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INTERNATIONAL STANDARD

colour inside

Wind turbines –
Part 11: Acoustic noise measurement techniques

IEC 61400-11:2012-11+AMD1:2018-06 CSV(en)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FOREWORD

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This consolidated version of the official IEC Standard and its amendment has been prepared for user convenience.

IEC 61400-11 edition 3.1 contains the third edition (2012-11) [documents 88/436/FDIS and 88/440/RVD], its amendment 1 (2018-06) [documents 88/615/CDV and 88/644A/RVC] and its corrigendum (2019-10).

In this Redline version, a vertical line in the margin shows where the technical content is modified by amendment 1. Additions are in green text, deletions are in strikethrough red text. A separate Final version with all changes accepted is available in this publication.

International Standard IEC 61400-11 has been prepared by IEC technical committee 88: Wind turbines.

This third edition constitutes a technical revision, introducing new principles for data reduction procedures.

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

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

The committee has decided that the contents of the base publication and its amendment will remain unchanged until the stability 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- withdrawn,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.

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

The purpose of this part of IEC 61400 is to provide a uniform methodology that will ensure consistency and accuracy in the measurement and analysis of acoustical emissions by wind turbine generator systems. This International Standard has been prepared with the anticipation that it would be applied by:

- wind turbine manufacturers striving to meet well defined acoustic emission performance requirements and/or a possible declaration system (e.g. IEC/TS 61400-14);
- wind turbine purchasers for specifying performance requirements;
- wind turbine operators who may be required to verify that stated, or required, acoustic performance specifications are met for new or refurbished units;
- wind turbine planners or regulators who must be able to accurately and fairly define acoustical emission characteristics of a wind turbine in response to environmental regulations or permit requirements for new or modified installations.

This standard provides guidance in the measurement, analysis and reporting of complex acoustic emissions from wind turbine generator systems. The standard will benefit those parties involved in the manufacture, installation, planning and permitting, operation, utilization, and regulation of wind turbines. The measurement and analysis techniques recommended in this document should be applied by all parties to ensure that continuing development and operation of wind turbines is carried out in an atmosphere of consistent and accurate communication relative to environmental concerns. This standard presents measurement and reporting procedures expected to provide accurate results that can be replicated by others.

INTRODUCTION to the Amendment

This amendment to IEC 61400-11:2012 addresses the situation where a measurement consists of measurements series on different days or with substantially different conditions. Furthermore, clarifications have been introduced on tonality analysis and reporting. Editorial changes have been made.

WIND TURBINES –

Part 11: Acoustic noise measurement techniques

1 Scope

This part of IEC 61400 presents measurement procedures that enable noise emissions of a wind turbine to be characterised. This involves using measurement methods appropriate to noise emission assessment at locations close to the machine, in order to avoid errors due to sound propagation, but far away enough to allow for the finite source size. The procedures described are different in some respects from those that would be adopted for noise assessment in community noise studies. They are intended to facilitate characterisation of wind turbine noise with respect to a range of wind speeds and directions. Standardisation of measurement procedures will also facilitate comparisons between different wind turbines.

The procedures present methodologies that will enable the noise emissions of a single wind turbine to be characterised in a consistent and accurate manner. These procedures include the following:

- location of acoustic measurement positions;
- requirements for the acquisition of acoustic, meteorological, and associated wind turbine operational data;
- analysis of the data obtained and the content for the data report; and
- definition of specific acoustic emission parameters, and associated descriptors which are used for making environmental assessments.

This International Standard is not restricted to wind turbines of a particular size or type. The procedures described in this standard allow for the thorough description of the noise emission from a wind turbine. A method for small wind turbines is described in Annex F.

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 60688, *Electrical measuring transducers for converting a.c. electrical quantities to analogue or digital signals*

IEC 60942:2003, *Electroacoustics – Sound calibrators*

IEC 61260:1995, *Electroacoustics – Octave-band and fractional-octave-band filters*

IEC 61400-12-1:2005, *Wind turbines – Part 12-1: Power performance measurements of electricity producing wind turbines*

IEC 61400-12-2, *Wind turbines – Part 12-2: Power performance verification of electricity producing wind turbines*[1]

1 To be published.

IEC 61672 (all parts), *Electroacoustics – Sound level meters*

ISO/IEC Guide 98-3, *Uncertainty of measurement – Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

3 Terms and definitions

For the purposes of this standard, the following terms and definitions apply.

3.1
apparent sound power level
L_{WA}
A-weighted sound power level re. 1 pW of a point source at the rotor centre with the same emission in the downwind direction as the wind turbine being measured, L_{WA} is determined at bin centre wind speeds at hub height

Note 1 to entry: Apparent sound power level is expressed in dB re. 1 pW.

3.2
apparent sound power level with reference to wind speed at 10 m height
$L_{WA,10m}$
A-weighted sound power level re. 1 pW of a point source at the rotor centre with the same emission in the downwind direction as the wind turbine being measured, $L_{WA,10m}$ are determined at bin centre wind speeds at 10 m height within the measured wind speed range

Note 1 to entry: Apparent sound power level with reference to wind speed at 10 m height is expressed in dB re. 1 pW.

3.3
audibility criterion
L_a
frequency dependent criterion curve determined from listening tests, and reflecting the subjective response of a “typical” listener to tones of different frequencies

Note 1 to entry: Audibility criterion is expressed in dB re. 20 μPa.

3.4 sound pressure levels

3.4.1 A-weighted sound pressure levels

L_A
sound pressure levels measured with the A frequency weighting networks specified in IEC 61672

Note 1 to entry: A-weighted sound pressure levels are expressed in dB re. 20 μPa.

3.4.2 C-weighted sound pressure levels

L_C
sound pressure levels measured with the C frequency weighting networks specified in IEC 61672

Note 1 to entry: C-weighted sound pressure levels are expressed in dB re. 20 μPa.

3.5
bin centre
centre value of a wind speed bin

3.6
inclination angle
ϕ
angle between the plane of the measurement board and a line from the microphone to the rotor centre

Note 1 to entry: Inclination angle is expressed in °.

3.7
maximum power
maximum value of the binned power curve for the power optimised mode of operation

Note 1 to entry: Maximum power is expressed in kW.

3.8
measured wind speed at height Z
$V_{Z,m}$
wind speed measured at height Z with a mast mounted anemometer

Note 1 to entry: Measured wind speed at height Z is expressed in m/s.

3.9
measured nacelle wind speed at hub height
$V_{nac,m}$
wind speed measured at hub height with a nacelle anemometer

Note 1 to entry: Measured nacelle wind speed at hub height is expressed in m/s.

3.10
normalised nacelle wind speed at hub height
$V_{nac,n}$
normalised wind speed measured at hub height with a nacelle anemometer corrected to standard meteorological conditions

Note 1 to entry: Normalised nacelle wind speed at hub height is expressed in m/s.

3.11
normalised wind speed derived from power curve
$V_{P,n}$
normalised wind speed derived from power curve under standard meteorological conditions

Note 1 to entry: Normalised wind speed derived from power curve is expressed in m/s.

3.12
normalised wind speed at hub height during background noise measurements
$V_{B,n}$
normalised wind speed at hub height from anemometer

Note 1 to entry: Normalised wind speed at hub height during background noise measurements is expressed in m/s.

3.13
normalised wind speed at hub height
$V_{H,n}$
normalised wind speed at hub height

Note 1 to entry: Normalised wind speed at hub height is expressed in m/s.

3.14
normalised wind speed at height Z
$V_{Z,n}$
normalised wind speed at height Z from mast mounted anemometer