	Statistical determination of characteristic value for resistance models.....	151
K.12.1	General .....	151
K.12.2	Step 1: Develop a design model .....	152
K.12.3	Step 2: Compare experimental and theoretical values.....	152
K.12.4	Step 3: Estimate the mean value correction factor (bias) $b$ .....	153
K.12.5	Step 4: Estimate the coefficient of variation of the errors .....	153
K.12.6	Step 5: Analyse compatibility.....	154
K.12.7	Step 6: Determine the coefficients of variation $V_{X_i}$ of the basic variables.....	154
K.12.8	Step 7: Determine the characteristic value $r_k$ of the resistance .....	154
K.13	Reference documents .....	156
Annex L (informative)	Cold climate: assessment and effects of icing climate.....	157
L.1	Assessment of icing climate conditions .....	157
L.1.1	General .....	157
L.1.2	Icing climate .....	157
L.1.3	Rotor icing.....	158
L.1.4	Measurement methods .....	159
L.1.5	Profile coefficients modification for ice.....	159
L.2	Ice mass effects on wind turbine blades.....	160
L.3	Cold climate design situations and load case .....	161
L.3.1	General .....	161
L.3.2	Power production (DLC 1.1 to 1.6).....	161



L.3.3	Parked (standstill or idling) (DLC 6.1 to 6.5)	161
L.3.4	Parked and fault conditions (DLC 7.1)	161
L.4	Cold climate load calculations	161
L.5	Reference documents and bibliography	162
Annex M	(informative) Medium wind turbines	163
M.1	Overview	163
M.2	External conditions	163
M.2.1	General	163
M.2.2	Wind shear	163
M.3	Assembly, installation and erection	163
M.4	Commissioning, operation and maintenance	164
M.5	Documentation	165
Bibliography		167

Figure 1	– Turbulence standard deviation and turbulence intensity for the normal turbulence model (NTM)	32
Figure 2	– Example of extreme operating gust	34
Figure 3	– Example of extreme direction change magnitude	35
Figure 4	– Example of extreme direction change transient	35
Figure 5	– Example of extreme coherent gust amplitude for ECD	36
Figure 6	– Direction change for ECD	37
Figure 7	– Example of direction change transient	37
Figure 8	– Examples of extreme positive and negative vertical wind shear, wind profile before onset ( $t = 0$ , dashed line) and at maximum shear ( $t = 6$ s, full line)	38
Figure 9	– Example of wind speeds at rotor top and bottom, respectively, which illustrate the transient positive wind shear	38
Figure 10	– Examples of 30° sectors for fitting the terrain data	73
Figure 11	– Terrain variation ( $\Delta z$ ) and terrain slope ( $\theta$ )	74
Figure 12	– Possible combinations of normalized mean wind speed and Weibull shape parameter $k$ (shaded area)	81
Figure D.1	– Structure model for response spectrum method	108
Figure E.1	– Configuration – Inside a wind farm with more than 2 rows	113
Figure E.2	– The three fundamental parts of the DWM model	114
Figure K.1	– $r_e$ - $r_t$ diagram	153
Figure L.1	– Definition of meteorological icing and rotor icing	158
Figure L.2	– Representative ice affected rotor area as defined by rotor icing height	159
Figure L.3	– Iced airfoil lift and drag penalty factors	160

Table 1	– Basic parameters for wind turbine classes	29
Table 2	– Design load cases (DLC)	43
Table 3	– Partial safety factors for loads $\gamma_f$	54
Table 4	– Minimum safety factor $S_{H,min}$ and $S_{F,min}$ for the yaw gear system	63
Table 5	– Threshold values of the terrain complexity categories L, M and H	75
Table 6	– Values of lateral and vertical turbulence standard deviations relative to the longitudinal component depending on terrain complexity category L, M and H	75

Table 7 – Values of turbulence structure correction parameter depending on terrain complexity category L, M and H .....	76
Table A.1 – Design parameters for describing cold climate wind turbine class S (CC-S) .....	94
Table B.1 – Design load cases.....	97
Table C.1 – Turbulence spectral parameters for the Kaimal model.....	104
Table E.1 – Number (N) of neighbouring wind turbines .....	112
Table G.1 – Parameters needed to establish binomial-based confidence intervals .....	126
Table G.2 – Short-term load exceedance probabilities as a function of hub-height wind speed for different wind turbine classes for use with the IFORM procedure.....	128
Table I.1 – Extreme loading matrix.....	135
Table K.1 – Partial safety factor for model uncertainty, $\gamma_{\delta}$ .....	145
Table K.2 – Recommended values for partial safety factor for fatigue strength, $\gamma_{Mf}$ .....	146
Table K.3 – Recommended partial safety factor for fatigue stresses, $\gamma_{Ff}$ .....	147
Table K.4 – Values of $k_n$ for the 5 % characteristic value .....	151
Table L.1 – Cold climate design load cases .....	161
Table L.2 – Blade ice mass and airfoil penalty factors used in different analysis types.....	162

# INTERNATIONAL ELECTROTECHNICAL COMMISSION

## WIND ENERGY GENERATION SYSTEMS –

### Part 1: Design requirements

#### 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 itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 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 61400-1 has been prepared by IEC technical committee 88: Wind energy generation systems.

This fourth edition cancels and replaces the third edition published in 2005 and Amendment 1:2010. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) general update and clarification of references and requirements;
- b) extension of wind turbine classes to allow for tropical cyclones and high turbulence;
- c) Weibull distribution of turbulence standard deviation for normal turbulence model (NTM);
- d) updated design load cases (DLCs), in particular DLC 2.1 and 2.2;
- e) revision of partial safety factor specifications;
- f) major revision of Clauses 8, 10 and 11;

- g) introduction of cold climate requirements, Clause 14;
- h) new Annex B on design load cases for site-specific or special class S wind turbine design or site suitability assessment;
- i) new Annex J on prediction of the extreme wind speed of tropical cyclones by using Monte Carlo simulation method;
- j) new Annex K on calibration of structural material safety factors and structural design assisted by testing;
- k) new Annex L on assessment and effects of icing climate;
- l) new Annex M on medium wind turbines.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
88/696/FDIS	88/701/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

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

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

Future standards in this series will carry the new general title as cited above. Titles of existing standards in this series will be updated at the time of the next edition.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document will be

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

The contents of the corrigendum of September 2019 and the Interpretation Sheet 1 (2025-02) 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 document 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 document 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 document does not relieve any person, organization, or corporation from the responsibility of observing other applicable regulations.

This document is not intended to give requirements for wind turbines installed offshore, in particular for the support structure. For offshore installations, reference is made to the IEC 61400-3 series.

## **WIND ENERGY GENERATION SYSTEMS –**

### **Part 1: Design requirements**

#### **1 Scope**

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

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

This document applies to wind turbines of all sizes. For small wind turbines, IEC 61400-2 can be applied. IEC 61400-3-1 provides additional requirements to offshore wind turbine installations.

This document is intended to be used together with the appropriate IEC and ISO standards mentioned in Clause 2.

#### **2 Normative references**

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60034 (all parts), *Rotating electrical machines*

IEC 60038, *IEC standard voltages*

IEC 60071-1, *Insulation co-ordination – Part 1: Definitions, principles and rules*

IEC 60071-2, *Insulation co-ordination – Part 2: Application guidelines*

IEC 60076 (all parts), *Power transformers*

IEC 60204-1, *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 AC or 1 500 V DC and not exceeding 36 kV*

IEC 60364 (all parts), *Low voltage electrical installations*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 60664-1, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

IEC 60664-3, *Insulation coordination for equipment within low-voltage systems – Part 3: Use of coating, potting or moulding for protection against pollution*

IEC 60721 (all parts), *Classification of environmental conditions*

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

IEC 61400-3, *Wind turbines – Part 3: Design requirements for offshore wind turbines*

IEC 61400-4, *Wind Turbines – Part 4: Design requirements for wind turbine gearboxes*

IEC 61400-24, *Wind turbines – Part 24: Lightning protection*

IEC 61439 (all parts), *Low-voltage switchgear and controlgear assemblies*

IEC 61800-4, *Adjustable speed electrical power drive systems – Part 4: General requirements – Rating specifications for AC power drive systems above 1 000 V AC and not exceeding 35 kV*

IEC 61800-5-1, *Adjustable speed electrical power drive systems – Part 5-1: Safety requirements – Electrical, thermal and energy*

IEC 62271 (all parts), *High-voltage switchgear and controlgear*

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*

IEC 62477-1:2012, *Safety requirements for power electronic converter systems and equipment – Part 1: General*

ISO 76, *Rolling bearings – Static load ratings*

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

ISO 2394, *General principles on reliability for structures*

ISO 2533, *Standard Atmosphere*

ISO 4354, *Wind actions on structures*

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

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

ISO 12494:2001, *Atmospheric icing on structures*

ISO 13850, *Safety of machinery – Emergency stop function – Principles for design*

ISO/TS 16281, *Rolling bearings – Methods for calculating the modified reference rating life for universally loaded bearings*