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Wind turbines – **iTeh STANDARD PREVIEW**
Part 4: Design requirements for wind turbine gearboxes
(standards.iteh.ai)

Éoliennes –
Partie 4: Exigences de conception des boîtes de vitesses des éoliennes

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CONTENTS

FOREWORD.....	7
INTRODUCTION.....	9
1 Scope.....	10
2 Normative references	10
3 Terms, definitions and conventions.....	12
3.1 Terms and definitions	12
3.2 Conventions	15
4 Symbols, abbreviations and units	17
4.1 Symbols and units	17
4.2 Abbreviations	21
5 Design for reliability.....	23
5.1 Design lifetime and reliability.....	23
5.2 Design process	24
5.3 Documentation	26
5.4 Quality plan.....	26
6 Drivetrain operating conditions and loads	27
6.1 Drivetrain description	27
6.1.1 General	27
6.1.2 Interface definition.....	27
6.1.3 Specified requirements across interfaces.....	28
6.2 Deriving drivetrain loads.....	28
6.2.1 Wind turbine load simulation model.....	28
6.2.2 Wind turbine load calculations	29
6.2.3 Reliability of load assumptions	29
6.3 Results from wind turbine load calculations	29
6.3.1 General	29
6.3.2 Time series.....	30
6.3.3 Fatigue load	30
6.3.4 Extreme loads	31
6.4 Operating conditions	31
6.4.1 General	31
6.4.2 Environmental conditions.....	31
6.4.3 Operating strategies	32
6.5 Drivetrain analysis.....	32
7 Gearbox design, rating, and manufacturing requirements	32
7.1 Gearbox cooling	32
7.2 Gears	33
7.2.1 Gear reliability considerations.....	33
7.2.2 Gear rating	33
7.2.3 Load factors	34
7.2.4 Gear materials.....	36
7.2.5 Subsurface initiated fatigue	37
7.2.6 Gear accuracy	37
7.2.7 Gear manufacturing	37
7.3 Bearings.....	38
7.3.1 General	38

7.3.2	Bearing reliability considerations	38
7.3.3	Bearing steel quality requirements	39
7.3.4	General design considerations	39
7.3.5	Bearing interface requirements	42
7.3.6	Bearing design issues	43
7.3.7	Bearing lubrication	46
7.3.8	Rating calculations	47
7.4	Shafts, keys, housing joints, splines and fasteners	50
7.4.1	Shafts	50
7.4.2	Shaft-hub connections	51
7.4.3	Flexible splines	51
7.4.4	Shaft seals	52
7.4.5	Fasteners	52
7.4.6	Circlips (snap rings)	53
7.5	Structural elements	53
7.5.1	Introduction	53
7.5.2	Reliability considerations	53
7.5.3	Deflection analysis	54
7.5.4	Strength verification	54
7.5.5	Static strength assessment	55
7.5.6	Fatigue strength assessment	58
7.5.7	Material tests	63
7.5.8	Documentation	63
7.6	Lubrication	64
7.6.1	General considerations	64
7.6.2	Type of lubricant	65
7.6.3	Lubricant characteristics	65
7.6.4	Method of lubrication	67
7.6.5	Oil quantity	68
7.6.6	Operating temperatures	68
7.6.7	Temperature control	69
7.6.8	Lubricant condition monitoring	70
7.6.9	Lubricant cleanliness	70
7.6.10	Lubricant filter	71
7.6.11	Ports	71
7.6.12	Oil level indicator	72
7.6.13	Magnetic plugs	72
7.6.14	Breather	73
7.6.15	Flow sensor	73
7.6.16	Serviceability	73
8	Design verification	73
8.1	General	73
8.2	Test planning	73
8.2.1	Identifying test criteria	73
8.2.2	New designs or substantive changes	74
8.2.3	Overall test plan	74
8.2.4	Specific test plans	74
8.3	Workshop prototype testing	75
8.3.1	General	75

8.3.2	Component testing	75
8.3.3	Workshop testing of a prototype gearbox	75
8.3.4	Lubrication system testing	76
8.4	Field test	76
8.4.1	General	76
8.4.2	Validation of loads	76
8.4.3	Type test of gearbox in wind turbine	77
8.5	Production testing	78
8.5.1	Acceptance testing	78
8.5.2	Sound emission testing.....	78
8.5.3	Vibration testing	78
8.5.4	Lubrication system considerations	78
8.5.5	System temperatures.....	78
8.6	Robustness test	78
8.7	Field lubricant temperature and cleanliness.....	78
8.8	Bearing specific validation	79
8.8.1	Design reviews	79
8.8.2	Prototype verification/validation	79
8.9	Test documentation	80
9	Operation, service and maintenance requirements	80
9.1	Service and maintenance requirements	80
9.2	Inspection requirements	80
9.3	Commissioning and run-in	80
9.4	Transport, handling and storage	81
9.5	Repair	81
9.6	Installation and exchange	81
9.7	Condition monitoring	81
9.8	Lubrication	81
9.8.1	Oil type requirements	81
9.8.2	Lubrication system.....	81
9.8.3	Oil test and analysis	82
9.9	Operations and maintenance documentation	82
Annex A (informative)	Examples of drivetrain interfaces and loads specifications	83
Annex B (informative)	Gearbox design and manufacturing considerations.....	94
Annex C (informative)	Bearing design considerations	97
Annex D (informative)	Considerations for gearbox structural elements.....	124
Annex E (informative)	Recommendations for lubricant performance in wind turbine gearboxes.....	127
Annex F (informative)	Design verification documentation	142
Annex G (informative)	Bearing calculation documentation.....	145
Bibliography	153
Figure 1	– Shaft designation in 3-stage parallel shaft gearboxes.....	15
Figure 2	– Shaft designation in 3-stage gearboxes with one planet stage.....	16
Figure 3	– Shaft designation in 3-stage gearboxes with two planet stages	17
Figure 4	– Design process flow chart	25
Figure 5	– Examples of bearing selection criteria	40

Figure 6 – Blind bearing assembly	46
Figure 7 – Definition of section factor $n_{pl,\sigma}$ of a notched component	57
Figure 8 – Idealized elastic plastic stress-strain curve	58
Figure 9 – Synthetic S/N curve (adapted from Haibach, 2006)	61
Figure A.1 – Modular drivetrain	83
Figure A.2 – Modular drivetrain with 3-point suspension	84
Figure A.3 – Integrated drivetrain	84
Figure A.4 – Reference system for modular drivetrain	86
Figure A.5 – Rear view of drivetrain	87
Figure A.6 – Reference system for modular drivetrain with 3-point suspension	88
Figure A.7 – Reference system for integrated drivetrain	89
Figure A.8 – Example of rainflow counting per DLC	91
Figure A.9 – Example of load revolution distribution (LRD)	92
Figure C.1 – Load bin reduction by lumping neighbouring load bins	98
Figure C.2 – Consumed life index (CLI)	100
Figure C.3 – Time share distribution	100
Figure C.4 – Effects of clearance and preload on pressure distribution in radial roller bearings (from Brandlein et al, 1999)	103
Figure C.5 – Nomenclature for bearing curvature	104
Figure C.6 – Stress distribution over the elliptical contact area	106
Figure C.7 – Examples of locating and non-locating bearing arrangements	115
Figure C.8 – Examples of locating bearing arrangements	115
Figure C.9 – Examples of accommodation of axial displacements	116
Figure C.10 – Examples of cross-locating bearing arrangements	116
Figure C.11 – Examples of bearing arrangements with paired mounting	117
Figure D.1 – Locations of failure for local (A) and global (B) failure	125
Figure D.2 – Local and global failure for two different notch radii	125
Figure D.3 – Haigh-diagram for evaluation of mean stress influence (Haibach, 2006)	126
Figure E.1 – Viscosity requirements versus pitch line velocity	128
Figure E.2 – Test apparatus for filterability evaluation	136
Figure E.3 – Example for circuit design of combined filtration and cooling system	140
Table 1 – Symbols used in the document	18
Table 2 – Abbreviations	21
Table 3 – Mesh load factor K_γ for planetary stages	35
Table 4 – Required gear accuracy	37
Table 5 – Temperature gradients for calculation of operating clearance	44
Table 6 – Bearing lubricant temperature for calculation of viscosity ratio, κ	47
Table 7 – Guide values for maximum contact stress at Miner's sum dynamic equivalent bearing load	49
Table 8 – Minimum safety factors for the different methods	50
Table 9 – Partial safety factors for materials	55
Table 10 – Partial safety factors γ_m for synthetic S/N-curves of cast iron materials	62
Table 11 – Recommended cleanliness levels	71

Table A.1 – Drivetrain elements and local coordinate systems	85
Table A.2 – Drivetrain element interface dimensions	86
Table A.3 – Interface requirements for modular drivetrain	87
Table A.4 – Interface requirements for modular drivetrain with 3-point suspension	88
Table A.5 – Interface requirements for integrated drivetrain	89
Table A.6 – Engineering data and required design load descriptions.....	90
Table A.7 – Rainflow matrix example	90
Table A.8 – Example of load duration distribution (LDD)	92
Table A.9 – Extreme load matrix example	93
Table B.1 – Recommended gear tooth surface roughness.....	95
Table C.1 – Guide values for basic rating life L_{h10} for preliminary bearing selection.....	97
Table C.2 – Static load factors for radial bearings	102
Table C.3 – Bearing types for combined loads with axial loads in double directions	111
Table C.4 – Bearing types for combined loads with axial loads in single direction	112
Table C.5 – Bearing types for pure radial load	113
Table C.6 – Bearing types for axial load.....	114
Table C.7 – Bearing selection: Legend.....	118
Table C.8 – Bearing selection: Low speed shaft (LSS) / planet carrier	119
Table C.9 – Bearing selection: Low speed intermediate shaft (LSIS).....	120
Table C.10 – Bearing selection: High speed intermediate shaft (HSIS)	121
Table C.11 – Bearing selection: High speed shaft (HSS).....	122
Table C.12 – Bearing selection: Planet bearing	123
Table D.1 – Typical material properties	124
Table E.1 – Viscosity grade at operating temperature for oils with $VI = 90$	129
Table E.2 – Viscosity grade at operating temperature for oils with $VI = 120$	130
Table E.3 – Viscosity grade at operating temperature for oils with $VI = 160$	131
Table E.4 – Viscosity grade at operating temperature for oils with $VI = 240$	132
Table E.5 – Standardized test methods for evaluating WT lubricants (fresh oil).....	134
Table E.6 – Non-standardized test methods for lubricant performance (fresh oil)	135
Table E.7– Guidelines for lubricant parameter limits	138
Table F.1 – Design validation and verification documentation	142

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WIND TURBINES –

Part 4: Design requirements for wind turbine gearboxes

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International Standard IEC 61400-4 has been prepared by IEC technical committee 88: Wind turbines, in co-operation with ISO technical committee 60: Gears.

It is published as a double logo standard.

This bilingual version (2020-02) corresponds to the monolingual English version, published in 2012-12.

This first edition cancels and replaces ISO 81400-4 published in 2005. It constitutes a technical revision of ISO 81400-4 with extended content and changes in all pertinent sections.

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

- a) extension of the scope to wind turbines above 2 MW rated power;

- b) considerations for converging differing approaches to reliability in gear, bearing and wind turbine standards;
- c) a new clause on wind turbine loads specific to drivetrains;
- d) new clause on testing and validation of new gearbox designs;
- e) updated bearing selection tables for different locations in a wind turbine gearbox;
- f) expanded design considerations on the use of bearings based on avoiding standard failures;
- g) a new clause on considerations and requirements in the design and analysis of gearbox structural elements;
- h) updated considerations and requirements on lubricants and lubrication systems.

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

FDIS	Report on voting
88/438/FDIS	88/441/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. In ISO, the standard has been approved by 11 P-members out of 12 having cast a vote.

The French version of this standard has not been voted upon.

iTech STANDARD PREVIEW
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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.

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INTRODUCTION

IEC 61400-4 outlines minimum requirements for specification, design and verification of gearboxes in wind turbines. It is not intended for use as a complete design specification or instruction manual, and it is not intended to assure performance of assembled drive systems. It is intended for use by experienced gear designers capable of selecting reasonable values for the factors, based on knowledge of similar designs and the effects of such items as lubrication, deflection, manufacturing tolerances, metallurgy, residual stress and system dynamics. It is not intended for use by the engineering public at large.

Any of the requirements of this standard may be altered if it can be suitably demonstrated that the safety and reliability 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 4: Design requirements for wind turbine gearboxes

1 Scope

This part of the IEC 61400 series is applicable to enclosed speed increasing gearboxes for horizontal axis wind turbine drivetrains with a power rating in excess of 500 kW. This standard applies to wind turbines installed onshore or offshore.

This International Standard provides guidance on the analysis of the wind turbine loads in relation to the design of the gear and gearbox elements.

The gearing elements covered by this standard include such gears as spur, helical or double helical and their combinations in parallel and epicyclic arrangements in the main power path. This standard does not apply to power take off gears (PTO).

The standard is based on gearbox designs using rolling element bearings. Use of plain bearings is permissible under this standard, but the use and rating of them is not covered.

Also included is guidance on the engineering of shafts, shaft hub interfaces, bearings and the gear case structure in the development of a fully integrated design that meets the rigours of the operating conditions.

Lubrication of the transmission is covered along with prototype and production testing. Finally, guidance is provided on the operation and maintenance of the gearbox.

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

IEC/TS 61400-13:2001, *Wind turbine generator systems – Part 13: Measurement of mechanical loads*

IEC 61400-22:2010, *Wind turbines – Part 22: Conformity testing and certification*

ISO 76, *Rolling bearings – Static load ratings*

ISO 281:2007, *Rolling bearings – Dynamic load ratings and rating life*

ISO 683 (all parts), *Heat-treatable steels, alloy steels and free-cutting steels*

ISO 1328-1, *Cylindrical gears – ISO system of accuracy – Part 1: Definitions and allowable values of deviations relevant to corresponding flanks of gear teeth*

ISO 4287, *Geometrical Product Specifications (GPS) – Surface texture: Profile method – terms, definitions and surface texture parameters*

ISO 4288, *Geometrical Product Specifications (GPS) – Surface texture: Profile method – rules and procedures for the assessment of surface texture*

ISO 4406, *Hydraulic fluid power – Fluids– Method for coding the level of contamination by solid particles*

ISO 5725-2, *Accuracy (trueness and precision) of measurement methods and results – Part 2: Basic methods for the determination of repeatability and reproducibility of a standard measurement method*

ISO 6336 (all parts), *Calculation of load capacity of spur and helical gears*

ISO 6336-1:2006, *Calculation of load capacity of spur and helical gears – Part 1: Basic principles, introduction and general influence factors*

ISO 6336-2:2006, *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 6336-5:2003, *Calculation of load capacity of spur and helical gears – Part 5: Strength and quality of materials*
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ISO 6336-6:2006, *Calculation of load capacity of spur and helical gears – Part 6: Calculation of service life under variable load*

ISO/TR 10064-3, *Cylindrical gears – Code of inspection practice – Part 3: Recommendations relative to gear blanks, shaft centre distance and parallelism of axes*

ISO 12925-1, *Lubricants, industrial oils and related products (class L). Family C (Gears) – Part 1: Specifications for lubricants for enclosed gear systems*

ISO/TR 13593, *Enclosed gear drives for industrial applications*

ISO/TR 13989-1, *Calculation of scuffing load capacity of cylindrical, bevel and hypoid gears – Part 1: Flash temperature method*

ISO/TR 13989-2, *Calculation of scuffing load capacity of cylindrical, bevel and hypoid gears – Part 2: Integral temperature method*

ISO 14104, *Gears – Surface temper etch inspection after grinding*

ISO 14635-1:2000, *Gears – FZG test procedures – Part 1: FZG test method A/8,3/90 for relative scuffing load-carrying capacity of oils*

ISO 15243:2004, *Rolling bearings – Damage and failures – Terms, characteristics and causes*

ISO/TS 16281:2008, *Rolling bearings – Methods for calculating the modified reference rating life for universally loaded bearings*

AGMA 9005, *Industrial Gear Lubrication*

ANSI/AGMA 925-A02, *Effect of lubrication on gear surface distress*

ANSI/AGMA 6001-E10, *Design and selection of components for enclosed gear drives*

ANSI/AGMA 6123, *Design manual for enclosed epicyclic gear drives*

ASTM E1049-85, *Standard practices for cycle counting in fatigue analysis*

DIN 471, *Circlips (retaining rings) for shafts: Normal type and heavy type*

DIN 472, *Circlips (retaining rings) for bores: Normal type and heavy type*

DIN 743:2000, *Shafts and axles, calculations of load capacity, Parts 1, 2, 3*

DIN 3990-4, *Calculation of load capacity of cylindrical gears: calculation of scuffing load capacity*

DIN 6885-2, *Parallel Key Geometries*

DIN 6892, *Mitnehmerverbindungen ohne Anzug – Passfedern – Berechnung und Gestaltung* (available in German only)

DIN 7190, *Interference fits – Calculation and design rules*

DIN 51517-3, *Lubricants: Lubricating oils* IEC 61400-4 Part 3: *Lubricating oils CLP; Minimum requirements*

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EN 12680-3:2003, *Ultrasonic examination. Spheroidal graphite cast iron castings*

3 Terms, definitions and conventions

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61400-1:2005 and IEC 60050-415 as well as the following apply.

NOTE The definitions in this standard take precedence.

3.1.1

bearing manufacturer

legal entity supplying bearings for the wind turbine gearbox, and who is responsible for the design and the application engineering of the bearing

Note 1 to entry: Typically, the bearing supplier will also manufacture the bearing.

3.1.2

certification body

entity that conducts certification of conformity of the wind turbine gearbox in accordance with IEC 61400-22

3.1.3

characteristic load

load value having a prescribed probability of not being exceeded

Note 1 to entry: See also 3.1.5, design load.

3.1.4

design lifetime

specified duration for which strength verification shall be performed

Note 1 to entry: Some serviceable components and wear parts may have a lower design lifetime than the one specified for the entire gearbox.

3.1.5

design load

load for which the strength of any component has to be documented

Note 1 to entry: It consists of the characteristic load multiplied by the appropriate partial safety factor for load.

Note 2 to entry: See also IEC 61400-1 and Clause 6.

3.1.6

double-row bearings

rolling bearings with two rows of rolling elements

3.1.7

equivalent load

load which when repeated for a specified number of cycles causes the same damage as the actual load variation if a specified life exponent applies

Note 1 to entry: When applied to load ranges, the equivalent load does not take the mean-stress level of the load cycles into account.

3.1.8

extreme load

that design load from any source, either operating or non-operating, that is the largest absolute value of the respective load component

Note 1 to entry: This component can be a force, a moment, a torque or a combination of these.

3.1.9

gearbox manufacturer

the entity responsible for designing the gearbox, and specifying manufacturing requirements for the gearbox and its components

Note 1 to entry: In reality, several legal entities may be involved in this process, which is not further reflected in this standard.

3.1.10

interface

defined boundary of the gearbox that is either a physical mount to another wind turbine subcomponent or a path of exchange such as control signals, hydraulic fluid, or lubricant

3.1.11

load reserve factor

LRF

ratio of the design load to the maximum allowable load on a specific component

Note 1 to entry: *LRF* can be determined separately for both the ultimate and fatigue strength calculation.

3.1.12

local failure

failure which occurs when at a critical location, the maximum allowable strain is exceeded