

Ocean Energy Converter Certification

General

In countries with powerful ocean waves and current environments, developers and investors are increasingly looking to exploit the ocean as a source of infinitely renewable energy. As a result, development activities are running at full speed and, with significant new developments coming up for series production in the next decade, there is a growing need for third-party evaluation, verification and certification.

For 140 years Germanischer Lloyd (GL) has been setting technology, safety and quality standards in a wide variety of fields. Today, GL is one of the world’s leading maritime technical surveillance societies. Making use of its long-standing experience in the maritime and renewable energy sector the draft “Guideline for the Certification of Ocean Energy Converters - Part I: Ocean Current Turbines” was issued in 2005 and is permanently further developed.

GL offers its skills to the key players in the up-and-coming ocean energy market – to designers, manufacturers, investors and insurers interested in assessment, expertise and certification services that evaluate the engineering integrity and safety of ocean energy converter

Assessment Activities

1. General

Comparable to the development in the field of wind energy, an increasing demand of assessment, expertise and certification services of products with respect to engineering integrity and safety is required.

GL carries out assessments, verifications and certifications for tidal and wave energy devices on the basis of its own Guidelines for the Certification of Ocean Energy Converters and international standards. Additional reference is also made to GL’s Rules and Guidelines for Offshore Structures and Offshore Wind Turbines. In case of novel structures where no guidelines or standards may be applicable, or for increased flexibility, a risk based design may be performed.

The assessment activities involve examining environmental and load assumptions, mechanical/structural design and safety features by means of parallel computation, assessment and evaluation in the context of the Guideline, as well as inspecting the manufacturing process and assessing the prototype or the whole project.

A successful converter assessment may be documented in different levels of assessment. In view of the variability of the designs GL always provides a customised evaluation/certification procedure.

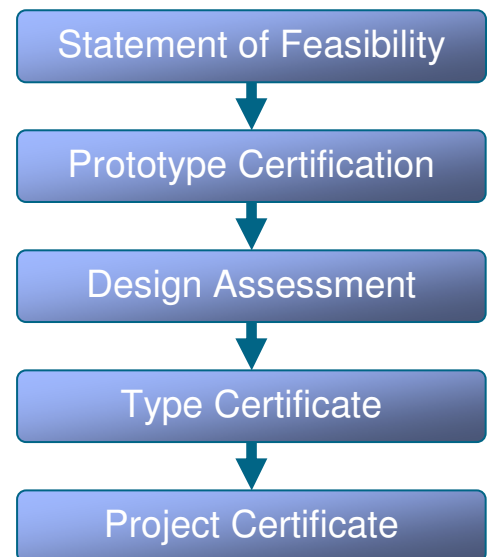


Figure 1: Principal elements of certification

2. Feasibility evaluation

Since ocean energy converters are novel devices, a concept study can be performed and reported in early stages of the design. This optional assessment precedes any certification work and is used to improve confidence in the project. During this assessment conceptual design of the power production concept, of safety relevant systems and the structure is assessed.

3. Design basis assessment

Load assumptions as well as support structure or mooring design are strongly dependent on the environmental and system parameters assumed and specified. Design is heavily influenced by material selection and structural analysis principles. All these are generally compiled in the Design Basis document. Review and check of this document will be performed with respect to guidelines and standards to be applied. Successful assessment demonstrates the establishment of a solid base for further development and design.

4. Design assessment

En route to serial production a thorough evaluation of the energy converter is performed. Within the design assessment a complete examination of the design analyses with all required material and component tests are assessed. Further commissioning witnessing of one of the first devices of the type is performed. Following completion, GL will issue a Statement of Compliance for the A- or B-Design Assessment. The B-Design Assessment may be issued with items that are outstanding, if these are not directly safety-relevant. Furthermore it has a validity period of one year only. This period can be used to fulfil the missing requirements for the A-Design Assessment which will not be issued as long as outstanding items are present

The assessment of the design comprises the elements of evaluation on the basis of the respective standards to be applied in the assessments as defined in the design basis. The elements considered are:

- Safety systems incl. emergency shutdown system
- Load and response analyses
- 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
- Component testing
- Maintenance procedures

It is generally carried out in two sequential steps. The first part covers all aspects of the safety and control concept as well as the load assumptions and load calculations. During the second part of the design assessment all components (see list above) of the system are being examined on the basis of the previously approved loads and the relevant standards and guidelines.

At the end of the design assessment manuals and procedures for erection, commissioning, operation and maintenance are checked for suitability, completeness and compliance with the assumptions in the design documentation. Component testing (e.g. blades, gearboxes) forms an integral part of the design assessment.

5. Development accompanying assessment

GL offers a development accompanying assessment (DAA). Therefore, GL provides the client with broad expert knowledge from comprehensive certification activities to the benefit of the design of the ocean energy converter. Communication shall take place within expert meetings, telephone and email as well as via video conferences. The aim of GL is to support the manufacturer in achieving best technical solutions and a “reduced time to market” for the product. The DAA can be requested by the manufacturer during the certification phase at any time, if desired, and comes into action when questions need to be clarified obviously exceeding the normal extent of certification, e.g. innovative verification approaches, application of special materials or tests. The extent is to be agreed with the manufacturer.

6. Prototype Certification

This certificate is issued to enable testing of prototypes and is based on design evaluation. As a rule, power and load measurements shall be performed at the prototype, after which they shall be compared to the calculated values. 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 evaluation (C – Design Assessment)
- Prototype fabrication surveillance
- Installation evaluation
- Final acceptance / commissioning inspection
- Annual inspection

During the prototype design evaluation (C – Design Assessment) matters with no safety implication within the period of validity can be considered using simplified methods. Design assessment is usually based on a complete plausibility check of the loads, the power generating structure, the machinery components as well as of the structure. Modifications, e.g. to the control system are permissible, provided that the safety of the device is not adversely influenced.

Items as safety concept, support structure and mooring system and the related load assumptions shall be analysed in detail. National or local regulations may require additional detailed analysis.

7. Type certification

When carrying out Type Certification, the overall concept of the ocean energy converter is assessed. The certification covers all components and elements of the ocean energy converter built in series, i.e. safety as well as design, construction, workmanship and quality are checked, assessed and certified.

It consists of a design assessment and an assessment of the quality system, the implementation of the design-related requirements in production and installation (IPE), manufacturing evaluation, as well as witnessing of the test operation of a prototype. The results of the prototype tests regarding power measurement, load measurements and converter behavior are an integral part of the Type Certification

The evaluation of the manufacturer's quality management covers the whole range of activities necessary to confirm the quality of the product. The certification of the manufacturer's quality management system (QMS) according to ISO 9001 (including design) covers a large portion of these requirements. However, the link between quality management and product quality needs to be specially addressed. It shall be ensured that the requirements stipulated in the technical documentation with respect to the components are observed and implemented in production and erection (IPE). The respective IPE assessment requires an inspection in which it shall be

demonstrated on at least one specimen that it is manufactured following the design requirements under certification. IPE shall be carried out by GL at the manufacturers of the components and the manufacturer of the converter.

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 the 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

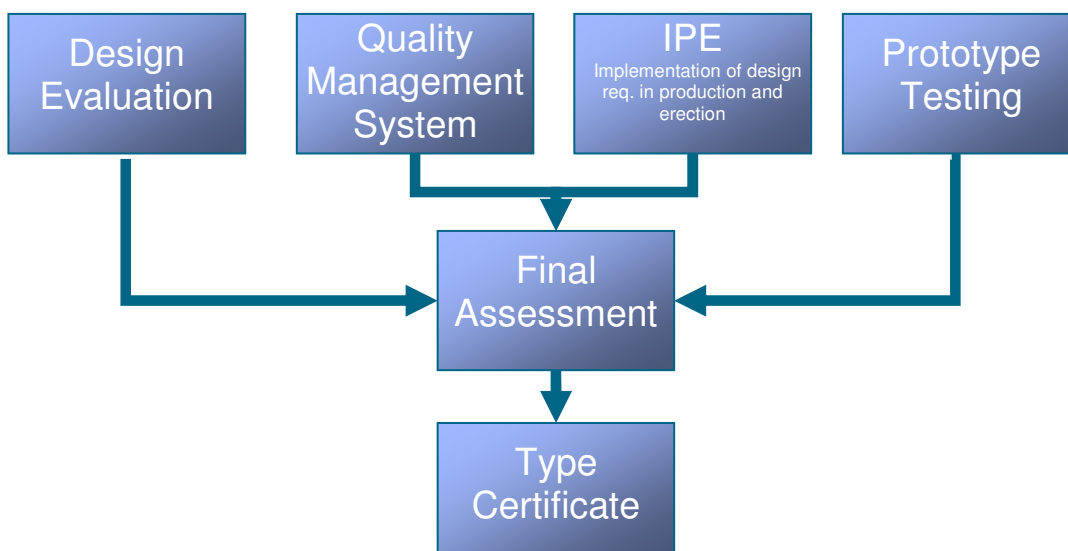


Figure 2: Modules of type certification

8. Project certification

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. In this case any additional site specific designs and/or design changes related to the energy converter are considered within the Project Certification.

It is a vital assessment and monitoring service to ensure that devices meet the requirements in the safety standards at every stage of their working life. Monitoring begins during the manufacturing process and continues during transport and erection of the energy converters. GL specialists witness the commissioning of a device and carry out periodic monitoring at agreed intervals throughout its working life.

Project Certification, as a rule, covers more than one converter, i.e. an entire power plant. It includes the design, manufacturing, installation and commissioning of all necessary installations such as land falls, power cabling, power transmission and the transformer station.

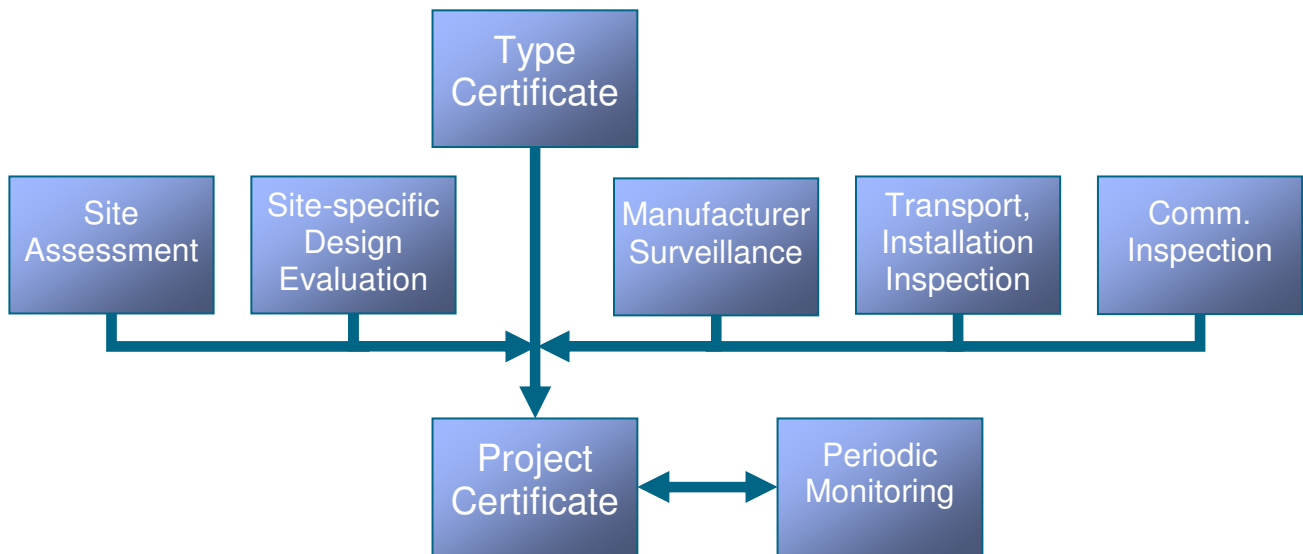


Figure 3: Modules of project certification

9. Component Certification

The procedures set up for the type certification may be applied to individual components and subassemblies of the energy converter built in series. These items may be e.g. machinery or electrical components which may be used in different ocean energy converter types. In this case a set of external and load conditions is defined by the manufacturer. Component certification is performed based on these defined conditions and the applicable guidelines and standards. In a subsequent type certification it is assessed if the conditions and standards defined for the component fulfil the requirements for the energy device under consideration.

Benefits

GL's expertise and experience in wind energy, oil and gas as well as maritime industry are invaluable not only to designers and manufacturers but also to investors and insurers. These key players in the up-and-coming ocean energy market are particularly interested in assessment, expertise and certification services that evaluate the engineering integrity and safety of ocean energy converters.

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