

Standard for Wave and Tidal Energy Certification Schemes

Standard for Wave and Tidal Energy Certification Schemes

Revision	Verifier	Signature	Date
Draft 1	Claudio Bittencourt	CBF	19/09/2007
Draft 2	Claudio Bittencourt	CBF	21/12/2007

contents:

1.0	Objective	4
2.0	Scope.....	4
3.0	Use of Standard.....	5
4.0	References	5
5.0	Definitions.....	5
6.0	Symbols and Abbreviations	6
7.0	Criteria for Acceptance of Certification Bodies.....	7
8.0	Management of Certification System	7
8.1	General	7
8.2	Certification Scope.....	7
8.2.1	Type Certification	7
8.2.2	Project Certification	8
8.3	Agreement on Certification	8
8.4	Issue of Certificates and Conformity Statements	8
8.4.1	Statement of Feasibility	9
8.4.2	Design Assessment	9
8.4.3	Product Certificates for Components and Assemblies	9
8.4.4	Survey Reports.....	9
8.4.5	Prototype Certificate	9
8.4.6	Conditioned Type Certificate	10
8.4.7	Type Certificate	10
8.5	Security of Relevant Documentation.....	10
8.6	Maintenance and Expiration of Certificates.....	10
8.7	Periodic Survey	11
8.8	Risk Based Inspection	11
8.9	Withdrawal of Certificate	11
8.10	Corrective Actions	11
9.0	Extent of Certification	12
9.1	General	12
9.3	Risk Based Approach	12
9.4	Type Certification	12
9.4.1	General	12
9.4.2	Document Control	13
9.4.4	Design Assessment	13
9.4.4.1	Control and Protection System.....	13
9.4.4.2	Loads and Load Cases	14
9.4.4.3	Structural, Mechanical and Electrical Components.....	14
9.4.5	Component Tests	14
9.4.6	Foundation and/or Mooring Design Requirements.....	15
9.4.7	Manufacturing Plan	16
9.4.8	Installation Plan.....	16
9.4.9	Maintenance and Inspection Plan.....	16
9.4.10	Personnel Safety	17
9.4.11	Design Assessment Statement.....	17
9.5	Type Testing	17
9.5.1	Safety and Function Tests.....	17
9.5.2	Power Performance Measurements	18
9.5.3	Load Measurements.....	18
9.5.4	Other Tests	19
9.5.5	Test Reports	19
9.6	Manufacturing Evaluation	19

Standard for Wave and Tidal Energy Certification Schemes

9.6.1	Quality System Evaluation	19
9.6.2	Manufacturing Inspection.....	19
9.6.3	Manufacturing Conformity Statement	20
9.6.4	Type Characteristics Measurements	20
9.6.5	Type Test Conformity Statement	20
9.7	Final Evaluation	21
9.8	Type Certificate	21
10.0	Project Certification	21
10.1	General	21
10.2	Site Assessment.....	21
10.3	Foundation and Mooring Design Evaluation	22
10.4	Installation Evaluation	22
10.4.1	Installation Quality System	22
10.4.2	Surveillance / Audits	22
10.4.3	Installation Conformity Statement.....	22
10.5	Operation and Maintenance Surveillance	23
10.5.1	General	23
10.5.2	Operation and Maintenance Conformity Statement.....	23
10.6	Project Certificate.....	23

Standard for Wave and Tidal Energy Certification Schemes

1.0 Objective

This document responds to the request for harmonisation 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 Standard 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 Standard 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.

2.0 Scope

This document defines a certification scheme for wave and tidal energy devices. It provides guidance for procedures and management to carry out conformity evaluation of such devices, with respect to relevant standards and other technical requirements, relating to safety, reliability, performance, testing and interaction with electrical power networks.

The certification scheme provides:

- Principles for the conformity evaluation in a wave/tidal energy certification scheme;
- 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

The standard is not limited to wave or tidal energy devices of any particular size or type. It describes procedures relating to design, manufacture and installation, operation and maintenance, and decommissioning. The requirements deal with the assessment of loads and safety, testing, characteristics measurements and surveillance of manufacturing, transportation, installation and operation.

The purpose of the standard is to provide a common basis for the certification of wave and tidal energy devices, including a basis for acceptance of operating bodies and mutual recognition of certificates.

3.0 Use of Standard

This document forms part of the suite of Renewable Energy Standards. Where reference is made to internationally recognised standards, guidance on relevant standards can be found in the following documents:

- Design Basis Guideline for Marine Energy Converters
- Reliability and Maintainability Guideline for Marine Energy Converters
- Manufacture and Testing Guideline for Marine Energy Converters
- Health and Safety Guide for Marine Energy Converters

4.0 References

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

Design Basis Guideline for Marine Energy Converters

Reliability and Maintainability Guideline for Marine Energy Converters

Manufacture and Testing Guideline for Marine Energy Converters

Health and Safety Guide for Marine Energy Converters

5.0 Definitions

Applicant

Entity applying for certification.

Certificate Holder

Entity holding a certificate after certification.

Certification

Action by a third party, providing written assurance that adequate confidence is provided that a duly identified product, process or service is in conformity with a specific standard or other normative document.

Certification Basis

Requirements for the system's specifications, operating conditions, performance targets and reliability targets. The basis to which the system will be assessed during certification.

Certification Body

The organisation conducting the certification of conformity.

Certification System

The structure and processes used to provide certification.

Compliance

Adherence to a specific set of criteria.

Commissioning

Standard for Wave and Tidal Energy Certification Schemes

Process by which the operating systems are tested and adjusted prior to being put into service.

Installation

The process of preparing and placing a functional unit in position for use.

Manufacture

The process of putting a system together out of components or parts.

Metocean conditions

Meteorological and oceanographic conditions.

Project certification

Certification of a device or set of devices for use at a specific location (see Section 10.0).

Prototype

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

Qualification

Confirmation by examination and provision of evidence that technology with a degree of novelty meets the specified requirements for the intended use. A documented set of activities to prove that the technology is fit for purpose.

Quality system

A system that outlines how all of the relevant processes shall be controlled and improved.

Surveillance

The process of inspecting tests, calibrations or other activities to assure that the necessary quality is maintained, operation is within safety limits, and operation will be maintained within limiting conditions.

System boundary

The separation between those components subject to the certification, and those that are out with the scope.

Type Certification

Procedure by which a certification body gives written assurance that a wave or tidal energy converter conforms to specified requirements (see Section 9.4)

Verification

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

6.0 Symbols and Abbreviations

Standard for Wave and Tidal Energy Certification Schemes

EMEC – European Marine Energy Centre
ISO – International Standardisation Organisation
IEC – International Electrical Commission
ULS – Ultimate Limit State
ALS – Accidental Limit State
FLS – Fatigue Limit State
FMEA – Failure Modes and Effects Analysis
RBI – Risk Based Inspection
RCM – Reliability Centred Maintenance

7.0 Criteria for Acceptance of Certification Bodies

Bodies carrying out certification of wave or tidal energy conversion systems must conform to some basic requirements – independence and competence.

The organisation carrying out certification must be able to demonstrate independence from pressures, especially of a financial or operational nature, which could affect sound judgement. They should also not be subject to conflicts of interest (such as checking their own work or having direct financial involvement in the object under certification).

The person or group carrying out the certification must also be able to demonstrate the technical expertise required to carry out the job in a competent manner. This should be shown through relevant experience and/or training.

Other aspects such as certification of quality system, extent of R&D in the field and other aspects related to performance and experience in the field of certification in general are also required from certification bodies.

8.0 Management of Certification System

8.1 General

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

8.2 Certification Scope

The scope of Certification applies for a tidal and wave energy converter unit or a farm consisting of several energy converter units.

Main topics are:

8.2.1 Type Certification

Type certification includes the components of an energy converter built in series. It can be performed to a complete energy converter or only for the machinery and part of the structure (e.g. turbine, energy extraction devices, drive train, hydraulic, electrical installation and supporting structure with given foundation and soil characteristics / mooring design for given water depth, or what ever is relevant for the energy converter). It consists of a design

Standard for Wave and Tidal Energy Certification Schemes

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.

8.2.2 Project Certification

Within Project Certification it will 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 are considered within the Project Certification. These in general include foundations, support structure and moorings. The Project Certificate includes the design, manufacturing, installation and commissioning of the wave / tidal farm including cable laying and additional structures required for the transport and connection of the farm to the grid or the consumer.

8.3 Agreement on Certification

The Applicant must first submit a request for certification in writing to the Certification Body. The Applicant and the Certification Body must then make an agreement on certification, which should include:

- Scope of certification (including system boundaries)
- Standards under which certification and verification activities shall be carried out
- Certification processes, deliverables and other requirements of the Applicant and Certification Body
- Methods and conditions of reporting
- Level of fees, which should not make undue demands on the Applicant

8.4 Issue of Certificates and Conformity Statements

The deliverables indicate the incremental nature of the certification process with every previous stage contributing to the next step. The first deliverables are associated with the earlier stages of certification and the final certificates grading from prototype stage to full project certificate for a well developed product. Typically these deliverables will be termed as follows:

Certification

- Statement of Feasibility
- Design Assessment
- Product Certificates for Components and Assemblies
- Survey Reports / Conformity Statements

Certificates

In order to account for the different stages in the development of the device, the Certifier may in addition to the Type Certificate issue the following certificates:

- Prototype Certificate
- Type Certificate Class B

Standard for Wave and Tidal Energy Certification Schemes

- Type Certificate
- Project Certificate

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

8.4.1 Statement of Feasibility

The Statement of Feasibility is a document 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.

8.4.2 Design Assessment

During the design assessment stage, intermediary deliverables such as letters with comments and reports may be issued. The conclusion of the design approval process should be documented by a Statement of Design Assessment.

8.4.3 Product Certificates for Components and Assemblies

Certificates issued by the Certification Body regarding different components including design appraisal, manufacturing surveillance and factory acceptance testing.

8.4.4 Survey Reports

Survey Reports are issued by a surveyor appointed by the Certification Body addressing the issues related to a surveillance activity that may cover different stages such as manufacturing, testing, commissioning and installation.

8.4.5 Prototype Certificate

This certificate is issued to enable testing of prototypes and is based on design evaluation and, if needed, tests. This certificate implies that all the required certification steps up to this point were carried out successfully for the specified location / conditions. The location of the device is stated on the certificate and the period of validity is limited to up to 3 years. The issue of the Prototype Certificate is 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 can be considered at a higher level approach with the use of simplified methods (sufficient to demonstrate that the risk of

Standard for Wave and Tidal Energy Certification Schemes

significant damage to structure and equipment is minimised), pending operational data from the prototype and any resulting design changes. Those issues will 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.

8.4.6 Conditioned Type Certificate

The Conditioned Type Certificate is issued to allow for 0-series production as well as to allow for outstanding matters with no safety implication. The Conditioned Type Certificate is based on full certification scope with the exception that outstanding matters are allowed. The outstanding matters are however limited to:

- 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

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.

8.4.7 Type Certificate

The Type Certificate is issued for production models with no outstanding issues (validity of 5 years subject to annual endorsement).

8.4.8 Surveillance

Surveys of the manufacturing, commissioning and installation procedures shall be carried out in accordance with the relevant standards, and additionally as identified during the risk assessment phase.

8.5 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. Subsequently the material and any copies shall be returned to the Applicant or destroyed with written notice thereof.

8.6 Maintenance and Expiration of Certificates

In order to maintain the Certification the tidal / wave energy converter will need to undergo regular surveys. Typically this may involve a shorter period survey and a more comprehensive long periodic survey (in other industries annual and 5 yearly survey periods are used). The extent of the survey

Standard for Wave and Tidal Energy Certification Schemes

(areas, methods, frequencies) will normally be dictated by the design life, degradation mechanisms and the consequences of possible failure.

Periodic survey intervals are to be defined in the inspection plan and to be agreed with the Certification Body. These intervals may be varied depending on the condition of the energy converter. Additional surveys and design assessment may need to be carried out should the energy converter or one of a similar design sustain damage, or if it is significantly modified (changes on the loading and structural response, power output, safety and control systems and changes other than replacements) in the periods between regular surveys.

It is important that there is a system in place to capture and report faults and failures, handling of modifications and improvements and complaints. In addition to the benefits in order to identify areas for improvement in the design, handling and operation of the devices, the system provides important feedback to the certification process. See also Section 8.10.

8.7 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 above. See also Section 8.8.

8.8 Risk Based Inspection

Inspection periods for the equipment during the operation phase shall be based on minimised risk to all stakeholders. These risks will be investigated during a Failure Mode and Effects Analysis (FMEA) of the system. Once the design is sufficiently developed and component lifetimes and reliabilities are known, a Risk Based Inspection (RBI) analysis should be carried out and documented inspection plan produced to ensure that the risks are effectively managed.

The inspection plan produced here will be subject to review and approval by the Certification Body, and will form part of the basis for Periodic Survey outlined above.

8.9 Withdrawal of Certificate

In case unexpected malfunctions occur, based on the design or bad 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 may reserve the right to require recertification or to withdraw the Certificate. See also Section 8.10.

8.10 Corrective Actions

A Certification Basis will be used to define the tidal or wave energy converter's modes of operation, and operating conditions. Through the

Standard for Wave and Tidal Energy Certification Schemes

certification process, a set of actions to be taken when these conditions are exceeded will 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 out with the specifications in the Certification Basis, the Certifying Body will be informed immediately.

The Certifying Body will 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 will be immediately suspended pending further evaluation.

The Certifying Body will then carry out a thorough investigation into the problem, the outcome of which will either result in re-instatement of the certificate, or the identification of corrective actions to be carried out.

If no satisfactory corrective action is taken, the Type Certificate in question will be withdrawn. Certification documents shall upon withdrawal or suspension be returned as requested by the Certifying Body.

9.0 Extent of Certification

9.1 General

These certification procedures cover the certification of a particular type of wave or tidal energy converter (Type Certification) or one or more wave or tidal energy converters installed at a specific location (Project Certification).

9.2 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.

9.3 Risk Based Approach

As stated above, the current nature of the wave and tidal energy industry and the associated novelty of technology hinder the development of a prescriptive standard for wave and tidal energy converters. In order to ensure that the devices will function reliably it is therefore considered necessary that a risk-based approach is developed and used by the certification body in applying their certification procedure. This risk-based procedure should 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.

9.4 Type Certification

9.4.1 General

Type certification includes the components of an energy converter built in series. It can be performed to a complete energy converter or only for the machinery and part of the structure (e.g. turbine, energy extraction devices, drive train, hydraulic, electrical installation and supporting structure with given

Standard for Wave and Tidal Energy Certification Schemes

foundation and soil characteristics / mooring design for given water depth, or what ever is relevant for the energy converter). It consists 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.

9.4.2 Document Control

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

9.4.3 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.

9.4.4 Design Assessment

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

- Establish an overall plan for the certification. 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. The novelty of the technology should be classified and the effort focussed on the areas where the most significant uncertainty exists.
- Design review and attendance to tests
- Assess maintenance, condition monitoring and possible modification effects to reduce the risk.

9.4.4.1 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 system includes:

- 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 will be identified during the certification process, and the Certifying Body may ask for further

Standard for Wave and Tidal Energy Certification Schemes

documentation in addition to those listed above in order to minimise any uncertainties.

9.4.4.2 Loads and Load Cases

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

Strength and fatigue acceptance levels are to be defined within the certification process and should reflect the functional requirements and underwriters' / authorities' expectations, including third parties affected by the installation and operation of the device. Also it should reflect the level of uncertainty on loading and structural response as well as device maturity.

9.4.4.3 Structural, Mechanical and Electrical Components

Typical scope for certification comprises the in-place condition for the following systems:

- Safety systems incl. emergency shutdown 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

9.4.5 Component Tests

The certification process may highlight some critical components where uncertainty in the load amplitude or load conditions may require measurements or tests to 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 should be completed to the requirements of relevant international standards and any other tests identified as critical and necessary during the failure mode identification and design review process. Standards should be clearly identified in test reports, along with the component being tested and the conditions for which the tests have been carried out.

9.4.6 Foundation and/or Mooring Design Requirements

The requirements for certification of the device foundation or mooring design will depend on the nature of the device. As noted in Section 8.2.1, in some cases the foundations and mooring may be covered in Project Certification, while for some systems it will be necessary to include in the Type Certification. Where applicable, the Certification Body will evaluate the suitability of the foundation/mooring design, and ensure that the detailed design conforms to the strength requirements defined during the design process.

A fixed tidal or wave energy converter can be a gravity based structure, or a jacket structure. Typical documentation to be submitted for verification of the structural design of a fixed converter will be:

- 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 categorisation 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.

The mooring system will typically comprise the anchors/suction piles, anchoring lines, windlasses and winches on board the converter. The following documentation may typically be submitted:

- Line and anchor pattern;
- Type and 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);

Standard for Wave and Tidal Energy Certification Schemes

- Strength calculations of anchors, windlass components and fairleads;
- Corrosion allowance.

Foundation and mooring design must 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 will be confirmed by independent verification by the Certification Body. Internationally recognised standards should be used where relevant.

9.4.7 Manufacturing Plan

The designer is required to submit a plan to the Certification Body detailing the manufacture and assembly processes, fabrication specifications, welding procedures (if applicable).

The Certification Body may also require evidence of quality systems for manufacturers of critical components, and in some cases may 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.

9.4.8 Installation Plan

The Certification Body must be able to verify the suitability of the device for the specified installation processes. The installation plan must 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 check list, human resource requirements and identification of quality control check points.

The installation plan must also make provisions for both pre- and post-installation testing to verify soundness prior to and after the completed installation. All possible systems should be tested prior to transportation to site. Pre- and post-installation tests will include:

- Loading and response
- Control system
- Power take-off system
- Emergency shut down system
- Complete installation

9.4.9 Maintenance and Inspection Plan

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

- Maintenance and inspection intervals
- Maintenance actions to be carried out
- Procedures required for maintenance activities
- Description of quality recording and record keeping processes

Standard for Wave and Tidal Energy Certification Schemes

The maintenance and inspection strategy should be based upon assessment and minimisation of the risk, as described in Section 8.8.

9.4.10 Personnel Safety

Safety systems must be sufficient to ensure the safety of any personnel interacting with the device. Safety systems for consideration in certification should include

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

9.4.11 Design Assessment Statement

At the successful completion of the design phase, the Certification Body may issue a Statement of Design Assessment. This will be based on satisfactory assessment of:

- Control and protection system
- Loads and load cases
- Structural components
- Mechanical and electrical components
- Installation and deployment procedures

9.5 Type Testing

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 by an accredited testing laboratory where possible. Surveillance of testing shall be agreed during certification process depending upon criticality of components. Any tests not carried out by an accredited laboratory must be subject to surveillance by the Certification Body.

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.

9.5.1 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 safety system, failure modes shall be simulated as realistically as possible.

9.5.2 Power Performance Measurements

In order to verify that the system produces the electrical power stated in the certification basis, power performance measurements should 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.

The inclusion of power measurement in the certification scope may 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 should be carried out in conformance with requirements as agreed between the Applicant and the Certification body following the main principles outlined below:

- Power take-off measurements should be sufficient to allow for calibration of analytical models in order that the analytical model should also be able to predict, within a reasonable level of certainty, the power take-off for different metocean conditions than those investigated.
- The period of time dedicated for evaluation of power take-off should 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 are identified and described from the point of view of the device application.
- Extrapolation of results will need to be based on trends manifested during measurements and confirmation of adequacy of any numerical model.
- Reference should 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 may affect the overall power take-off calculations. The level of availability assumed and quality of power output should also be referred to.

9.5.3 Load Measurements

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

Load measurements should be carried out on a system which is structurally and dynamically similar to the system being certified, with minor changes allowed after agreement between the Applicant and the Certification Body.

Standard for Wave and Tidal Energy Certification Schemes

Any differences in performance and behaviour of the system due to these design changes should be predicted by the Applicant for verification by the Certification Body.

9.5.4 Other Tests

Other tests in addition to those described above may be requested by the the Certification Body. These should 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.

9.5.5 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.

9.6 Manufacturing Evaluation

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.

9.6.1 Quality System Evaluation

Manufacturers of materials, components and equipment shall be approved according to criteria established by the Certification Body, as applicable (defined in the respective standards or from the Certification Process).

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.

9.6.2 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 approved welders, with approved welding consumables and at welding shops accepted by the Certification Body.

Standard for Wave and Tidal Energy Certification Schemes

During fabrication and construction work, the Certifying 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 Certifying Body is notified as to when and where the surveyor's attendance is needed.

9.6.3 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 wave or tidal 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
- Standard under which certification is carried out.

9.6.4 Type Characteristics Measurements

The device performance is to be tested under specified conditions to ensure that it conforms with the critical operating parameters defined in the Certification Basis. These tests are to be performed at an accredited laboratory and/or under surveillance by the Certifying Body. The tests may include any or all of the following as relevant:

- Power quality
- Acoustic noise
- Marine systems, including bilges
- Other systems

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.

9.6.5 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 wave or tidal energy converter type
- Test report references
- The device specifications, including environmental conditions, major components, electrical network conditions and design lifetime
- Standard under which certification is carried out.

9.7 Final Evaluation

The final evaluation requires that a report be produced, which includes:

- 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.

9.8 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
- Standard under which certification has been carried out
- Conditions for validity of certificate

10.0 Project Certification

10.1 General

Project Certification shall confirm for a specific site that energy converters meet requirements governed by site-specific external conditions and are in conformity with other requirements relevant to the site (such as soil and environmental conditions, mooring / anchoring, etc) . It includes the design assessment of site specific built components. A Project Certification may be based on a Type Certification and includes all its elements.

10.2 Site Assessment

Site specific conditions (including soil properties, metocean conditions, electrical network conditions and other environmental conditions) shall form the basis for the project certification, with their impact on the foundations, structure, moorings and power output (as relevant).

Standard for Wave and Tidal Energy Certification Schemes

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

10.3 Foundation and Mooring Design Evaluation

Foundation and mooring design must 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 will be confirmed by independent verification by the Certification Body, using the documentation detailed in Section 9.4.6 for the specific site. Internationally recognised standards should be used where relevant.

10.4 Installation Evaluation

Installation evaluation is carried out to ensure that one or more wave or tidal energy converters have been installed and commissioned in conformity with specific standards and other technical requirements. Evaluation will include review of necessary documentation (including the installation plan – see Section 9.4.8) and surveillance of key stages of the installation and commissioning process.

If no specific standards are identified (or are shown not to be applicable), the installation will be evaluated with respect to requirements agreed between the Applicant and the Certification Body during the Project Certification process.

10.4.1 Installation Quality System

The Applicant should 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 may be verified by the Certification Body through systematic surveillance, or through assessment with regard to requirements specified in International Standards.

10.4.2 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 will 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.

10.4.3 Installation Conformity Statement

Standard for Wave and Tidal Energy Certification Schemes

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 wave or tidal energy converter
- Reference to Foundation Design and Site Assessment conformity statements
- Identification of verification, surveillance and/or audit reports.

10.5 Operation and Maintenance Surveillance

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 agreed maintenance activities are carried out as agreed in the Certification.

10.5.1 General

Operation and maintenance surveillance shall be carried out in accordance with the periodic inspection requirements identified in section 8.7 of this standard. In addition to these requirements, further surveillance may be requested by the Certifying Body to cover critical phases and activities.

10.5.2 Operation and Maintenance Conformity Statement

The operation and maintenance conformity statement can be issued once the Certification Body has verified that the required analysis and documentation has 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)
- Standard under which certification is being carried out
- Conditions for validity of the conformity statement.

10.6 Project Certificate

The Project Certificate can 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 wave or tidal 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)
- Standard under which the certification has been carried out
- Conditions of validity for the certificate

Standard for Wave and Tidal Energy Certification Schemes

- Type Certificate for the wave or tidal energy converter, including device specification