Irish Standard Recommendation
S.R. CWA 50272:2021

Methodology, procedures and equipment required for the laboratory testing of a modular and crosscutting Power Take-Off for wave energy converters

S.R. CWA 50272:2021

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National Foreword

S.R. CWA 50272:2021 is the adopted Irish version of the European Document CWA 50272:2021, Methodology, procedures and equipment required for the laboratory testing of a modular and crosscutting Power Take-Off for wave energy converters

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CEN WORKSHOP AGREEMENT

CWA 50272

April 2021

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English version

Methodology, procedures and equipment required for the laboratory testing of a modular and crosscutting Power Take-Off for wave energy converters

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Foreword

CWA 50272:2021 has been developed in accordance with the CEN-CENELEC Guide 29 “CEN/CENELEC Workshop Agreements – A rapid prototyping to standardization” and with the relevant provisions of CEN/CENELEC Internal Regulations – Part 2. It was approved by a Workshop of representatives of interested parties on 2021-02-10, the constitution of which was supported by CEN-CENELEC following the public call for participation made on 2020-06-10. However, this CEN-CENELEC Workshop Agreement does not necessarily include all relevant stakeholders.

The final text of CWA 50272:2021 was provided to CEN-CENELEC for publication on 2021-03-18.

Results incorporated in this CWA received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 764014.

The following organizations and individuals developed and approved this CEN-CENELEC Workshop Agreement:

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- CIEMAT, Mr. Marcos Lafoz
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Introduction

As stated in the SET-Plan Ocean Energy, ocean energy must reduce costs in order to be more competitive. Despite the current improvement in the technological development of different solutions, the harsh environment of the oceans is the main cause of uncertainties in the reliability of wave energy conversion systems, presenting the main barrier for the development of its massive energy potential[1)]. The concept of reliability implies many issues, all of them related to minimize both the levelized cost of energy (LCOE) and the total expected life-cycle costs (operation, maintenance and failure costs). Since the wave energy conversion integrates many disciplines, the problem could be analysed from different perspectives. This CWA focusses in the reliability analysis of the device in charge of the energy conversion from mechanical into electrical, what is usually named power take-off (PTO). In particular, in the frame of the named modular and crosscutting PTO, which are defined by the existence of a unitary module with complete operative functionality and the ability to be adapted to different WECs in terms of available space, force, power, velocity and stroke. Since the testing of rotary generators has been addressed in greater detail in the literature [2], this CWA focuses on linear PTOs.

The PTO comprises the electric generator, power electronic converters, control devices and sometimes additional mechanical devices for the conditioning of the mechanical power provided by the prime mover.

Since the PTO system operation can be tested in a dry laboratory emulating the WEC operation conditions, preliminary commissioning of this important part of a WEC could be debugged and validated. An important reduction on the commissioning time could be achieved by this stage, saving important budget and reducing the potential failure risks involving the PTO equipment.

The CWA is defined in the frame of the stage III of full scale and mechanical loads at scaled tests of wave energy converters (IEC/TS 62600-103-2018 and IEC/TS 62600-3-2020 respectively) and the tests described below can be framed during the calibration and setup dry tests. According to IEC/TS 62600-103-2018, "*accurate calibration of the PTO arrangement is essential and shall be performed prior to experimental testing over the design frequency range to fully characterize the dynamic function of the PTO*". Although there are previous standards facing the tank tests of scaled or full-scale prototypes, including some similar power conversion system, not necessarily the final PTO is currently tested at this stage. The current CWA present the laboratory testing of a unitary module but completely functional full-scale PTO before the final integration into the WEC, and previous to the sea commissioning.

This CWA aims to facilitate:

— Testing different parts of a PTO under rated power and/or operational conditions.

— Testing the different parts of a certain PTO together and under operational conditions.

1) Gunn and Stock-Williams, Quantifying the global wave power resource. Renewable Energy, 44 (2012), pp. 296-304. https://doi.org/10.1016/j.renene.2012.01.101

— Characterizing a certain PTO in order to obtain a mathematical model. The model is useful to:

  — Evaluate the LCOE/evaluate other stage gate parameters;

  — Evaluate in different locations under different sea states;

  — Evaluate the performance under different control strategies;

  — Compare different PTO technologies or the same PTO with different WECs.

The CWA comprises the following information:

1) A methodology to test in dry laboratory the performance of a modular and crosscutting linear PTO.

2) The definition of the different procedures for testing a modular and crosscutting linear PTO.

3) The equipment suggested for the experimental tests of each component at the laboratory.

4) The description of application cases, with examples of the different stages and equipment used in previous developments, are included in a final Annex.

This document has been developed in the frame of the project H2020 SEA TITAN (Grant Agreement No. 764014).

1 Scope

This CWA establishes a methodology, procedures and the required equipment in order to test and validate in dry laboratories a modular and crosscutting linear PTO, used for wave energy converters (WEC). It considers common procedures for different types of PTO solutions, as well as operation ranges related to its final location.

Some examples of application of this methodology are presented in Annex A at the end of the document.

Initially, the concepts of modular and crosscutting power take-off or PTO, its components, and the actuator are defined. Additionally, a set of testing scenarios are defined, corresponding to operation at the location, as well as the control strategies to be followed by the PTO. Both subsystems will be operated together with the PTO and the actuator, governed by an upper level supervision system, operating in a hardware-in-the loop scheme. Finally, a whole set of required instrumentation is defined in order to measure the system variables, used subsequently to compile the PTO characterization report.

Regarding the types of WEC where this methodology could be applied, there is no restriction in the WEC topology. Any WEC where a linear PTO is suitable could be in the scope of this document.

The potential users of this document are:

— Developers of power-take-off, either focused on electric machines, power electronics, control systems, instrumentation, or integration of the whole equipment.

— Developers of wave energy converters.

— Experimental facilities where PTOs or WECs are tested.

— Research centres who develop complementary technologies for the PTO.

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 62600-1:2020, *Marine energy — Wave, tidal and other water current converters — Part 1: Vocabulary*

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

IEC/TS 62600-3:2020, *Marine energy — Wave, tidal and other water current converters — Part 3: Measurement of mechanical loads.*

IEC/TS 62600-103, *Marine energy — Wave, tidal and other water current converters — Part 103: Guidelines for the early stage development of wave energy converters — Best practices and recommended procedures for the testing of pre-prototype devices*

IEC/TS 62600-30:2018, *Marine energy — Wave, tidal and other water current converters — Part 30: Electrical power quality requirements*

IEC 62506:2013, *Methods for product accelerated testing*

IEC 61439-1, *Low-voltage switchgear and control gear assemblies — Part 1: General rules*