SLOVENSKI PREDSTANDARD

oSIST prEN 81400-4:2005

februar 2005

Sistemi generatorjev za vetrne turbine – 4. del: Menjalniki za turbine od 40 kW do 2 MW in večje

Wind turbine generator systems – Part 4: Gearboxes for turbines from 40 kW to 2 MW and larger

ICS 27.180

Referenčna številka
oSIST prEN 81400-4:2005(en)

IEC

88/220/CDV

COMMITTEE DRAFT FOR VOTE (CDV)
PROJET DE COMITÉ POUR VOTE (CDV)

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Titre du CE/SC:

TC/SC Title: Wind turbines

Secretary: A.C. van der Giessen
Secrétaire:

Also of interest to the following committees / Intéresse également les comités suivants

Supersedes document / Remplace le document: 88/178/NP - 88/183/RVN

Functions concerned / Fonctions concernées

☐ Safety / Sécurité ☐ EMC / CEM ☐ Environment / Environnement ☒ Quality assurance / Assurance qualité

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Titre : ISO/CEI 81400-4 Ed.1 : Aérogénérateurs — Partie 4: Boîtes de vitesses pour générateurs de 40 kW à 2 MW ou plus

Title : ISO/IEC 81400-4 Ed.1: Wind turbine generator systems — Part 4: Gearboxes for turbines from 40 kW to 2 MW and larger

Introductory note

Following the circulation of 88/178/NP and 88/183/RVN, and subsequent negotiations with ISO TC 60 a Joint Working Group (JWG) of IEC TC 88 and ISO TC 60 on wind turbine gearboxes was set up. See documents 88/196/AC, 88/210/AC, 88/212/AC, 88/219/INF.

On 11 and 12 October 2004 the JWG convened its second meeting at Danish Standards Association (DS) near Copenhagen, Denmark.

The following details were agreed to by the JWG:

1. Existing document ANSI/ AGMA/ AWEA 6006-A03 will be fast- tracked through ISO.
   - balloting will occur in both ISO and IEC starting at CDV (DIS) stage
   - the JWG will resolve the comments in a meeting
   - document will be an ISO document with IEC logo (Edition 1)
2. JWG concurrently works on and develops Edition 2
   - Edition 2 will be an IEC document (with ISO logo)
   - Then Edition 1 will be withdrawn when Edition 2 is published
   - parallel voting in ISO and IEC at CDV (DIS) and FDIS stages
3. A joint maintenance team will be created as a continuance of the JWG to keep the document updated as requested by TC 88 and/or TC 60

ATTENTION	ATTENTION
CDV soumis en parallèle au vote (CEI) et à l'enquête (CENELEC)	Parallel IEC CDV/CENELEC Enquiry

FORM CDV (IEC)
2002-08-09

DRAFT INTERNATIONAL STANDARD ISO/DIS 81400-4

ISO/TC **60** Secretariat: **ANSI**

Voting begins on **2004-12-01** Voting terminates on **2005-05-01**

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION
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FAST-TRACK PROCEDURE

Wind turbine generator systems —

Part 4: Gearboxes for turbines from 40 kW to 2 MW and larger

Aérogénérateurs —

Partie 4: Boîtes de vitesses pour générateurs de 40 kW à 2 MW ou plus

ICS 21.200

This draft is submitted to a parallel enquiry in ISO and a CDV vote in the IEC.

NOTE FROM THE ISO CENTRAL SECRETARIAT

This draft International Standard is submitted for voting to ISO member bodies under the fast-track procedure.

Technical Committee ISO/TC 60, *Gears*, at its meeting held in 2004-11-12, decided to approve the submission of the standard ANSI/AGMA/AWEA 6006-A03, *Standard for design and specification of gearboxes for wind turbines (from 40 kW to 2 MW and larger)*, for processing under the “Fast-track procedure”, in accordance with the provisions of Clause F.2, Annex F, of the ISO/IEC Directives, Part 1 (fourth edition, 2001).

F.2 “Fast-track procedure”

F.2.1 Proposals to apply the fast-track procedure may be made as follows.

F.2.1.1 Any P-member or category A liaison organization of a concerned technical committee may propose that an **existing standard from any source** be submitted for vote as an enquiry draft. The proposer shall obtain the agreement of the originating organization before making a proposal. The criteria for proposing an existing standard for the fast-track procedure are a matter for each proposer to decide.

F.2.1.2 An international standardizing body recognized by the ISO or IEC council board may propose that a **standard developed by that body** be submitted for vote as a final draft International Standard.

F.2.1.3 An organization having entered into a formal technical agreement with ISO or IEC may propose, in agreement with the appropriate technical committee or subcommittee, that a **draft standard developed by that organization** be submitted for vote as an enquiry draft within that technical committee or subcommittee.

F.2.2 The proposal shall be received by the Chief Executive Officer, who shall take the following actions:

a) settle the copyright and/or trademark situation with the organization having originated the proposed document, so that it can be freely copied and distributed to national bodies without restriction;

b) for cases F.2.1.1 and F.2.1.3, assess in consultation with the relevant secretariats which technical committee/subcommittee is competent for the subject covered by the proposed document; where no technical committee exists competent to deal with the subject of the document in question, the Chief Executive Officer shall refer the proposal to the technical management board, which may request the Chief Executive Officer to submit the document to the enquiry stage and to establish an ad hoc group to deal with matters subsequently arising;

c) ascertain that there is no evident contradiction with other International Standards;

d) distribute the proposed document as an enquiry draft (F.2.1.1 and F.2.1.3) in accordance with 2.6.1, or as a final draft International Standard (case F.2.1.2) in accordance with 2.7.1, indicating (in cases F.2.1.1 and F.2.1.3) the technical committee/subcommittee to the domain of which the proposed document belongs.

F.2.3 The period for voting and the conditions for approval shall be as specified in 2.6 for an enquiry draft and 2.7 for a final draft International Standard. In the case where no technical committee is involved, the condition for approval of a final draft International Standard is that not more than one-quarter of the total number of votes cast are negative.

F.2.4 If, for an enquiry draft, the conditions of approval are met, the draft standard shall progress to the approval stage (2.7). If not, the proposal has failed and any further action shall be decided upon by the technical committee/subcommittee to which the document was attributed in accordance with F.2.2 b).

If, for a final draft International Standard, the conditions of approval are met, the document shall progress to the publication stage (2.8). If not, the proposal has failed and any further action shall be decided upon by the technical committee/subcommittee to which the FDIS was attributed in accordance with F.2.2 b), or by discussion between the originating organization and the office of the CEO if no technical committee was involved.

If the standard is published, its maintenance shall be handled by the technical committee/subcommittee to which the document was attributed in accordance with F.2.2 b), or, if no technical committee was involved, the approval procedure set out above shall be repeated if the originating organization decides that changes to the standard are required.

ANSI/AGMA/AWEA 6006-A03
(Supersedes AGMA/AWEA 921–A97
ISO/TC 60 865)

AMERICAN NATIONAL STANDARD

Standard for Design and Specification of Gearboxes for Wind Turbines

(from 40 kW to 2 MW and Larger)

ANSI/AGMA/AWEA 6006-A03

AGMA STANDARD

American National Standard

Standard for Design and Specification of Gearboxes for Wind Turbines
ANSI/AGMA/AWEA 6006-A03

Approval of an American National Standard requires verification by ANSI that the requirements for due process, consensus, and other criteria for approval have been met by the standards developer.

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CAUTION NOTICE: AGMA technical publications are subject to constant improvement, revision, or withdrawal as dictated by experience. Any person who refers to any AGMA technical publication should be sure that the publication is the latest available from the Association on the subject matter.

[Tables or other self-supporting sections may be referenced. Citations should read: See ANSI/AGMA/AWEA 6006-A03, *Standard for Design and Specification of Gearboxes for Wind Turbines*, published by the American Gear Manufacturers Association, 500 Montgomery Street, Suite 350, Alexandria, Virginia 22314, http://www.agma.org.]

Approved January 9, 2004

ABSTRACT

This standard is intended to apply to wind turbine gearboxes. It provides information for specifying, selecting, designing, manufacturing, procuring, operating and maintaining reliable speed increasing gearboxes for wind turbine generator system service.

Annex information is supplied on: wind turbine architecture, wind turbine load description, quality assurance, operation and maintenance, minimum purchaser gearbox manufacturer ordering data, lubrication selection and monitoring, determination of an application factor from a load spectrum using the equivalent torque, and bearing stress calculations.

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American Gear Manufacturers Association
500 Montgomery Street, Suite 350, Alexandria, Virginia 22314

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Foreword

[The foreword, footnotes and annexes, if any, in this document are provided for informational purposes only and are not to be construed as a part of ANSI/AGMA/AWEA 6006-A03, *Standard for Design and Specification of Gearboxes for Wind Turbines.*]

The operation and loading of a wind turbine speed increasing gearbox is unlike most other gear applications. The intent of this standard is to describe the differences. Much of the information is based on field experience. This standard is a tool whereby wind turbine and gearbox manufacturers can communicate and understand each other's needs in developing a gearbox specification for wind turbine applications. The annexes present informative discussion of various issues specific to wind turbine applications and gear design.

A combined committee of AWEA and AGMA members representing wind turbine manufacturers, operators, researchers, consultants, and gear, bearing and lubricant manufacturers were responsible for the drafting and development of this standard.

The committee first met in 1993 to develop AGMA/AWEA 921-A97, *Recommended Practices for Design and Specification of Gearboxes for Wind Turbine Generator Systems.* The AGMA Information Sheet was approved by the AGMA/AWEA Wind Turbine Gear Committee on October 25, 1996 and by the AGMA Technical Division Executive Committee on October 28, 1996. This standard supersedes AGMA/AWEA 921-A97.

The first draft of ANSI/AGMA/AWEA 6006-A03 was made in March, 2000. It was approved by the AGMA membership in October, 2003. It was approved as an American National Standard on January 9, 2004.

Suggestions for improvement of this standard will be welcome. They should be sent to the American Gear Manufacturers Association, 500 Montgomery Street, Suite 350, Alexandria, Virginia 22314.

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American National Standard -

Standard for Design and Specification of Gearboxes for Wind Turbines

1 Scope

This standard applies to gearboxes for wind turbines with power capacities ranging from 40 kW to 2 MW. It applies to all parallel axis, one stage epicyclic, and combined one stage epicyclic and parallel shaft enclosed gearboxes. The provisions made in this standard are based on field experience with wind turbines having the above power capacities and configurations.

Guidelines of this standard may be applied to higher capacity wind turbines provided the specifications are appropriately modified to accommodate the characteristics of higher capacity wind turbines.

Life requirements apply to wind turbines with a minimum design lifetime of 20 years.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the documents indicated below.

AGMA 901-A92, *A Rational Procedure for Preliminary Design of Minimum Volume Gears*

AGMA 913-A98, *Method for Specifying the Geometry of Spur and Helical Gears*

AGMA 925-A03, *Effect of Lubrication on Gear Surface Distress*

AMS 2301, *Aircraft quality steel cleanliness, magnetic particle inspection procedure*

ANSI Y12.3-1968, *Letter symbols for quantities used in mechanics of solids*

ANSI/AGMA 1012-F90, *Gear Nomenclature, Definitions of Terms with Symbols*

ANSI/AGMA 2101-C95, *Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth*

ANSI/AGMA 6000-B96, *Specification for Measurement of Linear Vibration on Gear Units*

ANSI/AGMA 6001-D97, *Design and Selection of Components for Enclosed Gear Drives*

ANSI/AGMA 6025-D98, *Sound for Enclosed Helical, Herringbone, and Spiral Bevel Gear Drives*

ANSI/AGMA 6110-F97, *Standard for Spur, Helical, Herringbone and Bevel Enclosed Drives*

ANSI/AGMA 6123-A88, *Design Manual for Enclosed Epicyclic Metric Module Gear Drives*

ANSI/AGMA 9005-E02, *Industrial Gear Lubrication*

ANSI/AGMA/ISO 1328-1, *Cylindrical Gears - ISO System Of Accuracy - Part 1: Definitions and Allowable Values of Deviations Relevant to Corresponding Flanks of Gear Teeth*

ASTM A534, *Standard specification for carburizing steels for anti-friction bearings*

Det Norske Veritas Classification AS, Classification Notes No. 41.2, *Calculation of Gear Rating for Marine Transmissions,* July 1993

DIN ISO 281 Bbl. 4:2003, *Dynamische Tragzahl und nominelle Lebensdauer - Verfahren zur Berechnung der modifizierten Referenzlebensdauer für allgemein belastete Wälzlager (Dynamic load ratings and life - Method for calculation of the modified reference rating life for generally loaded rolling bearings)*[1)]

DIN 743:2000, *Tragfähigkeitsberechnung von Wellen und Achsen (Calculation of load capacity of shafts and axles)*

[1)] English translation available as ISO TC 4/SC 8 N254a

DIN 7190:2001, *Interference fits - Calculation and design rules*

ISO 76:1987, *Rolling bearings - Static load ratings*

ISO 281:1990, *Rolling bearings - Dynamic load rating and rating life*

ISO R773:1969, *Rectangular or square parallel keys and their corresponding keyways (dimensions in millimeters)*

ISO 4406:1999 (SAE J1165), *Hydraulic fluid power - Fluids - Method for coding the level of contamination by solid particles*

ISO 6336- 1: 1996, *Calculation of load capacity of spur and helical gears- Part 1: Basic principles, introduction and general influence factors*

ISO 6336- 2: 1996, *Calculation of load capacity of spur and helical gears- Part 2: Calculation of surface durability (pitting)*

ISO 6336- 3: 1996, *Calculation of load capacity of spur and helical gears- Part 3: Calculation of tooth bending strength*

ISO 6336-5: 1996, *Calculation of load capacity of spur and helical gears- Part 5: Strength and quality of materials*

ISO/CD 6336-6[2)], *Calculation of load capacity of spur and helical gears - Part 6: Calculation of service life under variable load*

ISO 8579-1:2002, *Acceptance code for gears - Part 1: Determination of airborne sound power levels emitted by gear units*

ISO 8579-2:1993, *Acceptance code for gears - Part 2: Determination of mechanical vibration of gear units during acceptance testing*

ISO/TR 13593:1999, *Enclosed gear drives for industrial applications*

ISO/TR 13989-1:2000, *Calculation of scuffing load capacity of cylindrical, bevel and hypoid gears - Part 1: Flash temperature method*

ISO 14104:1995, *Gears - Surface temper etch inspection after grinding*

ISO/TR 14179-1:2001, *Gears - Thermal capacity - Part 1: Rating gear drives with thermal equilibrium at 95 °C sump temperature*

3 Definitions and symbols

The terms used, wherever applicable, conform to ANSI/AGMA 1012-F90, and ANSI Y12.3-1968.

3.1 Symbols

The symbols, terms and units used in this standard are shown in table 1.

> **NOTE:** The symbols and terms contained in this document may vary from those used in other AGMA standards. Users of this standard should assure themselves that they are using these symbols and terms in the manner indicated herein.

3.2 Wind turbine terms

active yaw: A system to rotate the nacelle relative to the changing direction of the wind. See passive yaw.

airfoil: Two dimensional cross section of a blade.

annual average wind speed: The time averaged, mean, horizontal wind speed for one calendar year at a particular site and a specified height.

annual average turbulence intensity: A measure of the short-time and spatial variation of the inflow wind speed about its long time average.

availability: The ratio of the number of hours that a turbine could operate to the total number of hours in that period, usually expressed as a percentage. Downtime due to faults or maintenance (scheduled or otherwise) generally make up the unavailable time.

bedplate: In a modular system, the structure that supports the drive train components and nacelle cover. Also called a main frame.

blade: The component of the rotor that converts wind energy into rotation of the rotor shaft.

brake: A device capable of stopping rotation of the rotor or reducing its speed.

certification: Procedure by which a third party gives written assurance that a product, process or service conforms to specified requirements, also known as conformity assessment.

certification standard: Standard that has specific rules for procedures and management to carry out certification of conformity.

control system: A system that monitors the wind turbine and its environment and adjusts the wind turbine to keep it within operating limits.

2) Presently at the development stage.