

PD IEC/TS 62600-201:2015



BSI Standards Publication

Marine energy — Wave, tidal and other water current converters

Part 201: Tidal energy resource assessment
and characterization

bsi.

...making excellence a habit.™

National foreword

This Published Document is the UK implementation of IEC/TS 62600-201:2015.

The UK participation in its preparation was entrusted to Technical Committee PEL/114, Marine energy — Wave, tidal and other water current converters.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

© The British Standards Institution 2015.

Published by BSI Standards Limited 2015

ISBN 978 0 580 79776 7

ICS 27.140

Compliance with a British Standard cannot confer immunity from legal obligations.

This Published Document was published under the authority of the Standards Policy and Strategy Committee on 31 August 2015.

Amendments/corrigenda issued since publication

Date	Text affected
-------------	----------------------



TECHNICAL SPECIFICATION



Marine energy – Wave, tidal and other water current converters – Part 201: Tidal energy resource assessment and characterization

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 27.140

ISBN 978-2-8322-2591-2

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

CONTENTS

FOREWORD.....	4
INTRODUCTION.....	6
1 Scope.....	7
2 Normative references	7
3 Terms and definitions	7
4 Symbols, units and abbreviations	7
4.1 Symbols and units	7
4.2 Abbreviations.....	8
5 Methodology overview	8
5.1 Project definition.....	8
5.1.1 General	8
5.1.2 Stage 1: Feasibility study.....	9
5.1.3 Stage 2: Layout design study.....	9
5.2 Methodology	9
6 Data collection.....	12
6.1 Introduction.....	12
6.2 Bathymetry	12
6.3 Tidal characteristics.....	13
6.3.1 General	13
6.3.2 Assessment of data quality	13
6.3.3 Tidal height	14
6.3.4 Tidal current mobile survey.....	14
6.3.5 Tidal current stationary survey.....	16
6.4 Meteorological data	19
6.4.1 General	19
6.4.2 Wind data	19
6.4.3 Atmospheric pressure.....	20
6.5 Wave climate	20
6.6 Turbulence.....	20
6.6.1 General	20
6.6.2 Flow structure / Eddies	20
6.7 Stratification, seawater density and sediment measurement	21
7 Model development and outputs	21
7.1 General.....	21
7.2 Model coverage, resolution and boundary conditions	21
7.2.1 Bathymetric data	21
7.2.2 Model coverage	22
7.2.3 Model boundary conditions	22
7.2.4 Model resolution	23
7.3 Choice of model (including characteristics)	23
7.3.1 General considerations.....	23
7.3.2 Model selection	24
7.3.3 Model characteristics.....	25
7.4 Analysing data to provide model inputs, calibration and validation	25
7.4.1 Bathymetry interpolation.....	25

7.4.2	Currents	25
7.4.3	Meteorological analysis	25
7.4.4	Waves	26
7.4.5	Turbulence	26
7.4.6	Flow Structures / Eddies.....	27
7.4.7	Seawater density, salinity and temperature.....	28
7.4.8	Sediment	28
7.5	Model calibration / Validation	28
7.5.1	Model calibration	28
7.5.2	Model validation	29
7.6	Incorporating energy extraction.....	30
7.6.1	General	30
7.6.2	Methodology for incorporating energy extraction.....	31
7.6.3	Practical incorporation of energy extraction in modelling.....	32
8	Data analysis and results presentation	33
8.1	General model result presentation	33
8.2	Generation of annual velocity distribution.....	33
8.2.1	General	33
8.2.2	Potential methodologies for simulating “missing” tidal constituents	34
8.2.3	Long-term model current predictions (harmonic analysis)	34
8.2.4	Results presentation	36
8.3	Velocity distribution curves – Joint probability distribution	37
9	Reporting of results	39
9.1	Purpose of reporting	39
9.2	Contents of the report	39
Annex A (informative)	Calculation of TEC Annual Energy Production	40
A.1	General.....	40
A.2	Individual TEC Annual Energy Production (AEP).....	40
A.3	Array Annual Energy Production	41
Annex B (informative)	Guidelines for current profiler measurements	42
B.1	General.....	42
B.2	Instrument configuration	42
B.3	Correcting for clock drift.....	42
B.4	Depth quality control	43
B.5	Velocity quality control	43
Bibliography	44
Figure 1	– The effect of predicting tides with various constituents from Cook Inlet, Alaska	36
Figure 2	– Joint velocity and direction probability distribution, a location in Cook Inlet, Alaska	38
Figure 3	– Example exceedance curve for velocity magnitude.....	39
Table 1	– Resource assessment stages.....	9
Table 2	– Model and field survey recommendations (Overview)	11

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**MARINE ENERGY –
WAVE, TIDAL AND OTHER WATER CURRENT CONVERTERS –****Part 201: Tidal energy resource assessment and characterization**

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.

The main task of IEC technical committees is to prepare International Standards. In exceptional circumstances, a technical committee may propose the publication of a technical specification when

- the required support cannot be obtained for the publication of an International Standard, despite repeated efforts, or
- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC TS 62600-201, which is a technical specification, has been prepared by IEC technical committee 114: Marine energy – Wave, tidal and other water current converters.

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
114/142/DTS	114/151A/RVC

Full information on the voting for the approval of this technical specification 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 in the IEC 62600 series, published under the general title *Marine energy – Wave, tidal and other water current converters*, can be found on the IEC website.

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

- transformed into an International standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

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 Technical Specification is for use by appropriately qualified and competent persons. The development of the tidal power industry is at an early stage and the significance of particular tidal energy resource characteristics is not well understood. This Technical Specification is intended to be updated as understanding of the resource and its response to power extraction becomes better understood. It is noted that it is presently particularly difficult to derive the uncertainty (within specified confidence limits) of the resource, given lack of field and model data for a statistically significant number of sites.

The purpose of this Technical Specification is to provide a uniform methodology that will ensure consistency and accuracy in the estimation, measurement, characterization and analysis of the theoretical tidal current resource at sites that could be suitable for the installation of an array of Tidal Energy Converters (TECs), together with defining a standardised methodology with which this resource can be described and reported. Application of the estimation, measurement and analysis techniques recommended in this Technical Specification will ensure that resource assessment is undertaken in a consistent and accurate manner. This Technical Specification presents techniques that are expected to provide fair and suitably accurate results that can be replicated by others.

The overall goal of the methodology is to enable calculation of the Annual Energy Production (AEP) for the proposed array of TECs at each TEC location in conjunction with IEC 62600-200.

In this Technical Specification, the theoretical tidal energy resource (undisturbed or disturbed by power extraction) is defined as the velocity probability distribution $f(U_i)$. For projects over c. 10 MW (circa 10 MW), the velocity probability distribution is calculated using hydrodynamic models that have been appropriately verified using measured data. The methodology for measuring the required data is also defined. For individual TECs within small projects of less than c. 10 MW, an alternative method which uses measured data at each TEC location may also be used to define the resource.

This Technical Specification describes only the aspects of the resource required to calculate AEP; e.g., it does not describe aspects of the resource required to evaluate design loads or to satisfy environmental regulations. Furthermore, this Technical Specification is not intended to cover every eventuality that may be relevant for any particular project. Therefore, this Technical Specification assumes that the user has access to, and reviews, other relevant IEC documentation before undertaking work (e.g., surveys and modelling) which could also satisfy other requirements.

MARINE ENERGY – WAVE, TIDAL AND OTHER WATER CURRENT CONVERTERS –

Part 201: Tidal energy resource assessment and characterization

1 Scope

This part of IEC 62600 establishes a system for analysing and reporting, through estimation or direct measurement, the theoretical tidal current energy resource in oceanic areas including estuaries (to the limit of tidal influence) that may be suitable for the installation of arrays of TECs.

It is intended to be applied at various stages of project lifecycle to provide suitably accurate estimates of the tidal resource to enable the arrays' projected annual energy production to be calculated at each TEC location in conjunction with IEC 62600-200.

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

IEC TS 62600-1, *Marine energy – Wave, tidal and other water current converters – Part 1: Terminology*

IEC TS 62600-200, *Marine energy – Wave, tidal and other water current converters – Part 200: Electricity producing tidal energy converters – Power performance assessment*

IHO (International Hydrographic Organisation), 2008, *Standards for Hydrographic Surveys. Special Publication No. 44. 5th Edition*

ICES, 2006, *Guidelines for Multibeam Echosounder Data*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC TS 62600-1 apply.

4 Symbols, units and abbreviations

4.1 Symbols and units

$f(U_i)$ Time occurrence likelihood of a velocity in each magnitude bin (%)

$f(U_i, \theta_k)$ Time occurrence likelihood of a velocity in each magnitude and direction bin (%)

I Turbulence intensity

i Index for velocity magnitude bin numbers