Guidelines for Marine Energy Converter Certification Schemes

Foreword

This document has been prepared in consultation with The European Marine Energy Centre Ltd (EMEC) and with other interested parties in the UK marine energy community. It is one of eleven publications in the *Marine Renewable Energy Guides* series, included in the following figure.

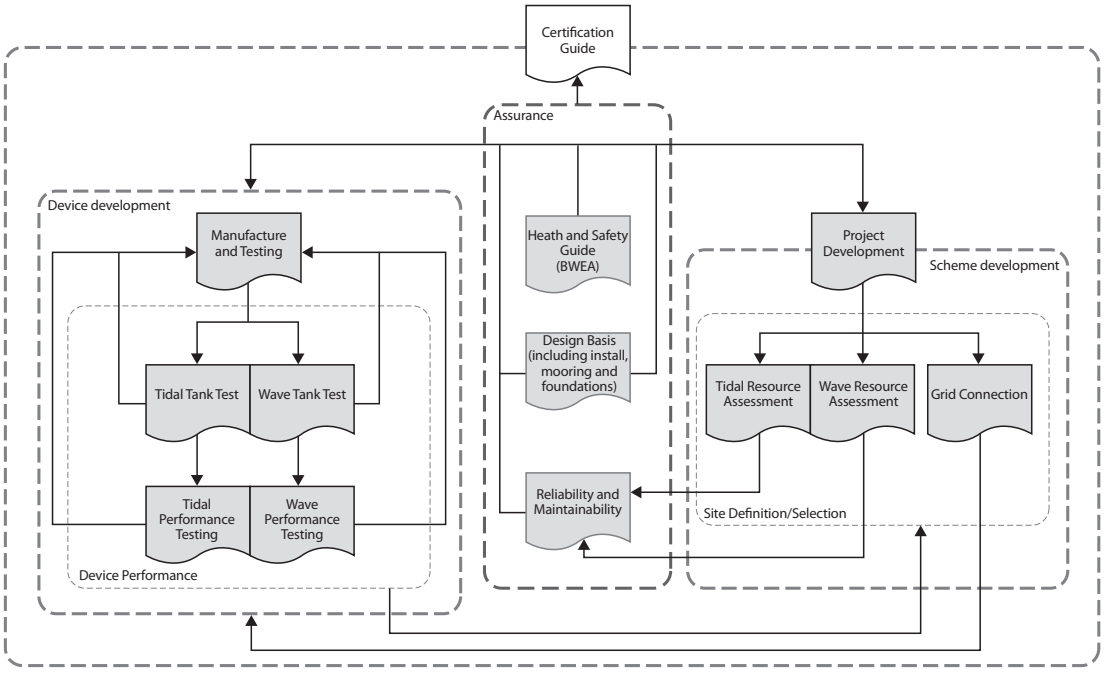

Figure 1 — Marine Renewable Energy Guides

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Marine Renewable Energy Guides

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Introduction

This document responds to the request for harmonization of the certification process to be applied worldwide, adding value to industry and stakeholder in the renewable energy sector and providing a more effective service.

The purpose of the document is to provide a common basis for the certification of marine energy converter units, including a basis for acceptance of operating bodies and mutual recognition of certificates.

The document also has the objective to clearly communicate to the stakeholders and society in general the framework of certification for the wave and tidal energy sector, its extent and the definition of common deliverables by certification bodies.

In addition to safety and environmental requirements, the certification framework defined in this document is focused on the functional requirements of the device.

It is not the intention of this document to specify how the certification service is provided.

1 Scope

This document establishes a certification scheme for marine energy converter units or a farm consisting of several energy converter units. It gives guidelines for procedures and management to carry out conformity evaluation of such devices, in compliance with standards and other technical requirements agreed between the applicant and the certification body, relating to safety, reliability, performance, testing and interaction with electrical power networks.

The certification scheme provides:

- principles for the conformity evaluation of wave and tidal energy converter units;
- principles for conformity surveillance;

- requirements for the documentation that is to be supplied by an applicant for the conformity evaluation; and
- criteria for the selection of certification and inspection bodies.

This document is applicable to marine energy converter units of any size or type. It specifies certification procedures relating to design, manufacture and installation, operation and maintenance, and decommissioning. The requirements deal with the assessment of the design concept, loads and safety, testing, characteristics measurements and surveillance of manufacturing, transportation, installation and operation.

2 Normative references

The following referenced documents are indispensable for the application 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.

ISO/IEC Guide 65: *General Requirements for Bodies Operating Product Certification Systems*

ISO/IEC Guide 2:2004, *Standardization and related activities — General vocabulary*

3 Terms and definitions

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

3.1
applicant
entity applying for certification

3.2
certificate holder
entity holding a certificate after certification

3.3
certification
action by a certification body, providing written assurance that a duly identified product, process or service conforms with a specific standard or other normative document

3.4
certification basis
requirements for the system's specifications, operating conditions, performance targets and reliability targets to which it will be assessed during certification

3.5
certification body
organization conducting the certification

3.6
certification system
structure and processes used to provide certification

3.7
commissioning
process by which the systems are tested and adjusted prior to being put into service

3.8
compliance
adherence to a specific set of criteria

3.9
farm
collection of similar machines at the same location used for the generation of electricity from wave or tidal energy

3.10
installation
process of preparing and placing a functional unit in position for use

3.11
manufacture
process of putting a system together out of components or parts

3.12
metocean conditions
meteorological and oceanographic conditions

3.13
project certification
certification of a device or set of devices for use at a specific location

NOTE See 7.4.

3.14
prototype
original type that serves as a model for later models, and allows for testing and improvement of the design

3.15
qualification
confirmation by examination and provision of evidence that technology with a degree of novelty meets the specified requirements for the intended use

NOTE The evidence can take the form of documentation of the examination that took place to prove that the technology is fit for purpose.

3.16
quality system
system that outlines how all of the relevant processes are controlled and improved

3.17
standard
document, established by consensus and approved by a recognized body, that provides, for common and repeated use, rules, guidelines and characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context

NOTE Standards should be based on the consolidated results of science, technology and experience, and aimed at the promotion of optimum community benefits.

[ISO/IEC Guide 2:2004, definition 3.2]

3.18
surveillance
process of inspection, tests, calibrations, reviews or other activities to assure that the necessary quality is obtained and/or maintained, that the operation is within safety limits and is maintained within limiting conditions once the device is in operation

3.19
system boundary
separation between those components that are subject to the certification, and those that are outside its scope

3.20
type certification
procedure by which a certification body gives written assurance that a wave or tidal energy converter conforms to specified requirements

NOTE See 6.2.1 and 7.4.

3.21
verification
act of reviewing, inspecting, testing, checking, auditing or otherwise establishing and documenting whether items, processes or documents conform to specified requirements

4 Abbreviated terms

For the purposes of this document, the following abbreviations apply.

4.1
ALS
Accidental Limit State

4.2
FLS
Fatigue Limit State

4.3
FMEA
Failure Modes and Effects Analysis

4.4
IEC
International Electrotechnical Commission

4.5
ISO
International Organization for Standardization

4.6
RBI
Risk-based Inspection

4.7
R&D
Research and Development

4.8
ULS
Ultimate Limit State

5 Criteria for acceptance of certification bodies

The organization carrying out certification shall be able to demonstrate independence from pressures, especially of a financial or operational nature, which could affect sound judgement. Furthermore, it shall not be subject to conflicts of interest.

EXAMPLE Conflicts of interest for the certification body could be checking its own design work or having direct financial involvement in the object under certification.

The person or group carrying out the certification shall also be able to demonstrate the breadth and extent of technical expertise required to carry out the full extent of the certification scheme in a competent manner.

Thus, certification bodies shall demonstrate certification of quality system, extent of R&D in the field, track record of provision of certification services, experience with marine designs and inspection and existence of competence register and qualification scheme.

6 Management of certification system

6.1 General

The certification system shall be managed and operated in accordance with ISO/IEC Guide 65: *General requirements for bodies operating product certification systems*.

6.2 Categories of certification

6.2.1 Type certification

Type certification shall include the components of a marine energy converter built in series.

NOTE It can be performed to a complete marine energy converter or only for the machinery and part of the structure (e.g. machinery related to the power take-off system and supporting structure with given foundation and soil characteristics/mooring design for given water depth, or whatever is relevant for the marine energy converter).

It shall consist of a design assessment and an assessment of the quality system, the implementation of the design-related requirements in production and installation, manufacturing evaluation, commissioning as well as assessment of the test operation of a prototype.

6.2.2 Project certification

Within project certification it shall be assessed whether the metocean conditions, other environmental and electrical network conditions, and soil properties at the site conform to those defined in the design documentation for the energy converter. Any additional site-specific designs and/or design changes related to the energy converter shall be considered within the project certification. These in general include foundations, support structure and moorings. The project certificate shall include the design, manufacturing, installation and commissioning of the marine farm including cable laying and additional structures required for the transport and connection of the farm to the grid or the consumer.

6.3 Agreement on certification

The applicant shall first submit a request for certification in writing to the certification body. The applicant and the certification body shall then make an agreement on certification, which shall include:

- scope of certification (including system boundaries);
- standards to which certification and verification activities shall be initially based on (subject to confirmation through risk management);
- certification processes, deliverables and other requirements of the applicant and certification body;
- methods and conditions of reporting;
- level of fees.

The level of fees should not make undue demands on the applicant.

6.4 Security of relevant documentation

The certification body shall keep a file of all received material that is relevant to the certificate or conformity statement. The files shall be kept in a place with restricted access for at least 5 years after the last date of receipt of the material or expiry of the last certificate issued. The files shall not be revealed to any other party outside the certification body without permission of the applicant.

6.5 Maintenance and expiration of certificates

In order to maintain the certification the marine energy converter shall undergo regular surveys.

This should involve a shorter periodic survey and a more comprehensive long periodic survey (in other industries annual and 5-yearly survey periods are used). The extent of the survey (areas, methods, frequencies) will normally be dictated by the design life, degradation mechanisms and the consequences of possible failure.

Periodic survey intervals shall be defined in the inspection plan and shall be agreed with the certification body.

NOTE 1 These intervals can vary depending on the condition of the marine energy converter.

Additional surveys and design assessment shall be carried out if the marine energy converter or one of a similar design sustains damage, or if it is significantly modified in the periods between regular surveys.

EXAMPLE Examples of significant modifications are changes on the loading and structural response, power output, safety and control systems and changes other than replacements.

There shall be a system in place to capture and report faults and failures, handling of modifications and improvements and complaints. In addition to these, benefits in terms of identification of areas for improvement in the design, handling and operation of the devices shall be obtained, along with important feedback to the certification process.

NOTE 2 See also 6.9, which provides requirements regarding the information in the log book, and other documentation.

6.6 Periodic survey

Surveys of the operation and maintenance of the device shall be carried out in accordance with the agreed requirements for maintenance of certificate, described in 6.5.

NOTE See also 6.7, which provides requirements regarding how the inspection plan is made, verified and agreed.

6.7 Risk-based inspection

Inspection periods for the equipment during the operation phase shall be based on minimized risk to all stakeholders.

The inspection plan should be produced using the procedures and guidance in *Guidelines for Reliability, Maintainability and Survivability of Marine Energy Conversion Systems* [1].

The inspection plan produced here shall be subject to review and approval by the certification body, and shall form part of the basis for periodic survey outlined above.

6.8 Withdrawal of certificate

In case unexpected malfunctions occur, based on the design or inappropriate assumptions on the external conditions, maintenance and repair is not carried out according to the maintenance plan and/or periodic monitoring is not carried out according to the inspection plan the certification body shall reserve the right to require recertification or to withdraw the certificate.

NOTE See also 6.9.

6.9 Corrective actions

A certification basis shall be used to define the tidal or wave energy converter's modes of operation, and operating conditions. Through the certification process, a set of actions to be taken when these conditions are exceeded shall be defined. If, through the log-book data or other information, it is brought to the attention of the certificate holder that the system is functioning outside the specifications in the certification basis, the certification body shall be informed immediately.

The certification body shall carry out a preliminary evaluation of the situation immediately. If the outcome of this evaluation suggests a serious defect with an impact on the safety of the device or its surroundings, the certificate shall be immediately suspended pending further evaluation.

The certification body shall then carry out a thorough investigation into the problem, as a result of which either the certificate shall be reinstated, or corrective actions to be carried out shall be identified.

If no satisfactory corrective action is taken, the certificate in question shall be withdrawn. Certification documents shall upon withdrawal or suspension be returned as requested by the certification body.

6.10 Certificates and conformity statements

6.10.1 General

The deliverables shall be termed as follows:

- statement of feasibility;
- design assessment;
- product certificates for components and assemblies;
- survey reports/conformity statements.

Certificates

- prototype certificate;
- conditioned type certificate;
- type certificate;
- project certificate.

NOTE The deliverables indicate the incremental nature of the certification process with every previous stage contributing to the next step. The deliverables provide for the gradual increase in detail and scope from the concept stage through to certification of a fully developed product.

In addition to the deliverables referred to above, the final conclusion from the certification shall be documented in a specific agreed report.

6.10.2 Statement of feasibility

The statement of feasibility is a document that shall be issued by the certification body affirming that, at the time of assessment, the technology is considered conceptually feasible and suited for further development and qualification according to criteria agreed at the commencement of certification.

6.10.3 Design assessment

During the design assessment stage, intermediary deliverables such as letters with comments and reports shall be issued indicating progress and identifying gaps in the information provided by the applicant. The conclusion of the design approval process shall be documented by a statement of design assessment.

6.10.4 Product certificates for components and assemblies

Certificates shall be issued by the certification body regarding different components including design appraisal, manufacturing surveillance and factory acceptance testing.

6.10.5 Survey reports

Survey reports shall be issued by a surveyor appointed by the certification body addressing the issues related to surveillance activities that shall cover different stages such as manufacturing, testing, commissioning and installation.

Relevant standards and any additional requirements covering new technology shall be identified and surveys of the manufacturing, commissioning and installation procedures shall be carried out in accordance with these standards and requirements. Additional surveys shall be carried out as identified during the risk assessment phase.

6.10.6 Prototype certificate

This certificate shall be issued to enable testing of prototypes and shall be based on design evaluation and, if needed, tests. This certificate shall imply that all the required certification steps up to this point were carried out successfully for the specified location/ conditions. The location of the device shall be stated on the certificate and the period of validity shall be limited to up to 3 years. The issue of the prototype certificate shall be based on successful evaluation by the certification body of:

- prototype design, including installation procedures;
- prototype fabrication surveillance;
- installation surveillance;
- final acceptance/commissioning inspection;
- periodic inspection.

During the prototype design evaluation, matters with no safety implication within the period of validity may be considered at a higher level approach with the use of simplified methods if it has been demonstrated that the risk of significant damage to structure and equipment is minimized, pending operational data from the prototype and any resulting design changes. Those issues should be assessed based on existing knowledge and with uncertainties to be clarified, under controlled circumstances, during prototype test stage.

Items including safety concept, support structure and mooring system shall be analysed in detail.

6.10.7 Conditioned type certificate

The conditioned type certificate shall be issued to allow for first commercial model production as well as to allow for outstanding matters with no safety implication. The conditioned type certificate shall be based on full certification scope.

The following outstanding matters may be excluded from the conditioned type certificate:

- matters with no safety implication within the period of validity (maximum 1 year);
- matters related to the finalization of manuals and quality control procedures;
- matters related to the finalization of inspections regarding the implementation of the design-related requirements in production and installation.

NOTE Provisions can be made for upgrade of conditioned type certificate to type certificate for a particular device, subject to conditions agreed between the applicant and certification body.

6.10.8 Type certificate

The type certificate shall be issued for production models with no outstanding issues and shall be valid for 5 years subject to annual endorsement.

6.10.9 Project certificate

The project certificate shall be issued for a specific device (or group of devices) at a specific site with no outstanding issues.

NOTE Please see 7.4.6 for more information on project certificate.

7 Extent of certification

7.1 Existing offshore and maritime standards

Existing offshore and maritime standards that are suitable (or partially suitable) to control the risks shall be identified and their requirements shall be incorporated into the certification process.

7.2 Risk-based approach

In order to ensure that the devices will function reliably the certification body shall develop and use a risk-based approach in applying its certification procedure. This risk-based procedure shall include provisions for full documentation of the risk management strategies, and a well-defined strategy for dealing with the novelty associated with the technology being certified.

NOTE 1 These certification procedures cover the certification of a particular type of wave or tidal energy converter (type certification) or one or more marine energy converters installed at a specific location (project certification).

NOTE 2 The current nature of the wave and tidal energy industry and the associated novelty of technology hinder the development of a prescriptive standard for marine energy converters.

7.3 Type certification

7.3.1 General

The type certification scheme shall include the modules shown in Figure 2.

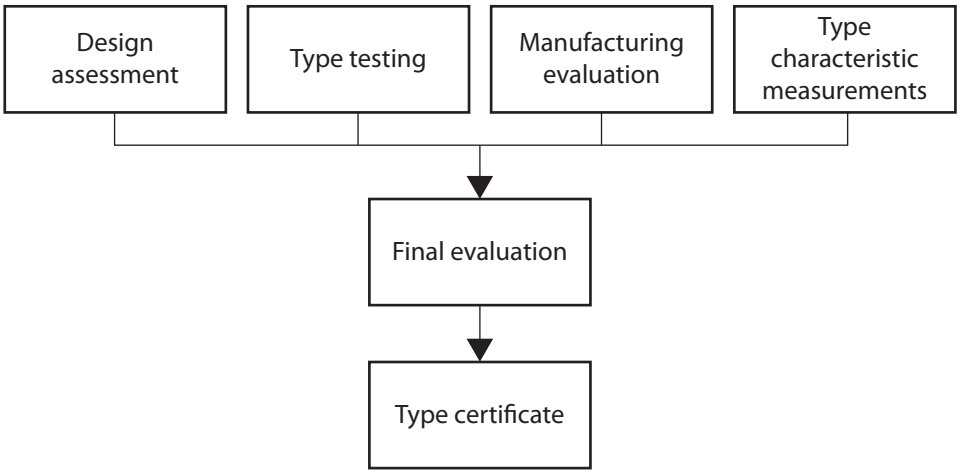

Figure 2 — Modules of type certification

NOTE The elements and processes included in each module are described in 7.3.4–7.3.9.

7.3.2 Document control

The status of each document shall be clear to all parties, using a clear system for denoting revision status.

7.3.3 Certification basis

The certification basis shall document the functional, safety, environmental and reliability targets of the device. It shall also describe the operating conditions and design survival conditions for the device. This forms the basis to which the certification shall be carried out.

7.3.4 Design assessment

7.3.4.1 General

The design assessment shall use a risk-based approach in order to qualify and verify the system in question. The design evaluation shall comprise the following main activities:

- establish an overall plan for the certification;

  NOTE This is a continuous process and needs updating after each step using the available knowledge on the status of the qualification.

- screen the technology based on identification of failure modes and their risk;
- design review and attendance to tests;
- assess maintenance, condition monitoring and possible modification effects to reduce the risk.

7.3.4.2 Control and protection system

The control and protection system shall be proven as sufficient to keep the system operating within the design load conditions as specified in the certificate.

Documentation required for certification of the control and protection system shall include:

- functional description of control system;
- system block diagrams;
- power supply arrangements;
- user interfaces;
- instrumentation and equipment lists;
- arrangement and layouts.

Critical requirements of the control and protection system shall be identified during the certification process.

The certification body should ask for further documentation in addition to those listed above in order to minimize any uncertainties.

7.3.4.3 Loads and load cases

Potentially critical loads and load cases to be analysed in the detailed design of structures and components shall be identified through the certification process. The nature and extent of analysis required shall be agreed between the applicant and certification body specifically for the device in question.

Strength and fatigue acceptance levels shall be defined within the certification process.

These levels should reflect the functional requirements and underwriters'/authorities' expectations, including third parties affected by the installation and operation of the device. They should also reflect the level of uncertainty on loading and structural response as well as device maturity.

7.3.4.4 Structural, mechanical and electrical components

The scope for certification shall include the in-place condition for the following systems:

- protection systems including emergency shut down system;
- structures;
- mooring/foundation system;
- electrical system;
- mechanical system;
- hydraulic system;
- control system;
- marine systems including bilge system;
- other systems such as: turbines, lubrication, dehumidification, cooling systems, corrosion protection etc.;
- power measurement;
- prototype testing.

7.3.4.5 Component tests

Where there is uncertainty in the load amplitude or load conditions, measurements or tests shall be carried out in order to ensure strength or other functional requirements are satisfied.

The certification body may also, where necessary, specify additional tests to be carried out. This may be used as an alternative to further design analysis.

All tests carried out shall be completed to the requirements of relevant standards and shall include any other tests identified as critical and necessary during the failure mode identification and design review process. Standards and additional requirements due to novelty of technology shall be clearly identified in test reports, along with the component being tested and the conditions for which the tests have been carried out.

Tests shall be carried out to the satisfaction of the certification body.

Requirements for surveillance or use of an accredited testing laboratory should be defined on a case-by-case basis depending upon the criticality and complexity of the test.

7.3.4.6 Foundation and/or mooring design requirements

The certification body shall evaluate the suitability of the foundation/mooring design, and ensure that the detailed design conforms to the strength requirements defined during the design process.

Depending on the nature of the device, in some cases the foundations and mooring may be covered in project certification, while for some systems it may be included in the type certification.

Documentation to be submitted for verification of the structural design of a fixed converter should include:

- general description of the design in terms of size and type of structure, layout of equipment, deck elevations, operational loading requirements, design life and construction material;
- general arrangement plan;
- description of computer programs used in design;
- field data in terms of location and orientation of the converter;
- soil data and foundation analysis;
- description of scour protection system;
- structural design brief;
- design load plan, including design accidental loads;
- structural categorization plan;
- structural drawings;
- fabrication specification, including welding procedures;
- design analyses, both global and local design, including temporary phases such as transit;
- standard details;
- local arrangement plans;
- corrosion protection;
- description of access for inspection and maintenance of the structure.

Typical documentation to be submitted for verification of the structural design of a floating converter should include:

- line and anchor pattern;
- type, weight and dimension of all line segments;
- characteristic line strength;

- anchor type, size, weight and material specification;
- arrangement of fairleads and anchor points/pretensions;
- position and weight of buoyancy elements and weight elements;
- position and type of connection elements, such as Kenter shackles, D-shackles and triplates;
- windlass, winch and stopper design;
- mooring line tensions in ULS and ALS limit states;
- fatigue calculations of mooring line segments and accessories (FLS);
- strength calculations of anchors, windlass components and fairleads;
- corrosion allowance.

Foundation and mooring design shall be shown by analysis (and testing if necessary) to be sufficient to survive the site conditions and lifetime identified in the basis for certification. This shall be confirmed by independent verification by the certification body. Relevant standards shall be identified and used.

7.3.4.7 Manufacturing plan

The designer shall submit a plan to the certification body detailing the manufacture and assembly processes.

NOTE The certification body might also require evidence of quality systems for manufacturers of critical components, and in some cases might specify that a manufacturing survey is required.

Manufacturing surveys shall assess the manufacturers' ability to control product quality and to comply with the scope, requirements and criteria laid down in the given specifications.

7.3.4.8 Installation plan

The certification body shall be able to verify the suitability of the device for the specified installation processes. The installation plan shall detail all actions to be carried out during the installation of the device, including technical specifications of the equipment to be used, commissioning procedures and checklist, human resource requirements and identification of quality control check points.

The installation plan shall also make provisions for both pre- and post-installation testing to verify soundness prior to and after the completed installation.

All systems should be tested as much as possible prior to transportation to site.

Pre- and post-installation tests should include:

- loading and response;
- control system;
- power take-off system;
- emergency shut down system;
- complete installation.

7.3.4.9 Maintenance and inspection plan

The maintenance and inspection strategy of the system shall be proven to be sufficient to maintain the level of reliability specified in the basis for certification. The plan shall include:

- maintenance and inspection intervals;
- maintenance actions to be carried out;
- procedures required for maintenance activities;
- description of quality recording and record keeping processes.

The maintenance and inspection strategy shall be based upon assessment and minimization of the risk, as described in 6.7.

7.3.4.10 Personnel safety

Safety systems shall be sufficient to ensure the safety of any personnel interacting with the device.

Safety systems for consideration in certification should include all or some of the following, depending on the design of the device:

- fire protection;
- fire resistance;
- escape and evacuation mechanisms;
- emergency stop;
- personnel transfer.

Guidance on personnel safety requirements can be found in *Guidelines for Health & Safety in the Marine Energy Industry* [2].

7.3.4.11 Design assessment statement

At the successful completion of the design phase, the certification body shall issue a statement of design assessment. This shall be based on satisfactory assessment of:

- control and protection system;
- loads and load cases;
- structural components;
- mechanical and electrical components;
- installation and deployment procedures.

7.3.5 Type testing

7.3.5.1 General

The components/aspects of the wave or tidal energy converter to be tested shall be agreed between the designer and the certification body. Tests shall be carried out to the satisfaction of the certification body.

Requirements for surveillance or use of an accredited testing laboratory should be defined on a case-by-case basis depending upon the criticality and complexity of the test.

The test program shall be defined by the designer and agreed by the certification body prior to commencement of testing. Upon completion of the test program, the applicant shall provide a report on the tests for evaluation by the certification body. The report shall be reviewed by the certification body to ensure that the tests have been carried out satisfactorily as agreed in the plan.

7.3.5.2 Safety and function tests

Functional tests shall be carried out as deemed necessary by the certification body.

A test program shall be prepared by the applicant. The program shall specify systems and components to be tested, and the testing procedure. The program shall include sea tests of the complete unit with machinery and equipment installed (as applicable). The tests shall give evidence of satisfactory operation in accordance with the design basis. When testing the control and protection system, failure modes shall be simulated as realistically as possible.

7.3.5.3 Power performance measurements

In order to verify that the system produces the electrical power stated in the certification basis, power performance measurements shall be carried out.

The results of these measurements should be presented to allow quantification of the power generated and power quality in a year under certain environmental conditions.

NOTE Guidance on power performance measurements can be found in *Assessment of Performance of Wave Energy Conversion Systems* and *Assessment of Performance of Tidal Energy Conversion Systems.*

The inclusion of power measurement in the certification scope should be carried out by review, auditing and certification of the process used to measure the power take-off and its integrity. Where available, standards for power measurement should be applied.

Power performance measurements shall be carried out in accordance with requirements as agreed between the applicant and the certification body following the main principles outlined below.

- Power take-off measurements shall be sufficient to allow for calibration of analytical models in order that the analytical model shall also be able to predict, within a reasonable level of certainty, the power take-off for different metocean conditions from those investigated.
- The period of time dedicated for evaluation of power take-off shall be defined to allow for the relevant metocean conditions to be recorded and provide the necessary statistical data.
- The main parameters investigated for power take-off measurements shall be identified and described from the point of view of the device application.
- Extrapolation of results shall need to be based on trends manifested during measurements and confirmation of adequacy of any numerical model.
- Reference shall be made to any limitations on the measurement process, field characteristics, metocean conditions (e.g. sea states, currents) measurement at site, effect of turbulence and level of uncertainty that might affect the overall power take-off calculations. The level of availability assumed and quality of power output shall also be referred to.

  EXAMPLE Metocean conditions could be sea states or currents.

7.3.5.4 Load measurements

The structural load magnitudes used in the design of the system shall be verified by load measurements. These shall be carried out for specific conditions related to the design calculations.

Load measurements shall be carried out on a system that is structurally and dynamically similar to the system being certified, with minor changes allowed after agreement between the applicant and the certification body. Any differences in performance and behaviour of the system due to these design changes shall be predicted by the applicant for verification by the certification body.

7.3.5.5 Other tests

If other tests are required in addition to those described in 7.3.5.2–7.3.5.4, these shall be selected based on their criticality to the system, and shall be agreed by both parties.

These tests shall be subject to surveillance as considered necessary by the certification body.

7.3.5.6 Test reports

Reports on the type tests described above shall be provided to the certification body by the applicant. These reports shall include a description of the test requirements, and:

- identification of the component/system and serial number/software revision as relevant;
- differences between the component tested and that used in the design;
- test results, including a description of any unexpected behaviour.

Satisfactory test reports shall be validated by the certification body.

7.3.6 Manufacturing evaluation

7.3.6.1 General

A manufacturing evaluation shall be carried out in order to ensure that the component or system is produced to the necessary specifications and quality as detailed in the design documentation.

7.3.6.2 Quality system evaluation

Manufacturers of materials, components and equipment shall be approved according to criteria established by the certification body.

NOTE The criteria established will depend on the criticality of the materials or components to the device.

The criteria shall be taken from existing standards for the device, if they exist, or shall be established by the certification body if no standard exists.

Any required quality control of materials, components and equipment shall be traceable and documented in writing. Further, quality control shall be carried out by qualified personnel at facilities and with equipment suitable for that control.

7.3.6.3 Manufacturing inspection

Manufacturers shall demonstrate their capability to carry out fabrication of adequate quality in accordance with the relevant standards, and with any additional requirements based on criticality of processes, before construction is started.

Welding of important structures, machinery installations and equipment shall be carried out by qualified and approved welders to qualified and approved weld procedures, with approved welding consumables and at welding shops accepted by the certification body.

During fabrication and construction work, the certification body shall have safe access to the works at all reasonable times, insofar as the work affects certification. The client shall ensure, through contracts with the parties concerned or otherwise, that such access is possible, and that the certification body is notified as to when and where the surveyor's attendance is needed.

7.3.6.4 Manufacturing conformity statement

The manufacturing conformity statement shall provide verification from the certification body that the manufacturing process has been planned, documented and carried out in accordance with their requirements. The manufacturing conformity statement shall include:

- identification of the marine energy converter type;
- references to the relevant documentation, including quality system evaluation, inspection reports, etc.;
- the device specifications, including environmental conditions, major components, electrical network conditions and design lifetime;
- the standards and additional specifications identified during the certification process that the method of certification conforms to.

7.3.7 Type characteristics measurements

7.3.7.1 General

The device performance shall be tested under specified conditions to ensure that it conforms to the critical operating parameters defined in the certification basis. These tests shall be performed under surveillance by the certification body.

The tests may include any or all of the following as relevant:

- power quality;
- acoustic noise;
- other systems.

The tests may be performed without surveillance by the certification body depending on the criticality of the tests, if they are performed by an accredited laboratory and the procedures have been approved by the certification body.

Where any of these characteristics are defined as device requirements in the certification basis, measurements shall be carried out as part of the type testing program to verify compliance. The measurement procedures shall conform to requirements agreed between the applicant and the certification body. A test report shall be produced by the applicant, describing the measurement conditions, instrumentation, calibration and analyses.

7.3.7.2 Type test conformity statement

The type test conformity statement shall provide verification from the certification body that the type tests and type characteristics measurements have been carried out and reported upon in accordance with their requirements. The type test conformity statement shall include:

- identification of the marine energy converter type;
- test report references;
- the device specifications, including environmental conditions, major components, electrical network conditions and design lifetime;
- the standards and additional specifications identified during the certification process that the method of certification conforms to.

7.3.8 Final evaluation

The final evaluation requires that a report be produced, which includes the following.

- Verification that the required documentation is complete and whether the type testing program has confirmed that the requirements set out in the certification basis have been satisfied.
- Review of all design documentation, including drawings, specifications, manufacturing, commissioning and installation procedures.
- Verification that the design meets the supporting design calculations.
- A reference list of all supporting documentation relevant to the type certificate.

The certification body shall confirm that the report clearly identifies any safety critical items and that the functional requirements were demonstrably achieved.

7.3.9 Type certificate

A type certificate can be issued once the certification body has verified that there are no outstanding design issues to be resolved. The type certificate shall include:

- identification of the device;
- references to all relevant conformity statements, and final evaluation reports;
- device specifications as outlined in the certification basis, including environmental conditions, electrical network conditions and design lifetime;
- the standards and additional specifications identified during the certification process that the method of certification conforms to;
- conditions for validity of certificate.

7.4 Project certification

7.4.1 General

Project certification shall confirm that marine energy converters meet requirements governed by site-specific external conditions and conform to other requirements relevant to the site.

EXAMPLE Examples of other requirements relevant to the site could be requirements associated with soil and environmental conditions or mooring/anchoring, subsea umbilical deployment, connection to grid requirements for substations etc.

It shall include the design assessment of site-specific built components. A project certification shall be based on a type certification and shall include all its elements.

7.4.2 Site assessment

Site-specific conditions shall form the basis for the project certification, with their impact on the foundations, structure, moorings and power output.

The site assessment shall be prepared by the applicant to form part of the basis for the project certification.

7.4.3 Foundation and mooring design evaluation

Foundation and mooring design shall be shown by analysis and testing as necessary to be sufficient to survive the site conditions and lifetime identified in the basis for certification. When analysis is insufficient or overly complex to prove the strength of the

foundation and mooring design, it shall be shown by testing. This shall be confirmed by independent verification by the certification body, using the documentation detailed in 7.3.4.5 for the specific site.

Standards should be used where relevant.

7.4.4 Installation evaluation

7.4.4.1 General

Installation evaluation shall be carried out to ensure that one or more marine energy converters have been installed and commissioned in conformity with specific standards and other technical requirements. Evaluation shall include review of necessary documentation (including the installation plan – see 7.3.4.7) and surveillance of key stages of the installation and commissioning process.

If no specific standards are identified, the installation shall be evaluated with respect to requirements agreed between the applicant and the certification body during the project certification process.

7.4.4.2 Installation quality system

The applicant shall prepare a documented quality system for installation of the device. The certification body shall evaluate whether the system is in agreement with the installation plan and other installation/construction plans.

The effectiveness of the installation quality system shall be verified by the certification body through systematic surveillance, or through assessment with regard to requirements specified in standards.

7.4.4.3 Surveillance/audits

After verification of the installation plan and associated quality system, the certification body shall undertake surveillance of the installation and commissioning in order to verify that activities are carried out in accordance with relevant manuals and procedures.

The surveillance extent should be dictated by the level of risk and complexity of installation operation and commissioning.

Surveillance shall be concluded with a report covering activities carried out, findings and observations, and any associated recommended actions.

7.4.4.4 Installation conformity statement

Following satisfactory evaluation of the installation and surveillance reports, an installation conformity statement shall be issued by the certification body. The conformity statement shall include:

- reference to a type certificate for the marine energy converter;
- reference to foundation design and site assessment conformity statements;
- identification of verification, surveillance and/or audit reports.

7.4.5 Operation and maintenance surveillance

7.4.5.1 General

Surveillance of the operation phase of the project shall be carried out to verify that the system is operating as expected from the design process, and also to ensure that the maintenance activities are carried out as agreed in the certification.

Operation and maintenance surveillance shall be carried out in accordance with the periodic inspection requirements identified in 6.6.

NOTE In addition to these requirements, further surveillance might be requested by the certification body to cover critical phases and activities.

7.4.5.2 Operation and maintenance conformity statement

The operation and maintenance conformity statement shall be issued once the certification body has verified that the required analysis and documentation have been completed satisfactorily, and survey reports show that the procedures are carried out in conformity with the requirements agreed between the applicant and the certification body. The operation and maintenance conformity statement shall include:

- identification of the wave or tidal energy converter;
- identification of the specific site;
- reference to the device's type certificate;
- reference to relevant documentation (e.g. operation and maintenance manual, operation and maintenance evaluation report);
- the standards and additional specifications identified during the certification process that the method of certification conforms to;
- conditions for validity of the conformity statement.

7.4.6 Project certificate

The project certificate shall be issued once the certification body has verified that there are no outstanding issues relating to the deployment of the specific device at the site in question. The project certificate shall include:

- identification of the marine energy converter;
- identification of the site for deployment;
- references to the relevant reports and conformity statements (including site assessment, installation, foundation and mooring design, operation and maintenance);
- the standards and additional specifications identified during the certification process that the method of certification conforms to;
- conditions of validity for the certificate;
- type certificate for the wave or tidal energy converter, including device specification.

Bibliography

[1] Michael Starling, *Guidelines for Reliability, Maintainability and Survivability of Marine Energy Conversion Systems*, EMEC, 2009

[2] Genie Webb, *Guidelines for Health & Safety in the Marine Energy Industry*, British Wind Energy Association, 2008