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TECHNICAL SPECIFICATION

Marine energy – Wave, tidal and other water current converters – Part 3: Measurement of mechanical loads

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FOREWORD

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 62600-3, 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
114/326/DTS	114/336A/RVDTS

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 document 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 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- withdrawn,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.

INTRODUCTION

This part of IEC 62600 outlines specifications for the full-scale mechanical loads measurement on hydrodynamic marine energy converters (MECs). It is directed at a technology readiness level (TRL) of 7 to 9, meaning the last prototype or the first production device. This document also outlines the demands for full-scale structural testing of rotor blades as well as the interpretation and evaluation of test results.

In the process of structural design of marine energy converters, thorough understanding and accurate quantification of the loading is of utmost importance. In the design stage, loads can be predicted with simulation models and codes. However, such models have their modelling restrictions and uncertainties, and they always need to be validated by measurement.

Mechanical load measurements can be used both as the basis for design and as the basis for certification. The design of marine energy converters is covered by IEC 62600-2: Marine Energy – Wave, tidal and other water current converters – Part 2: Design requirements for marine energy systems.

This document is aimed at the test institute, the marine energy converter manufacturer and the certifying body and defines the requirements for mechanical loads tests resulting in consistent and reproducible test results.

There exists a large variety of marine energy converter working principles. This document aims to cover most hydrodynamic marine energy converter working principles. Therefore, generalised tests are presented at the level of the common subsystems. For Tidal Energy Converters (TECs) and for other water current converters, the most common working principle is a turbine comprising blades connected to a rotor shaft. Therefore, detailed tests are specified for this working principle. For marine energy converter working principles that do not fit partly or completely in the scope of this document, the technology qualification process is introduced. Through the technology qualification process, the user can adapt the test programme to their specific marine energy converter.

This document is comparable to the international wind standards IEC 61400-13: Wind turbines – Part 13: Measurement of mechanical loads and IEC 61400-23: Wind turbines – Part 23: Full-scale structural testing of rotor blades. Since testing laboratories and certification bodies already have experience with these wind standards, it is convenient to adapt the same methods where possible.

There is not much published experience with offshore mechanical load measurement on marine energy converters. This document is a first step towards a future International Standard which can be used as part of a type certification process of marine energy converters. First, experience should be gained with offshore mechanical load measurement and with the application of this document.

Compliance with this document does not relieve any person, organization, or corporation from the responsibility of observing other applicable regulations.

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

Part 3: Measurement of mechanical loads

1 Scope

1.1 General

This part of IEC 62600 describes the measurement of mechanical loads on hydrodynamic marine energy converters such as wave, tidal and other water current converters (including river current converters) for the purpose of load simulation model validation and certification. This document contains the requirements and recommendations for the measurement of mechanical loads for such activities as site selection, measurand selection, data acquisition, calibration, data verification, measurement load cases, capture matrix, post-processing, uncertainty determination and reporting.

Informative annexes are also provided to improve understanding of testing methods. The methods described in this document can also be used for mechanical loads measurements for other purposes such as obtaining a measured statistical representation of loads, direct measurements of the design loads, safety and function testing, or measurement of subsystem or component structural loads.

Through a technology qualification process, the test requirements can be adapted to the specific marine energy converter.

This document also defines the requirements for full-scale structural testing of subsystems or parts with a special focus on full-scale structural testing of marine energy converter rotor blades and for the interpretation and evaluation of achieved test results. This document focuses on aspects of testing related to an evaluation of the structural integrity of the blade. The purpose of the tests is to confirm to an acceptable level of probability that the whole installed production of a blade type fulfils the design assumptions.

1.2 Subdivision of marine energy converter types

There is a wide variety of marine energy converter types, especially concerning wave energy converters (WECs). For tidal energy converters and other current energy converters (CECs) the working principle of a turbine comprising blades connected to a rotor shaft, is common, whether seabed mounted or mounted to floating structures. However, there are also other types of tidal energy converters under development without blades connected to a rotor shaft and there are wave energy converters under development with blades connected to a rotor shaft. This document aims to cover all types of hydrodynamic marine energy converters, being wave energy converters (WECs) and current energy converters (CECs). Therefore, this document provides requirements and recommendations for all wave energy converters and current energy converters. For wave energy converters and current energy converters with blades connected to a rotor shaft, the requirements are specified in more detail, since in this case there is more knowledge about the technical components of the device.

For all wave and current energy converters a subdivision can be made between seabed (or shore) mounted devices (see Figure 1) and floating devices (see Figure 2). The seabed can also be a riverbed and the shore can also be a pier, a bridge girder, a canal lock gate or another artificial construction. The seabed (or shore) mounted devices generally consist of the following subsystems:

- prime mover;

- power take-off (PTO);
- control;
- foundation and/or substructure.

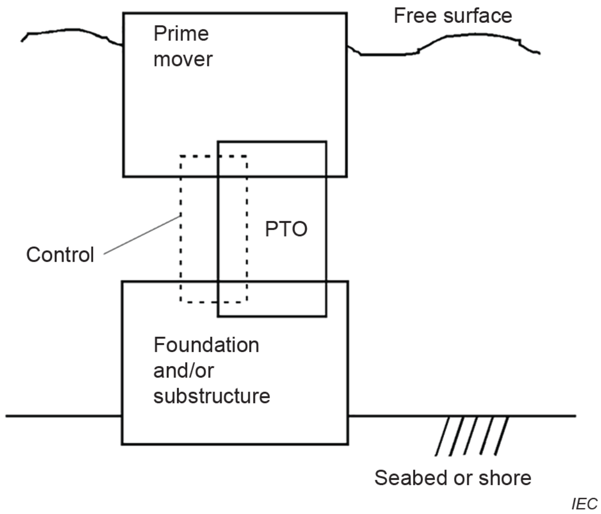

Figure 1 – General scheme of marine energy converters fixed to the seabed or shore

There can be marine energy converter types that do not fit in this characterization like the magneto hydrodynamic device (MHD), where the seawater itself is the prime mover. For such a device the scheme can be reduced to only “foundation and/or substructure”, “power take-off” and “control”. At the oscillating water column device (OWC), air is used to transfer power from the moving seawater to the turbine. Here the air turbine is the prime mover.

Figure 2 gives a scheme for floating marine energy converter working principles. The floating marine energy converters generally consist of the following subsystems:

- prime mover;
- power take-off (PTO);
- control;
- floating device;
- mooring system.

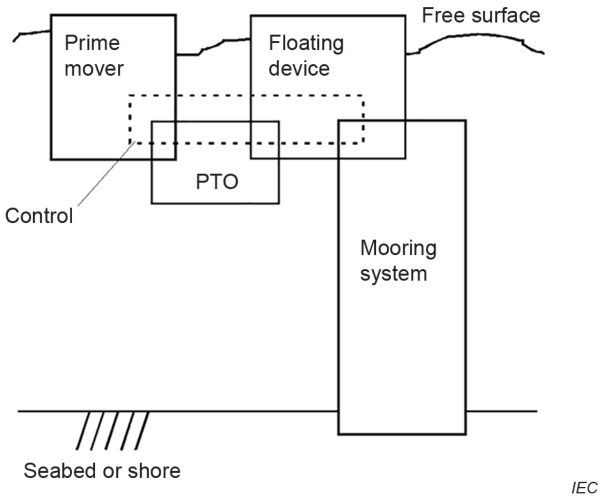

Figure 2 – General scheme of floating marine energy converters moored to the seabed or shore

Other configurations of the subsystems in these figures are also possible. For example, for wave energy converters the power take-off and prime mover can be inside the floating device. Also, a marine energy converter can be composed from more than one subsystem of any kind. The subsystems can also be connected in series, such as alternating series of prime movers and power take-offs, or in parallel. The floating device can also be moored above the seabed but below the free surface.

Special requirements are provided for marine energy converters with one or more blades connected at a single end to a rotor shaft. The rotor forms the prime mover of the marine energy converter. The rotor can rotate with respect to a substructure. The power take-off connects the rotor to the substructure and houses an energy conversion from mechanical power to electrical power or some other form of transportable power such as hydraulic power. This is also called the drive train. The power take-off can be housed in a nacelle. The substructure connects the power take-off to the foundation fixed to the seabed or shore (see Figure 3). A control subsystem can be applied to control critical functions like rotor speed, rotor torque and rotor braking.

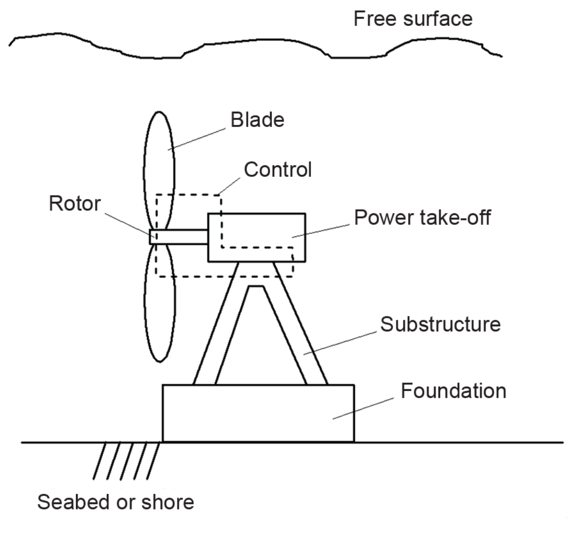

Figure 3 – Marine energy converter with blades connected to a rotor shaft supported by a fixed substructure

There are also optional mechanical components in a control subsystem for example:

- mechanism to allow yawing of the rotor towards the direction of the current (e.g. for the ebb and flood current direction);
- mechanism to allow pitching of the rotor blades for example to optimise power production, to shed loads or to adjust to the direction of the current.

The rotor and power take-off can also be supported by a floating device which is connected to the seabed (or shore) by a mooring system (see Figure 4).

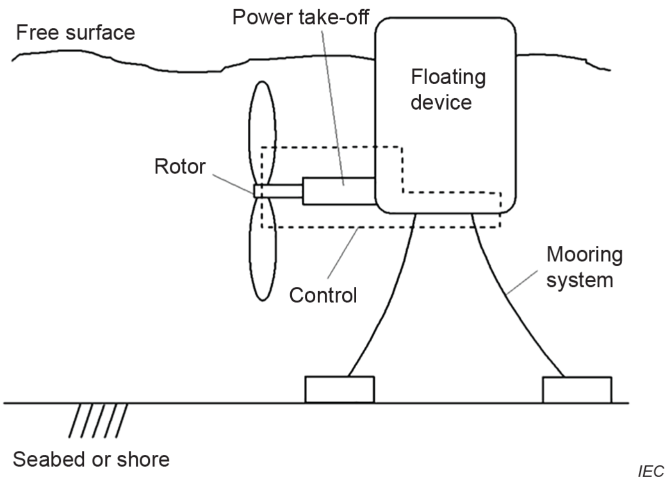

Figure 4 – Marine energy converter with blades connected to a rotor shaft supported by a floating device

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

IEC TS 62600-2:2019, *Marine energy – Wave, tidal and other water current converters – Part 2: Marine energy systems – Design requirements*

IEC TS 62600-10, *Marine Energy – Wave, tidal and other water current converters – Part 10: Assessment of mooring system for marine energy converters (MECs)*

IEC TS 62600-100, *Marine Energy – Wave, tidal and other water current converters – Part 100: Electricity producing wave energy converters – Power performance assessment*

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

IEC TS 62600-300, *Marine energy – Wave, tidal and other water current converters – Part 300: Electricity producing river energy converters – Power performance assessment*

ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*