NI631 DT R01 JANUARY 2024

CERTIFICATION SCHEME FOR MARINE RENEWABLE ENERGY TECHNOLOGIES

NI631 - JANUARY 2024

GUIDANCE NOTE

BUREAU VERITAS

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RULES, RULE NOTES AND GUIDANCE NOTES

NI631 DT R01 January 2024 takes precedence over previous revision.

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NI631

CERTIFICATION SCHEME FOR MARINE RENEWABLE ENERGY TECHNOLOGIES

January 2024

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Section 1 General

1 Introduction

1.1 Application

1.1.1 The purpose of this Guidance Note is to describe the certification schemes applicable to Marine Renewable Energy (MRE) technologies.

1.1.2 MRE technologies

This Guidance Note covers different types of technology for energy conversion from wind, wave, tidal, solar or temperature gradients at sea such as:

- Floating Offshore Wind Turbine (FOWT)
- Current and Tidal Turbine (CTT), including sea and river turbine
- Ocean Thermal Energy Converter (OTEC)
- Wave Energy Converter (WEC)
- Floating solar energy converter (FPV).

The different types of MRE technology are illustrated with their major components in Tab 1.

This Guidance Note may also cover hybrid technologies made of a combination of the above (e.g. combined FOWT with WEC).

Bottom fixed offshore wind turbines are not covered by this Guidance Note.

1.1.3 Technical requirements

Technical requirements for design, manufacturing, transportation and installation (T&I), commissioning or operations and maintenance (O&M) are not defined in this Guidance Note. They may be found in the relevant Rules and Guidance Notes of the Society, or adapted within the certification procedure, see Article [3]. The typical Rules, Guidance Notes and standards available for MRE technologies are given in [1.5].

1.2 General definitions and acronyms

1.2.1 Acronyms

AIP : Approval in Principle
BDA : Basic Design Assessment
CTT : Current and Tidal Turbine
IEC : International Electrotechnical Commission
IAC : Inter-Array Cable
ISO : International Standardisation Organisation
MRE : Marine Renewable Energy
FOWT : Floating Offshore Wind Turbine
OTEC : Ocean Thermal Energy Converter
RNA : Rotor Nacelle Assembly
O&M : Operation and Maintenance
T&I : Transport and Installation
TRL : Technology Readiness Level
WEC : Wave Energy Converter.

1.2.2 Administration

The Government of the State responsible for or managing the area in which the MRE unit is operating.

1.2.3 Approval

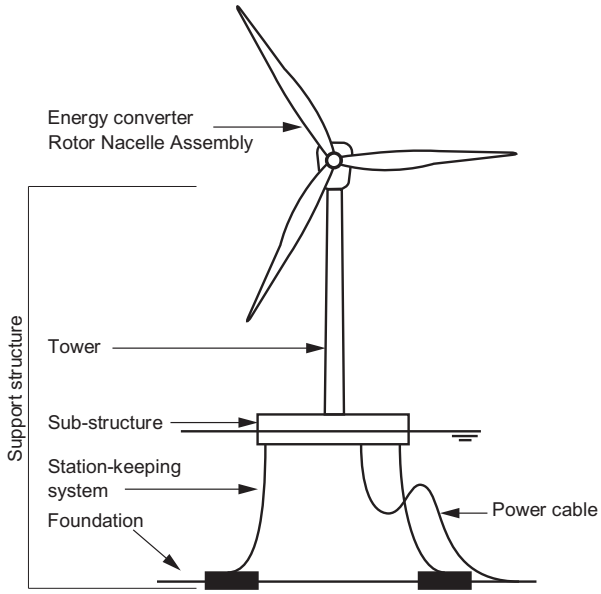
Review by the Society of documents, procedures or other items related to certification, verifying solely their compliance with the relevant Rules requirements, or other referential where requested.

1.2.4 Certification

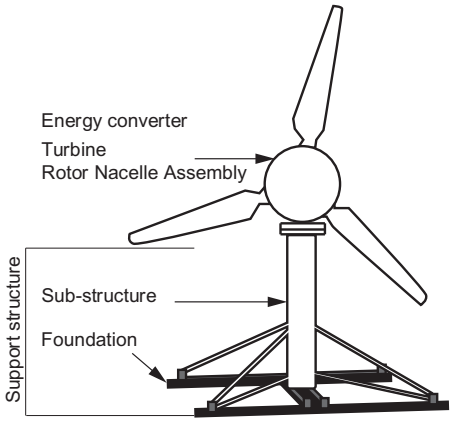
Procedure by which a third party gives written assurance that a product, process or service conforms to specified requirement; also known as conformity assessment.

Table 1 : Types of marine renewable energy technology

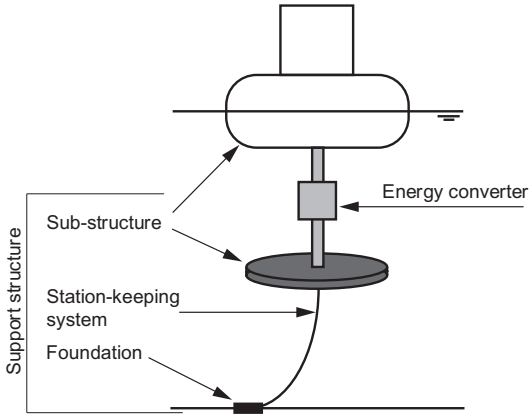
Floating Offshore Wind Turbine (FOWT)



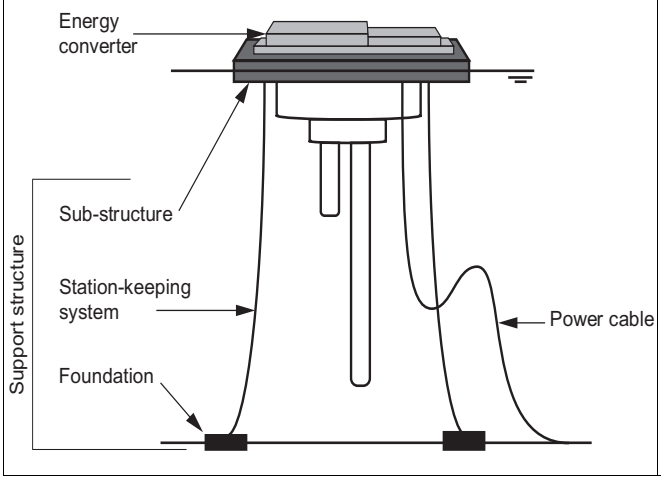
Current or Tidal Turbine (CTT)



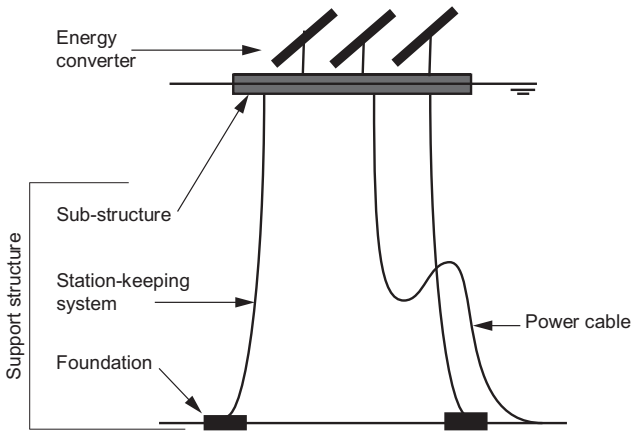
Wave Energy Converter (WEC)



Ocean Thermal Enegy Converter (OTEC)



Floating Solar Panels (FPV)



1.2.5 Client

Means the Party and/or its representative requesting the Services.

1.2.6 Conformity statement

A document issued upon successful completion of evaluation of a certification module.

Evaluation of conformity: systematic examination of the extent to which a product, process or service fulfils specified requirements.

1.2.7 Module

A certification scheme may be split into different modules covering the different life cycle phases or components of the asset to be certified. A module corresponds to the unitary subdivision of a certification scheme with its own deliverables (e.g. site conditions assessment, design evaluation for the project certification scheme, see Sec 5).

1.2.8 Provisional certificate or provisional conformity statement

A provisional certificate or provisional conformity statement may be issued on request if the Society considers this to be possible. Outstanding issues are to be listed in this document.

1.2.9 Survey

An intervention by the Surveyor for assignment or maintenance of certificate or interventions by the Surveyor within the limits of the tasks delegated by the Administration.

1.2.10 Technology maturity

The different definitions about technology maturity, technical maturity and Technology Readiness Level (TRL) may be found in NI525, Sec 3 [3].

1.2.11 Technology readiness level

The Technology Readiness Level (TRL) is a measure of the technology development state, see NI525, Sec 3, [3.3.3].

1.3 Technical definitions

1.3.1 Asset

The MRE technology object considered in the selected certification scheme.

Note 1: Depending on the certification scheme, the asset may be a component, a support structure, the MRE Unit or the entire MRE power plant.

1.3.2 Component

i.e. specific sub-systems of significant interest constituting a MRE Unit

1.3.3 Energy converter

The device for production of (electrical) energy from renewable energy (wind, current solar, thermal energy...) and its own structure. The energy converter is connected to the support structure.

1.3.4 Foundation

Installations at the seabed or in the seabed, providing the transfer of loads to soil. For floating units, foundations are connected to the stationkeeping system.

1.3.5 MRE unit

The energy converter with its support structure. A MRE unit is typically the unitary subdivision required to compose the MRE power plant. The MRE units are independent systems and may be connected between each other by inter-array cables (IAC) or potentially shared station keeping systems.

1.3.6 MRE power plant

Entire group of MRE units installed on a dedicated site, as well as any related asset (Offshore substations, IAC, export cable,…). This power plant may also be referred to as farm or array.

1.3.7 Stationkeeping system

System capable to maintain a floating unit in position within specified limits.

Note 1: Stationkeeping system may consist of mooring lines, tension legs, dynamic positioning system...

1.3.8 Sub-structure

Part of the support structure which connect the link to the soil (i.e. the stationkeeping system, if any, or directly the foundation) to the tower, if any, or directly to the energy converter. The transition piece (i.e. the mechanical interface between the sub-structure and the tower or interface with the energy converter) is considered to be part of the sub-structure.

1.3.9 Support structure

Consists of the foundation, station keeping system, sub-structure (including the transition piece) and the tower, when relevant.

1.3.10 Tower

Part of a support structure which connects, the sub-structure to the energy converter.

Note 1: Tower is typically generally to be considered for a FOWT

1.4 Certification schemes

1.4.1 Definitions

It is assumed that the engineering design process generally follows the following steps:

- Feasibility Study:

  The purpose of a feasibility study is to determine the critical technical issues of the project or technology and assess whether the project can proceed into the design phase. This typically corresponds to TRL 1 to 3.

- Conceptual Design:

  This is an early phase of the design process in which the broad outlines of project or technology are defined and specified. This typically corresponds to TRL 4 to 6.

- Basic Design (also called Preliminary design or FEED):

  The purpose of the basic design is to issue a set of documents comprising drawings, analysis and specifications demonstrating that the design meets the applicable Rules, Regulations and design codes with a view to later proceeding with the construction of the considered design. The design methodologies for the analysis are developed within the Basic Design. The analysis carried out are not exhaustive and are more for illustration of the methodology of analysis than for final assessment. This typically correspond to TRL above 6.

- Detailed Design (also called detailed engineering):

  The detailed design is developed from the basic design so as to allow the construction to be in accordance with the applicable Rules or standard recognized by the Society.

- Final Design:

  The final design is the as-built design and comprises the unit construction file.

For engineering process following final design, reference is made to the modules following the design evaluation module of the project certification scheme, in Sec 5. The different certification schemes defined in [1.4.2] cover one or several different phases of the engineering design process.

Table 2 : Certification schemes objectives, their typical technology readiness level (TRL)

Certification scheme	Objectives	Typical range of TRL
Approval In Principle (AIP)	• Flexible format for preliminary stages, determined by Client needs. This is first dedicated to feasibility studies (AIP level 1) and design concepts studies (AIP level 2). • Review of applicable rules. • Verification that there is no contradiction in methods and designs with the applicable rules.	AIP level 1: [1-3] AIP level 2: [4-6]
Basic Design Assessment (BDA)	• Verification of the basic design phase, • Verification that the design basis (principles and methodologies) and documentation are suitable, with a view to facilitate detailed design and construction.	[5-7]
Prototype	• Assessment of the general plausibility and safety of the unit. It covers design and testing. • Dedicated to the first unit of a new technology.	[5-7]
Type and component	Assessment of the design, manufacturing and testing of a standardized product to be ready for serial production. The design is specified with its design conditions envelope.	[8-9]
Project	Coverage of all project development phases, from design to commissioning, of a MRE power plant at a given location. Verification that the design, manufacturing, transport and installation, commissioning and operation and maintenance are in conformity with applicable local codes and other requirements relevant to the site.	[7-9]

1.4.2 General

To meet a broad range of needs within the MRE industry, different certification schemes are introduced:

- Approval in Principal (AIP) and Basic Design Assessment (BDA), defined in Sec 2
- Prototype Certification, defined in Sec 3
- Component and Type Certificate, defined in Sec 4
- Project Certification, defined in Sec 5. Project Design and Project Basic Design Assessment certification schemes are also proposed as intermediary schemes on the path to project certification.

These certification schemes broadly follow TRL progression. Preliminary certification schemes are recommended (but not mandatory), for later facilitating more advanced TRL certification scheme (e.g. project certification).

Each certification scheme covers a dedicated product life cycle phase and covers different ranges of technology maturity. The different certification schemes may generally be followed when the corresponding development stage of MRE technologies is completed.

An overview of the different certification schemes with short descriptions is presented in Tab 2, the requirements per project phase are defined in Tab 3, and the deliverables are defined in [2.2].

Note 1: For wind turbine, the Society's evaluation system can be based on the public, internationally recognized IEC 61400 series, including in particular the IEC 61400-22 describing the general certification scheme, the IEC 61400-1 related to general design and load cases, and the IEC 61400-3 for offshore wind turbines.

Table 3 : Certification phase and life cycle phases covered by the different certification schemes

Life cycle phase	Certification phase	AIP and BDA	Prototype certificate	Component certificate	Type certificate	Project certificate
		see Sec 2	see Sec 3	see Sec 4	see Sec 4	see Sec 5
Development	Site conditions assessment	–	–	–	–	see Sec 5, [3]
	Risk assessment	At least qualitative studies	(Optional) see Sec 3, [3]	–	(Optional) see Sec 5, [4]	(Optional) see Sec 5, [3]
	Design basis evaluation		Prototype design evaluation see Sec 3, [4]	see Sec 4, [4]	see Sec 4, [4]	see Sec 5, [5]
	Integrated loads			–	–	see Sec 5, [6]
	Design evaluation			see Sec 4, [5]	see Sec 4, [5]	see Sec 5, [7]
Construction T&I Commissioning	Manufacturing survey	–	(Optional) see Sec 3, [5]	see Sec 4, [6]	see Sec 4, [6]	see Sec 5, [8]
	Transport and installation survey	–	–	–	–	see Sec 5, [9]
	Testing	–	see Sec 3, [6]	see Sec 4, [7]	see Sec 4, [7]	-
	Commissioning survey	–	(Optional) see Sec 3, [7]	–	–	see Sec 5, [10]
	Characteristics measurements			–	(Optional) see Sec 4, [8]	(Optional) see Sec 5, [11]
O&M	In-service	–	–	–	–	see Sec 5, [12]

1.5 Guides, codes or standards

1.5.1 Reference standards

The standards referenced in the various sections of this Note are:

- ISO/IEC 17020:2012: Requirements for the operation of various types of bodies performing inspection
- ISO/IEC 17025:2017: General requirements for the competence of testing and calibration laboratories
- ISO/IEC 17065:2012: Conformity assessment - Requirements for bodies certifying products, processes and services.

1.5.2 FOWT technology documents

For Floating Offshore Wind Turbine (FOWT), the following rules and standards may be considered:

- NR572 Classification and certification of Floating Offshore Wind Turbines
- IEC 61400 series: Wind turbines series, in particular:
  - IEC TS 61400-3-2:2019 Design requirements for floating offshore wind turbines
  - IEC 61400-1:2019 Design requirements.

1.5.3 CTT technology standards and documents

For Current and Tidal Turbine (CTT), the following rules and standards may be considered:

- NI 603 Guidance Note on Current and Tidal Turbines
- IEC TS 62600 series: Marine energy - Wave, tidal and other water current converters.

1.5.4 OTEC technology standard and documents

For Ocean Thermal Energy converter (OTEC), the following rules and standards may be considered:

- NI 637 Classification and Certification of Ocean Thermal Energy Converter (OTEC) - Tentative Rules
- IEC TS 62600 series: Marine energy - Wave, tidal and other water current converters.

1.5.5 Additional Society Rules

The documents presented herebelow are only the governing documents. Specific documents to be used on each relevant design aspect are defined as part of the Design Basis of each element.

The main Society documents defining applicable technical requirements are:

- NR216 Rules on materials and welding for the classification of marine units
- NR426 Construction survey of steel structures of offshore units and installations
- NR432 Fiber ropes for offshore services
- NR493 Classification of mooring systems for permanent offshore units
- NR445 Rules for the classification of offshore units
- NI525 Risk based qualification of new technology - Methodological guidelines.
- NI594 Design and construction of offshore concrete structures
- NI605 Geotechnical and foundation design
- NI682 Certification of fixed offshore substations for renewable energy projects
- NI685 Certification of subsea power cables for renewable energy projects
- NI691 Environmental Conditions, Loads and Induced Responses of Marine Units

2 Certification approach

2.1 General

2.1.1 The certification scheme is based on a serie of modules, or a single module for AIP and BDA. Optional modules are also proposed and may be added to the mandatory modules. The completion of a module may be based on a documentation review and/or independant calculations and/or audits and/or inspections.

2.2 Deliverable

2.2.1 For each certification scheme, one or several deliverables are issued, see Tab 4.

Table 4 : Deliverables per certification scheme

Certification scheme	Deliverable per module	Final deliverable
Approval In Principle (AIP) and Basic Design Assessment (BDA)	Not applicable	An AIP/BDA verification letter or/ statement of AIP/BDA
Prototype	Each module of the certification procedure, once validated, is concluded by an evaluation report and a conformity statement	A certificate attesting the satisfactory completion of all mandatory modules is issued along with the final evaluation report
Type and component		
Project		

2.2.2 Provisional certificate

In the case of pending comments of no importance to the primary safety of the certified object, a provisional certificate or provisional conformity statement may be issued for a limited period of validity, maximum 1 year.

2.3 Third parties' certificates

2.3.1 General

Different organizations (referred to as certification bodies) may be involved in the certification process. The Client may therefore submit to the Society, Test Report, Conformity Statements or Certificates (e.g. Type Certificate) from other certification bodies.

The following applies:

- the Society may consider certificates from certification bodies holding an accreditation certificate to ISO/IEC 17065, covering the applicable rules and standards, which is issued by a national accreditation body.
- when relevant, for eligible components, class certificates issued by a classification society other than Bureau Veritas may be considered.

Inclusion of other certification bodies' certificates in the certification process is to be clearly stated. The Society reserves the right to require additional documentation to include certificates in the process.

The Society does not take any responsibility for other Certification Bodies' work.

2.4 Methodology

2.4.1 The evaluation process consists of document review as well as independent analyses or inspections, depending on the module under consideration.

2.4.2 Evaluation plan

At the beginning of the process, a detailed evaluation plan is submitted to the client. This evaluation plan describes the evaluation process into details, together with the working methods and the primary planning.

2.4.3 Document review

A large part of the evaluation consists in reviewing calculation notes, specifications, drawings, data sheets, reports, certificates, with regards to the applicable requirements.

2.4.4 Collaborative platform VPM

Bureau Veritas has developed a web-based collaborative platform, Veristar Project Management (VPM) as illustrated in Fig 1. It is a collaborative platform for document review, ensuring smart management of the documentation and communication between the Society and the client. Each document submitted is recorded in this tool which centralizes all the comments made by the reviewer and answers from the Client. This reviewing process ensures transparency and efficiency.

2.4.5 Independent analyses

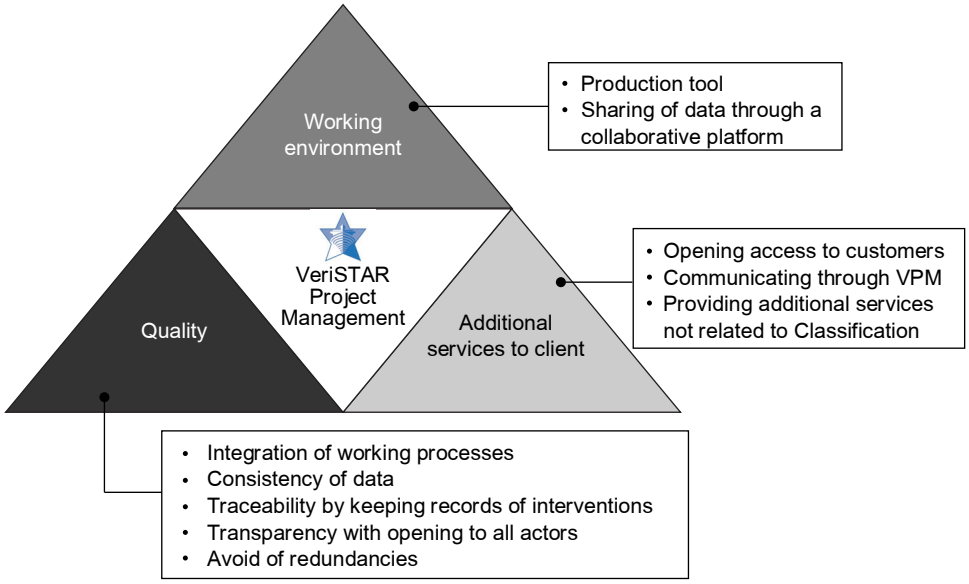
The Society may performs independent calculations based on its own assumptions and methods. The goal of these independent calculations is to verify some key characteristics of the project. They do not prevent the client from performing its own sensitivity analyses as required by the rules and standards.

Independent analyses are usually performed for the most critical cases only and not as a standard basis. They are based on inputs, to be provided by the Client upon request.

2.4.6 Tests

Tests are to be carried out by a testing aboratory holding an accreditation certificate to ISO/IEC 17025:2017 covering the applicable testing standards which is issued by a national accreditation body operating.. If it is not the case, the party conducting the testing is to comply with at least the criteria of ISO/IEC 17025:2017 or ISO/IEC17020:2012, as applicable.

Figure 1 : Veristar Project Management



2.4.7 Surveys

Surveys related to a specific process (manufacturing, transportation, installation, etc.) consist of verifying that the procedures in force meet specified requirements. It involves several methods:

- evaluation of the quality system
- verification of the compliance of the procedures with the specified requirements
- verification of the application of the procedures.

The quality system evaluation is normally limited to the verification that the quality systems of the different manufacturers or operators involved are certified according to ISO 9001:2015. If the quality system is not ISO 9001:2015 certified, an assessment of the quality system by the Society will be required.

The evaluation of the compliance of the procedures usually consists of reviewing the different documents related to the process under scrutiny (manuals, checklists, reports, etc.) and verifying their compliance to the specified requirements.

Finally, the verification of the application of the procedures involves review of records and reports related to the process under scrutiny and several on-site inspections of the process. The exact scope and extent of the inspections depend on the component to be inspected and the manufacturing process itself.

2.5 Validity and Maintenance

2.5.1 Validity

The period and conditions of validity depends on each certification scheme and are stated in Sec 2 to Sec 5.

2.5.2 Maintenance

Certificate maintenance is an optional feature to extend initial validity period of the certificates, applicable for different schemes (see Sec 3, [2.1], Sec 4, [2.4] or Sec 5, [2.5]).

3 Reference set of certification requirements

3.1 General

3.1.1 During the evaluation, the conformity of the component/unit/farm is assessed according to a hierarchy of requirements which need to be defined jointly at the start of the process. This set of requirements forms the reference basis for Prototype, Component, Type or Project Certification.

Note 1: This set of requirements is typically defined in so-called design basis documentation. Its verification is part of design basis evaluation.

3.1.2 Process

Different steps can be followed to determine the set of requirements:

a) Breakdown into components

Depending on the technology considered and associated available standards, the level of details of the breakdown may vary.

A functional analysis can be helpful to ensure exhaustive identification of each component constituting the unit such as blades, generator, cables, connectors, etc.

b) Technology maturity assessment

The technical maturity and similarity or difference in the operating conditions for each component identified is to be established by a Technology maturity Assessment, conducted following Tab 5.

A methodology for technology maturity assessment is defined in NI525, Sec 3, [3].

c) Identification of codes and standards

For each component identified and assessed, existing standards and their application for the specific MRE unit conditions are identified. For each component identified in a) and assessed in b), existing standards are identified and their applicability for the specific MRE conditions is to be investigated.

Note 1: Components for which the technology assessment is equal to 0 (proven technology in similar application conditions) are likely to be already covered by existing codes or standards applicable in the specific MRE unit conditions.

Table 5 : Technology rating

Technology maturity	Application conditions	
	Similar	Different
Proven	0	1
Limited field history	1	2
Extrapolated from proven	2	3
Unproven	3	3

3.1.3 Context

For mature sectors, the set of requirements mentioned in [3.1.1] comes from existing codes and standards. Depending on the considered certification procedure (prototype, component, type or project certification), all relevant areas have to be covered by these technical requirements, such as loads or structural design requirements

It is recognized that, as function of the MRE technology, existing record of in-service information may not be sufficient to provide a comprehensive set of dedicated MRE standards. In that purpose, use of existing codes and standards from MRE and related sectors may be combined with a risk-based approach for the most innovative and unknown part. The resulting reference set of certification requirements may contains:

- existing codes and standards
- existing codes and standards with appropriate modifications when necessary, to adapt them to the specific MRE unit context
- additional requirements for MRE unit components which are not covered by any existing code or standard.

The risk-based methodology for definition of requirements is defined in [3.2].

3.2 Risk based methodology

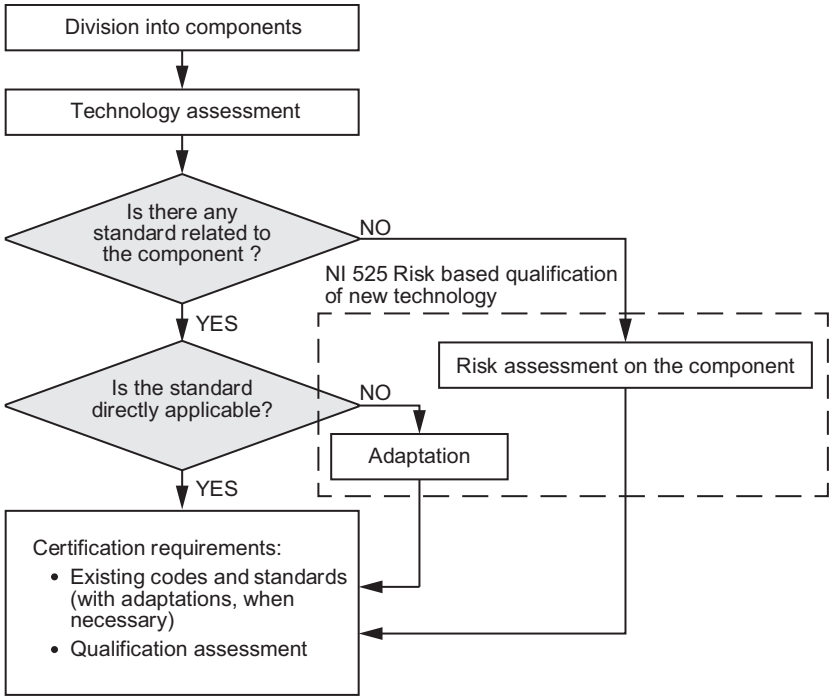
3.2.1 The purpose of the risk-based methodology for identification of requirements is to assess the availability and relevance of existing codes and standards for each MRE unit component and to provide adaptations or appropriate requirements when necessary.

Risk assessments are considered at different levels:

- when there is no existing codes and standards
- when there are codes and standards from related sectors, but they need to be adapted to the specific MRE unit conditions.

The risk-based methodology for the definition of the reference set of certification requirements is illustrated in Fig 2.

Figure 2 : Risk-based methodology of the reference set requirements



3.2.2 No existing code and standard

If there are no guidelines nor standards for a specific component, neither in the MRE sector, nor in related sectors; then the technology qualification steps described in NI525 may be implemented.

Potential high risks induced by the component are to be identified and assessed in terms of frequency and severity of the consequences. Associated mitigation measures and qualification activities (calculations or physical tests) are to be implemented to ensure safety and reliability of the component.

3.2.3 Codes and standards from related sectors

If there are standards from related sectors (such as shipping or offshore oil and gas), appropriate modifications or interpretation may be necessary to adapt their requirements to the specific MRE unit conditions. The specific MRE unit context deviations from their conditions of application are to be assessed.

Potential gaps or over-constraining requirements regarding MRE projects are to be investigated. Appropriate modifications or interpretation may be considered to adapt the requirements, subject to the agreement of the Society.

As a guidance, the qualification procedure described in NI525 is recommended to identify specific failure modes induced by the MRE unit conditions. Associated mitigation measures and qualification activities (calculations or physical tests) are to be deployed and conducted to ensure safety and reliability of the component.

Section 2 Approval in Principle and Basic Design Assessment Statements

1 General

1.1 Application

1.1.1 Approval In Principle (AIP) and Basic Design Assessment (BDA) are applicable for a concept of MRE unit or a MRE sub-system. AIP and BDA certification schemes are typically adapted to innovative and novel designs.

1.2 AIP

1.2.1 Purpose

The AIP may have the following objectives:

- To establish the design code to comply with
- To verify that the design is feasible, achievable, and contains no technological showstoppers or contradiction with applicable rules and that may prevent the design from being matured
- To verify that the design is deemed to be suitable for use in the metocean conditions that the unit facility will be located in
- To verify that the design is deemed to be suitable for use in all phases of operation including design, manufacturing, transportation, installation, commissioning, operation and maintenance
- Provide recommendations to fulfill through the following phases of the project.

1.2.2 Adaptation to design maturity

Two levels of AIP may be granted depending on the maturity of the design:

- Level 1 for feasibility study
- Level 2 for conceptual design.

The indicative list of documents that should be provided for each level is given in Tab 1.

1.2.3 AIP is a flexible process, adapted to early certification stages. Discussions need to be held between the Society and the Client as a first step to define the scope and extent of the AIP:

- rules and regulations to be considered for the review
- scope of the AIP (list of submitted documentation).

1.3 Basic Design Assessment (BDA)

1.3.1 The BDA certification scheme is a flexible format to cover different design review activities of the basic design engineering stage, also referred to as FEED. It demonstrates that the design is made in accordance with the design basis and that major possible showstoppers have been properly addressed.

Basic Design Assessment aims at:

- facilitating the project certification process by confirming that the technology may go to detailed design stage
- verifying there is no contradiction with the applicable Rules and regulations.

1.4 Scope of the AIP and BDA

1.4.1 Typical AIP and BDA types

Different typical AIP and BDA types may be considered. The following indicative list defines the main categories of AIP and BDA:

- Mooring system design
- Floating foundation design (supporting Wind turbine, solar panels, etc.)
- Energy converters design (e.g. for OTEC, WEC)
- Other (e.g. mooring or power cable component).

1.4.2 Type of verification

For AIP, the document review is generally not supported by independent calculations.

For BDA, the document review is completed by independent calculation verifications, as appropriate.

1.5 Documentation to be submitted

1.5.1 An indicative list of document per concept approval stage, from AIP level 1 to BDA, is defined in Tab 1.

Table 1 : Indicative list of documents per concept approval stage

	AIP level 1	AIP level 2	BDA
General drawings	X	X	X
Design basis / Project Specification /	X	X	X
Functional specification (if any)	X	X	X
General arrangement	X	X	X
Metocean / Hydrodynamic	X	X	X
Key structure drawings for primary structure	Partial documentation	Partial documentation	X
Key stationkeeping system drawings: line description plan and mooring layout	Partial documentation	Partial documentation	X
Design Brief / Methodology of analysis (extreme, accidental, fatigue, service)	Partial documentation	Partial documentation	X
Mooring analyses		X	X
Preliminary primary structure analysis reports		Partial documentation	X
Preliminary Risk analysis		X	X
Process Flow Diagram (PFD)	X (key PFDs only)	X	X
List and description of marine & safety systems (e.g. trim & ballast)		X	X
Material specification, corrosion protection system	X	X	X
Installation, maintenance and inspection manual			X
Stability analysis report		X	X
Hazardous area / Fire Integrity Plan		X	X

2 Approval

2.1 Deliverables

2.1.1 Approval in principle (AIP)

Approval In Principle may be granted by a letter of AIP, also referred to as AIP statement, i.e. a letter with a final report in which the documents reviewed, the Society's remarks and comments, and the rules for which fitness was checked are listed.

2.1.2 Basic Design Assessment (BDA)

BDA may be granted by a letter of BDA, also referred to as BDA statement, i.e. a final report in which the documents reviewed, the Society's remarks and comments, and the rules for which fitness was checked are listed.

2.2 Validity

2.2.1 Any major modification likely to invalidate the principles as evaluated on the documents reviewed may reconsider the validity of the statements.

Section 3 Prototype Certificate

1 General

1.1 Application

1.1.1 Prototype Certification is applicable for the first unit of a new generation. The general plausibility and safety of the unit design is assessed, with focus on previously identified risk areas.

2 Prototype Certification

2.1 Prototype Certification scheme

2.1.1 The Prototype Certification scheme consists of the completion of the following modules, as given in Fig 1:

- risk assessment (optional)
- prototype design evaluation
- manufacturing survey (optional)
- prototype testing evaluation
- commissioning survey(optional)

Note 1: Site conditions are not assessed as part of the prototype certification. However, the plausibility of the inputs site conditions presented in the prototype design evaluation documentation is considered.

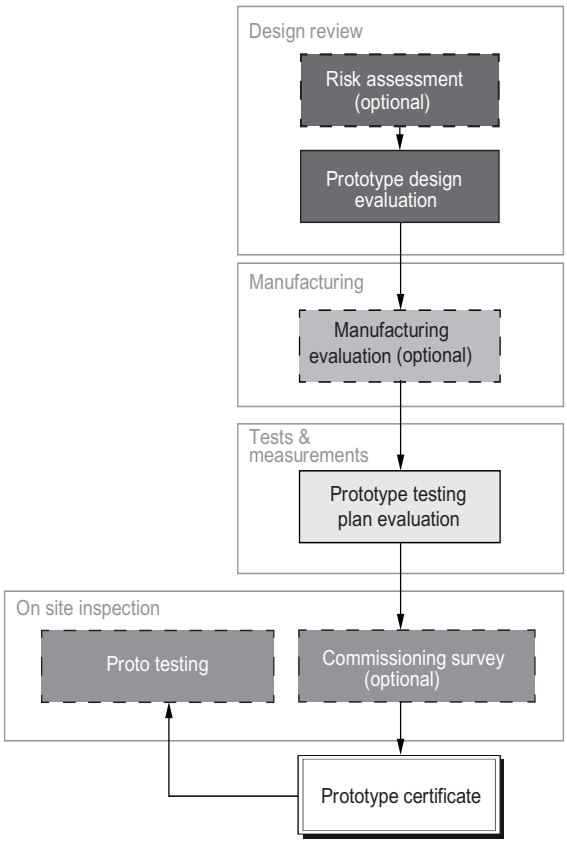
2.1.2 Validity

The validity period of the Prototype Certificate is maximum 3 years. Extension of the validity period is subject to maintenance of the certificate as defined in [2.1.3].

2.1.3 Maintenance of the certificate

The Prototype Certificate validity may be extended considering periodic inspections and/or monitoring outcomes provided by the Client, as validated in the Prototype test plan [6.2].

Figure 1 : Prototype Certificate scheme



3 Risk assessment (optional)

3.1 General

3.1.1 The risk assessment aims at identifying systematically:

- Hazardous situations, such as collision or climatic extremes and their possible causes and effects induced on asset integrity, personal safety and environment.

Note 1: HAZID (Hazard Identification method) is recommended.

- Component failures: failure modes and their possible causes and effects induced on asset integrity, personal safety and environment.

Note 2: FMECA (Failure Mode, Effects and Criticality Analysis) is recommended.

3.1.2 Evaluation of the risk assessment module consists of a review of the risk assessment documents to ensure that no hazard remain unaddressed.

3.1.3 The Society reserves the right to consider the risk assessment as mandatory.

4 Prototype design evaluation

4.1 General

4.1.1 The prototype design evaluation focus on integrity of major structural components. Particular attention is paid on risk areas identified through the risk assessment. It consists of a design basis evaluation and evaluation of design documentation and calculations at a detailed level.

Note 1: A previous AIP as described in Sec 2 can facilitate the review of this module.

4.2 Design basis evaluation

4.2.1 The design basis aims at identifying all requirements, assumptions and methodologies which are essential for the design and the design documentation, including:

- codes and standards

  and eventually additional requirements or deviations from these codes and standards when required and additional requirements for components which are not covered by existing codes and standards (see Sec 1, [3.2])

- design parameters, assumptions, methodologies and principles
- other requirements, e.g. for manufacture and commissioning as well as for operation and maintenance.

4.3 Design evaluation

4.3.1 The purpose of the design evaluation module is to examine whether the prototype is designed and documented in conformity with the design assumptions, specific standards and other technical requirements agreed with the Society at the design basis evaluation stage. It can be limited to loads, major structural components, control and protection systems and personnel safety issues.

Design evaluation consists in a review of detailed design documentation (calculation notes, drawings, specifications). Independent analytical and/or numerical calculations may be performed on a spot check basis by the Society for verification purpose, typically for major structural components.

5 Manufacturing evaluation (optional)

5.1 General

5.1.1 The manufacturing evaluation ensures that the intended quality requirements are met for the prototype and all its the component under consideration.

As part of the manufacturing evaluation, welding procedures specifications and existing qualification are reviewed and inspections are to be planned covering the critical phases of the fabrication process.

6 Prototype testing evaluation

6.1 General

6.1.1 The purpose of prototype testing evaluation is to verify that the prototype under test performs as predicted in the design. It may be limited to the safety and function tests and consists of:

- prototype test plan evaluation
- prototype testing.

Note 1: Power performance measurements may be considered.

6.2 Prototype test plan

6.2.1 The prototype test plan is to be designed to provide the data necessary to verify safety-critical aspects that require additional experimental verification. Main components to be tested during the test period and loads to be documented during the tests are to be specified.

The prototype test plan is to be submitted to the Society for review.

6.3 Prototype testing

6.3.1 The prototype testing is to be carried out according to the reviewed prototype test plan.

Evaluation is based on:

- demonstration that the control and protection system functions correspond to the approved test plan
- verification of the dynamic behaviour.

Note 1: Prototype testing may occur during or after the commissioning of the unit.

7 Commissioning survey (optional)

7.1 General

7.1.1 The commissioning survey is an optional module of the Prototype Certification procedure. On a case-by-case basis, the commissioning of the prototype unit may be surveyed by the Society at the request of the Client.

Section 4 Component and Type Certificates

1 General

1.1 Application

1.1.1 Type and Component Certification are applicable for the generic part of a standard commercial unit (i.e. the part which is not specific to a given site), considering of a standard commercial unit, considering a series of units of common design and manufacture. Type certification considers the same certification modules as Component Certification, but applied to a group of components or to the to the complete unit. As such, components that are already certified are easily integrated into the Type Certification procedure. Integration of component certificate into type certificate is described in [1.1.4].

1.1.2 Component Certification

Component Certification is applicable for unit components that are likely to be used in multiple projects. In such cases, a specific Component Certification can avoid the repetition of design evaluations for each project, as long as the external conditions are not more severe than those specified in the Component Certificate.

The purpose of Component Certification is to confirm that a major component of a specific type is designed, documented and manufactured in conformity with design assumptions, specific standards and other technical requirements.

1.1.3 Type Certification

The purpose of Type Certification is to confirm that the unit type is designed, documented and manufactured in conformity with design assumptions, specific standards and other technical requirements. Demonstration provided by the Client that it is possible to install, operate and maintain the unit in accordance with the design documentation is required.

Conformity of the unit is checked according to specified environmental conditions, corresponding to a specific load envelope.

This load envelope corresponds to a range of admissible loads and load effects.

Type Certification can avoid the repetition of the certification procedure for each project, as long as the loads and load effects are not more severe than those specified in the Type Certificate.

1.1.4 Integration of component certificates into type certificate

Component certificates may, after a successful evaluation, be integrated into a type certificate. A dedicated documentation is to be submitted to the Society to prove that the component certificate and its defined interfaces complies with the main inputs of the type certificate process: design basis, load assumptions and other requirements relevant for integration of the component.

The validity of the type certificate is not to exceed the validity of the integrated component certificate.

As specified in Sec 1, [2.3], the Society does not take any responsibility for the component certification work carried out by other certification bodies.

2 Type and Component Certification

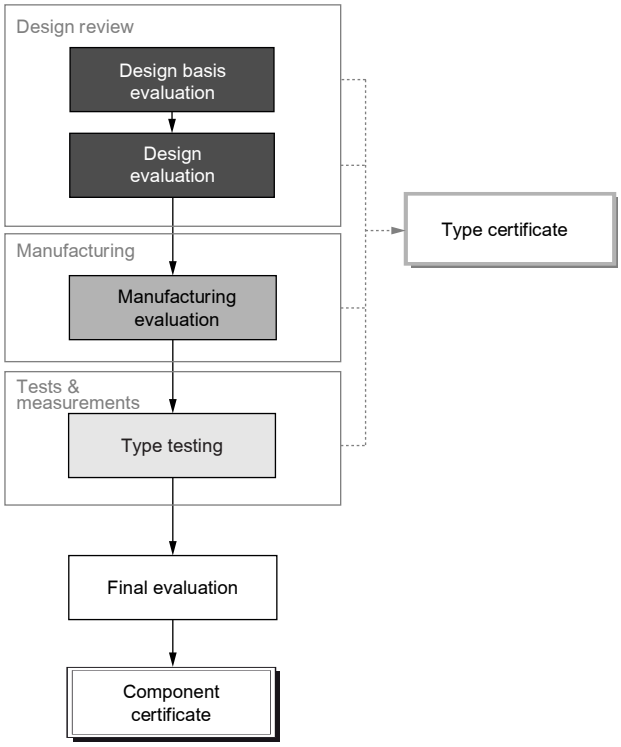
2.1 Component Certification scheme

2.1.1 Component certification consists of the modules:

- design basis evaluation
- design evaluation
- manufacturing evaluation
- type testing
- final evaluation.

Component certificate modules and their application for Type Certificate are illustrated in Fig 1.

Figure 1 : Component certification scheme and application with Type Certificate



2.2 Type Certification scheme

2.2.1 Main modules of the Type Certification scheme are:

- risk assessment (optional)
- design basis evaluation
- design evaluation
- manufacturing evaluation
- type testing
- type characteristics measurements (optional)
- final evaluation.

Type certificate modules and their application for Project Certificate are illustrated in Fig 2.

Any modification of the design, procedures or specifications by the Client is to be reported without delay to the Society with all documentation affected by the modification. Potential extension of the Type Certificate is to be decided by the Society on a case by case basis.

2.3 Deliverables

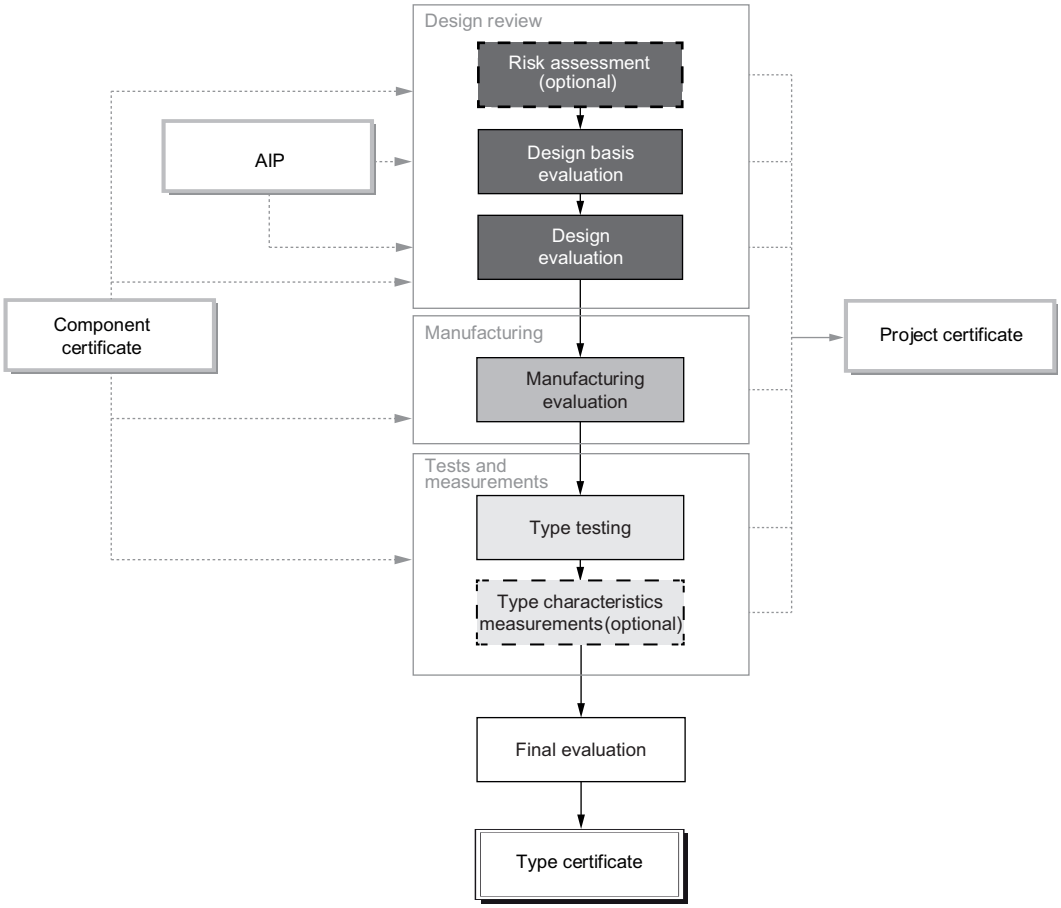
2.3.1 Evaluation reports

Evaluation report is delivered for each evaluated module. This report summarizes the evaluations and independent analyses performed by the Society for the evaluation of the said module, the different findings, and the final results. It gives the Society's conclusion on the conformity of the module under scrutiny.

The following reports are issued after evaluation of the corresponding module:

- evaluation report for risk assessment, when requested
- evaluation report for design basis
- evaluation report for design assessment
- evaluation report for manufacturing
- evaluation report for type testing
- evaluation report for type characteristics measurements, when requested
- final evaluation report.

Figure 2 : Type certification scheme and application with AIP, component and project certificate



2.3.2 Conformity Statements

If the modules are deemed to be compliant with the relevant requirements, the corresponding Conformity Statements are issued:

- conformity statement for risk assessment, when requested
- conformity statement for design basis
- conformity statement for design assessment
- conformity statement for manufacturing
- conformity statement for type testing
- conformity statement for type characteristics measurements, when requested.

2.3.3 Type/Component Certificate

A Type/Component Certificate is issued at the end of the certification procedure when all mandatory modules have been successfully completed. A Type/component Certificate attests to the conformity and correctness of all mandatory modules and, if applicable, of the optional modules.

2.4 Validity and maintenance of certificate

2.4.1 Validity

The validity period of the Type/Component Certificate is normally 5 years..

The period validity of a provisional certificate or conformity statement is not to exceed 12 months from the date of issuance.

2.4.2 Maintenance

It is assumed that project or prototype certification schemes will cover that project/prototype certification schemes will cover the maintenance of the type certified unit or component.

3 Risk assessment (optional)

3.1 General

3.1.1 The risk assessment aims at identifying:

- Hazardous situations, such as collision or climatic extremes and their possible causes and effects induced on asset integrity, personal safety and environment.

Note 1: HAZID (Hazard Identification method) is recommended.

- Component failures: failure modes and their possible causes and effects induced on asset integrity, personal safety and environment.

Note 2: FMECA (Failure Mode, Effects and Criticality Analysis) is recommended.

3.1.2 The risk assessment documents are to be submitted to the Society for review.

3.1.3 The Society reserves the right to consider the risk assessment as mandatory.

4 Design basis evaluation

4.1 General

4.1.1 The design basis aims at identifying all requirements, assumptions and methodologies provided by the Client, which are essential for the design and the design documentation, including:

- codes and standards

  and eventually additional requirements or deviations from these codes and standards when required and additional requirements for components which are not covered by existing codes and standards (see Sec 1, [3.2])
- design parameters, assumptions, methodologies and principles
- other requirements, e.g. for manufacture and commissioning as well as for operation and maintenance.

The design basis is to be submitted to the Society for review.

4.1.2 In particular, the following information is to be stated in the design basis:

- design loads cases
- external design parameters
- load factors and load reduction factors, if relevant
- safety factors
- duration of simulations and their number
- extreme and fatigue design analysis methodology
- environment conditions (including for installation)
- target lifetime
- inspection scope and frequency
- requirements for conditions monitoring systems.

5 Design evaluation

5.1 General

5.1.1 The purpose of the design evaluation module is to examine whether the unit is designed and documented in conformity with the design assumptions, specific standards and other technical requirements.

Design evaluation consists of a review of design documentation (calculation notes, drawings, specifications). Independent analytical and/or numerical calculations may be performed by the Society for verification purposes, typically for major structural components.

5.1.2 The design evaluation module is declined into sub-modules covering different topics. The main sub-modules are the followings:

- control and protection system
- loads and load cases:

  load envelope check through the review of behaviour and load calculations submitted to the society, including independent analysis by the society where deemed necessary
- structural component:

  design review of structural components based on the validated load envelope
- mechanical component:

  design review of mechanical components based on the validated load envelope

- safety electrical systems component, as applicable:

  design review of electrical components based on the validated load envelope
- blades, when relevant
- process evaluation (manufacturing, transportation, installation and maintenance)
- component tests.

6 Manufacturing evaluation

6.1 General

6.1.1 The manufacturing evaluation aims at assessing whether the manufacturer is able to build the unit type in conformity with the design documentation verified during the design evaluation.

This evaluation includes the following elements:

- quality system evaluation: conformity with ISO 9001:2015 or ad-hoc evaluation of the quality system in place
- review of the manufacturing plan and procedures
- manufacturing inspection: the manufacturig of one representative specimen is made under survey by the Society to check that requirements regarding critical components and manufacturing processes are implemented in production and assembly. Inspections by the Society are to be planned for each component and for the global integration within the final unit.

7 Type testing

7.1 General

7.1.1 The purpose of the type testing module is to prove that the MRE unit behaves as expected by the design. Testing reports are to be submitted to the Society for approval. At the convenience of the Society, attendance to tests may be required.

7.1.2 The purpose of the type testing is to provide data needed to verify safety-critical aspects and any other aspects that can not be reliably evaluated by analysis.

7.1.3 The type testing considers the following aspects:

- Safety and function tests: check that the unit under test displays the behavior predicted in the design.
- Load measurements: to validate design calculations and to determine the magnitude of loads under specific conditions.

Note 1: For FOWT and CTT, the type testing may consider blade tests to check blade structural design and to assess the suitability of manufacturing processes.

7.2 Documentation to be submitted

7.2.1 The following documents are to be submitted:

- Inspection records (completed preferably prior to tests), to demonstrate the conformity of the unit/component with the design documentation
- test plan
- test report (documented by testing and test results).

8 Type characteristics measurements (optional)

8.1 General

8.1.1 The type characteristics measurements are optional. They aim to establish the performance-related characteristics of the unit type other than power performance. Characteristics measurements may include:

- power performance measurements : to document a measured power curve for the unit type under specified conditions
- power quality tests: to document the characteristic quality of the power generated by the unit type
- low-voltage-ride-through measurements: to document the low-voltage-ride-through capabilities of the unit type.
- acoustic noise measurements: to document the acoustic emission characteristics of the unit type.

8.1.2 The evaluation of the type characteristics measurements is based on verification that measurements have been carried out on a unit representative of the type to be certified and have been carried out in accordance with an approved detailed program. The test report submitted by the Client is reviewed by the Society.

8.2 Documentation to be submitted

8.2.1 The following documents are to be submitted:

- inspection records (completed preferably prior to measurements), to demonstrate the conformity of the unit with the design documentation
- detailed measurement program
- test report (documented by measurements and test results)

9 Final evaluation

9.1 General

9.1.1 The purpose of the final evaluation is to provide documentation of the findings of all operating bodies involved in the evaluation of the elements of the type/component certificate. The verification activities and results are documented in the Final Evaluation Report.

9.2 Final evaluation report

9.2.1 The final evaluation report issued by the Society consists of:

- reference list of all documentation relevant to the Type/Component certificate
- report of all conformity statements issued by the Society for the certification modules for outstanding issues.

9.2.2 A final assessment is carried out on this basis and the decision whether or not to issue a Type/Component Certificate is made. In all cases, the final evaluation report is delivered to the Client.

Section 5 Project Certificate

1 General

1.1 Application

1.1.1 The purpose of Project Certification is to evaluate whether a specific MRE power plant, including typically made of several MRE Units and other auxiliary installations, is designed and built taking into account the external conditions at the intended location and in conformity with National Administration requirements, applicable standards, construction and electrical codes and other relevant site-specific requirements

1.1.2 Classification alternative

As an alternative and complementary approach to project certification, the classification scheme of the Society, as defined in the applicable rules, is an alternative scheme covering MRE units and power plants.

As function of the MRE technology, the followings apply:

- for FOWT, classification is provided in accordance with the requirements of the NR572 and NR445, Part A. Classed FOWT will be assigned the service notation **FOWT**.
- for OTEC, classification is provided in accordance with the requirements of NI637 and NR445, Part A. Classed OTEC will be assigned the service notation **special service (OTEC)**.
- for other types of MRE technologies, classification can be considered on a case-by-case basis.

1.2 Incremental certification procedure

1.2.1 An incremental certification procedure is proposed. It consists of:

- Project design certification (optional), as defined in [2.3]
- Project certification.

2 Project Certification

2.1 General

2.1.1 Modular approach

The Project Certification scheme contains both mandatory and optional modules. It is divided into several modules that are evaluated individually, though not always independently from each other as some use the results from previous modules as inputs.

The Project Certificate with the Final Evaluation Report, is issued at the end of the certification procedure when all mandatory modules have been successfully completed. A Project Certificate attests to the conformity and correctness of all mandatory modules and, if applicable, of the optional modules.

2.2 Project Certification scheme

2.2.1 General

A Project certification process covers the whole lifecycle of the project, including design, manufacturing, transportation, installation, commissioning, operation and maintenance, with the exception of decommissioning.

Note 1: Requirements for decommissioning are usually specified by local regulations.

2.2.2 Modules

Main modules of the Project Certification scheme are illustrated in Fig 1:

- site conditions assessment
- risk assessment (optional)
- design basis evaluation
- integrated load analysis
- design assessment
- manufacturing survey
- transportation and installation survey
- commissioning survey

- project characteristics measurements (optional)
- final evaluation
- operation and maintenance survey (optional).

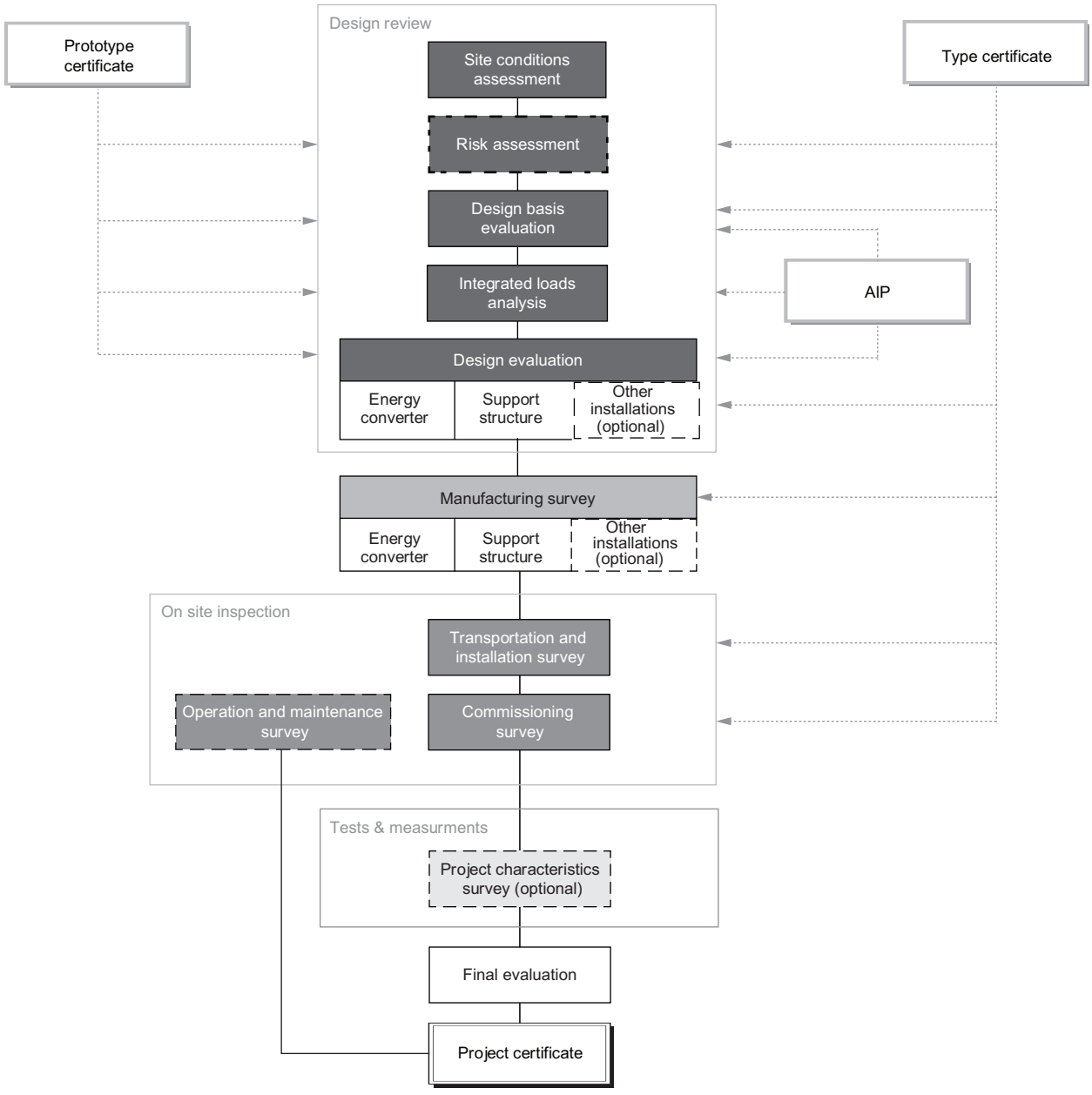
2.3 Project design certification scheme

2.3.1 General

After completion of all mandatory modules of the design phase of the project certification, a project design certificate may be provided upon request. Related modules are:

- site conditions assessment
- risk assessment (optional)
- design basis evaluation
- integrated load analysis
- design assessment.

Figure 1 : Project certification and project design certification schemes and application with AIP, Prototype and Type Certification



2.4 Interfaces with other certificates

2.4.1 General

AIP, Basic Design Assessment and Type/Component certificates may be used to facilitate the Project certification scheme. The integration of the already reviewed topics and documentation into Project Certification is to be agreed by the Society.

If there is no Type Certificate for the asset under consideration, the mandatory modules Type Certificate within Project Certification are to be fulfilled by the Client, and hence the mandatory modules of Type Certification covered by the Project Certification are evaluated by the Society with respect to the specific project and site-specific conditions.

2.5 Validity and maintenance of certificate

2.5.1 Validity

The validity period of the Project Certificate is 3 years. Extension of the validity period is subject to maintenance of the project certificate as defined in [2.5.2].

The period of validity for the Provisional Certificate or conformity statement, is not to exceed 12 months from the date of issuance.

2.5.2 Maintenance

The extension of the Project Certificate validity is subject to the periodic inspections outcomes and the annual review of monitoring, operation, maintenance and repair reports provided by the Client, see [13].

Any outstanding issue as well as the actions undertaken to resolve it are to be reported without delay to the Society for evaluation. Resulting unit inspections may be required at the convenience of the Society.

Any modification of the unit design, procedures or specifications by the Client is to be reported without delay to the Society with all documentation affected by the modification. Potential extension of the Project Certificate is to be decided by the Society on a case by case basis.

2.6 Deliverables

2.6.1 General

A modular based certification scheme are introduced in Sec 1, [2.2].

In addition, the requirements for:

- the specific deliverables for each modules are defined in [2.6.2] and [2.6.3] for, respectively, evaluation reports and conformity statements.
- the final evaluation report applicable for the project certification and project design certification schemes is defined in [2.6.4] and [2.6.6]
- the project certificate is defined in [2.6.5].

2.6.2 Evaluation reports

The evaluation report summarizes the evaluations and independent analyses performed by the Society for the evaluation of the considered module, the different findings, and the final results. It gives the Society's conclusion on the conformity of the module under scrutiny.

The following reports are issued after evaluation of the corresponding module:

- evaluation report for risk assessment, when requested
- evaluation report for site conditions assessment
- evaluation report for design basis
- evaluation report for integrated load analysis
- evaluation report for design assessment
- evaluation report for manufacturing survey
- evaluation report for transportation and installation survey
- evaluation report for commissioning survey
- evaluation report for project characteristics survey, when requested.

2.6.3 Conformity statements

If the modules are deemed to be compliant with the relevant requirements, the following Conformity statements are issued:

- conformity statement for site conditions assessment
- conformity statement for design basis
- conformity statement for integrated load analysis
- conformity statement for design assessment
- conformity statement for manufacturing survey
- conformity statement for transport and installation survey
- conformity statement for commissioning survey
- conformity statement for project characteristics survey, when requested.

2.6.4 Final evaluation report

Once all mandatory modules have been successfully evaluated and the corresponding conformity statements issued, a final evaluation is performed and a final evaluation report is issued, summarizing the conclusions from all evaluation reports. This Final Evaluation Report also references all the documents relevant to the Project Certificate.

A final assessment is carried out on this basis and the decision whether or not to issue a Project Certificate is made. In all cases, the Final Evaluation Report is delivered to the Client.

2.6.5 Project certificate

The Project Certificate, along with the Final Evaluation Report, are issued at the end of the certification procedure given that Conformity Statements are issued for all mandatory modules. The Project Certificate refers to the Conformity Statements for the completed modules.

Note 1: When a module is not reviewed by the Society (as requested by the Client), a valid Conformity statement and Evaluation report for this module are to be provided to the Society in order to deliver the Project Certificate, see Sec 1, [2.3] for additional details.

2.6.6 Project Design

For Project Design certification, the followings applies:

Once all mandatory design modules have been successfully evaluated and the corresponding conformity statements issued, a global evaluation is performed and a Design evaluation report issued, summarizing the conclusions from all Conformity Statements.

This Design Evaluation Report also reference all the documents relevant to the Project Design Certificate.

An assessment is carried out on this basis and the decision whether or not to issue a Project Design Certificate is made.

In all cases, the Design Evaluation Report will be delivered to Client.

3 Site condition assessment

3.1 General

3.1.1 Purpose

The purpose of the site conditions assessment module is to examine how the site conditions have been obtained and how these properties are defined as parameter design values.

Site conditions to be considered include at least:

- environmental conditions (i.e. metocean, earthquake)
- soil conditions (i.e. geotechnical)
- electrical power network conditions.

3.1.2 Evaluation

Evaluation of the site conditions assessment is to consist of:

- review of site surveys specifications
- deviations of design parameters (e.g. geotechnical interpretation)
- review of final deliverables.

The verification focuses, as a minimum, on:

- general methodology
- data acquisition
- data processing
- application of statistical methods for meteorological, marine and geotechnical conditions.

3.1.3 Site surveys specifications

The extent, quality and relevance of the metocean and soil surveys is reviewed. The associated reports are reviewed with regards to the selected design standards.

The models used to complement the on-site measurements (e.g. hindcast model for marine data) is evaluated, in particular in terms of correlation with existing measurements, and it is verified that their outputs are suitable for the structural design.

3.1.4 Derivation of design parameters

The methodology and assumptions used for the deviation of the site-specific design parameters on the basis of the measured and modelled data, in particular regarding the extrapolation of extreme values is reviewed.

3.1.5 Documentation to be submitted

The documentation to be submitted is to include:

- metocean report
- geotechnical report
- geotechnical interpretation.

All references listed in the documents are to be provided upon request.

4 Risk assessment (optional)

4.1 General

4.1.1 The risk assessment aims at identifying:

- Hazardous situations, such as collision or climatic extremes and their possible causes and effects induced on asset integrity, personal safety and environment.

Note 1: HAZID (Hazard Identification method) is recommended.

- Component failures: failure modes and their possible causes and effects induced on asset integrity, personal safety and environment.

Note 2: FMECA (Failure Mode, Effects and Criticality Analysis) is recommended.

4.1.2 The Society reserves the right to consider the risk assessment as mandatory.

5 Design basis assessment

5.1 General

5.1.1 The Design Basis may be split into three parts:

- the Design Basis Part A (site conditions and employer requirements)
- the Design Basis Part B (energy converter)
- the Design Basis Part C (support structure)
- the Design Basis Part D (other installations: e.g. inter-array cable or offshore substation).

The evaluation consider the conformity of the Design Load Cases (DLC) to the selected design standards, and the validity of the methodology and assumptions for the load simulation.

5.2 Site Conditions and Employer requirements (Design Basis Part A)

5.2.1 The Design Basis Part A evaluation typically includes:

- review of the meteorological, marine and geotechnical conditions at the site relevant for the design

Note 1: Meteorological conditions refer to wind, temperature, humidity, pressure, air density, solar radiation, precipitation and salinity.

Note 2: Marine conditions refer to waves, currents, water levels, sea ice (if relevant) and marine growth and their correlation in the perspective of environmental contour methods.

- review of the extent, quality and relevance of the metocean and soil surveys
- verification of the completeness and correctness of the associated reports with regards to the selected design standards
- evaluation of the models used to complement the on-site measurements (e.g. hindcast model for marine data), in particular in terms of correlation with existing measurements. It is verified that outputs are suitable for the structural design. This evaluation is based on the conclusions from the previous Site Condition Assessment module
- review of the methodology and assumptions used for the deviation of the site-specific design parameters on the basis of the measured and modelled data, in particular regarding the extrapolation of extreme values.

5.3 Energy Converter (Design Basis Part B)

5.3.1 The Design Basis Part B is generally the responsibility of the energy converter Supplier, and typically includes:

- interpretation of wind/wave/tide/sea and environmental input (turbulence, shear, etc.)
- definition of design load cases
- design parameters
- partial safety factors for the load simulations
- Energy converter (turbine) Type Certificate, if any and possible deviations from the certificate for site-specific adaptations.

Note 1: For wind, current or tidal power plant, the determination of the turbulence intensity is to include farm level inferences such as wake effects from neighboring turbines.

5.4 Support Structure (Design Basis Part C)

5.4.1 The Design Basis Part C is generally the responsibility of the Support Structure Supplier, and describes the general design requirements, methodology and assumptions for the design of the support structure.

The Society checks that the codes defined as references are appropriate and adapted to the specificities of the project and that the selected codes are compatible. The coherence of the design methodologies and assumptions is evaluated.

The following issues are addressed (if applicable):

- geotechnical interpretation and geotechnical design parameters
- material characteristics data (concrete, reinforcing steel, prestressing bars ...)
- load cases considered (permanent loads, operating loads, accidental loads...)
- load cases combinations for the different operating phases (construction, launch, towing, operating, ...)
- design methodologies and principles regarding:
  - natural frequencies
  - extreme events (uls)
  - fatigue analysis (fls)
  - serviceability (sls)
  - accidental events(als)
  - connections (bolted, flanged, etc.)
- scour protection
- corrosion protection
- requirements regarding transportation, installation, operation, maintenance and decommissioning.

5.5 Auxiliary installations (Design Basis Part D) (optional)

5.5.1 When requested, design basis of MRE power plant auxiliaries' installations such as the inter-array cables and offshore substations, are considered in a Design Basis Part D. It describes the general design requirements, methodology and assumptions for the design of the auxiliary installations.

5.6 Documentation to be submitted

5.6.1 The following documentation is to be submitted to the Society:

- metocean report
- geotechnical report
- geotechnical interpretation
- design Briefs
- design Basis Part A, B and C and D (optional).

All references listed in the documents are to be submitted upon request.

6 Integrated load analysis evaluation

6.1 General

6.1.1 The integrated loads analysis aims at verifying the site-specific loads and load effects on the complete unit. The integrated loads analysis is to verify that loads and loads effects are properly based on the design basis assumptions and, whenever relevant, in accordance with energy converter type certificate.

The evaluation of integrated load analysis includes:

- review of the calculation methodology
- independent calculations (in general based on an integrated model).

6.1.2 This module of integrated load analysis includes:

- site-specific load calculations review, based on the assessed designed conditions
- assessment of any difference between the site-specific loads and the design load envelope assumed for the Type Certification, if any
- further load analyses performed by the Client, when relevant.

6.2 Review of calculations

6.2.1 Review of calculation consists in reviewing the load reports, focusing in particular on the comparison of the applied calculation methodology with the agreed Design Basis and the reference standards (wind, wave or current models used, simulation characteristics, statistical extrapolation of extreme loads, etc.).

6.3 Independent calculations

6.3.1 In addition to the documentation review, the verification is based on independant calculations. These calculations may include:

- hydrodynamics analyses
- integrated model analyses to consider:
  - sub-structure model and hydrodynamic loads
  - -top-structure servo-mechanical model and its external loadings, e.g. turbine
  - interface
  - final combined loads.

7 Design evaluation

7.1 General

7.1.1 The design evaluation aims at reviewing the unit design with regard to the integrated loads as defined in the previous module. The design evaluation is typically split into sub-modules:

- design evaluation of the energy converter (Part B)
- design evaluation of the support structure (Part C)
- design evaluation of auxiliaries installations, such as inter-array cables, offshore sub-station,...(Part D).

7.2 Design evaluation of the energy converter (Part B)

7.2.1 The energy converter is to be Type Certified. If there is no Type Certification, see [2.4].

No detailed investigations are needed if the energy converter is type-certified and if the following conditions are satisfied:

- the design of the component to be installed is the same as the design that has been certified
- the calculated site-specific loads on the component are not higher than the design loads considered in the Type Certificate.

In case of site-specific modifications or reinforcements that are not covered by the Type Certificate, a specific assessment will need to be made on a case by case basis to evaluate the level of additional verification to be performed.

7.2.2 Design evaluation of the energy converter is based on the followings:

- comparison of the site-specific loads with the design loads specified in the Type Certificate

  If the loading on the machine implied by the actual site conditions is higher than the design loads, it is to be demonstrated that the increased loads do not endanger the structural integrity of the energy converter. The additional calculations and analysis are to take into account the results from the module Site Conditions Evaluation. Similarly, any change in vibration modes or natural frequencies are to be stated and carefully evaluated.
- verification that the system accelerations and inclinations remain within the design limits as specified in the Type Certificate.

Note 1: Attention is to be paid on the interface between the energy converter and the support structure if specifically designed for the site.

7.3 Design evaluation of the support structure (Part C)

7.3.1 The design evaluation of the support structure includes a detailed examination of the documentation.

7.3.2 The design evaluation aims to verify the compliance of calculations notes with the Design Basis. It includes (if relevant):

- sub-structure design evaluation
- tower design evaluation (for FOWT). The support structure is defined in Sec 1 [1.2].
- station keeping system design evaluation, if any
- foundation design evaluation

Note 1: The support structure, is defined in Sec 1, [1.2].

7.3.3 Verification steps

The design evaluation aims to verify the compliance of calculations notes with the Design Basis. It includes (if relevant):

- design calculations
  - structural review

Note 1: Independent analyses may be performed for the most significant structural elements.

  - compliance of drawing with calculations and specifications
  - corrosion protection system investigation, including the calculation of corrosion allowances and sacrificial anodes
  - review of the seabed stability, scour assessment and scour protection system around foundations.
- specification of materials
- manufacturing specification
- weight reports
- installation documentation:
  - intended installation procedures,
  - installation tolerances,
  - planned measurements and inspections.
  - driveability study
- O&M plan review to verify the suitability of the intended requirements and to ensure consistency with the assumptions for the design.

7.3.4 Sub-structure design evaluation

The sub-structure design evaluation is to consider the followings aspects:

- structural design, including connections
- sub-structure floating stability
- mechanical and electrical equipment
- fire and safety systems.

a) Structural review

The structural review is based on:

- Consideration of the design assumptions of the sub-structure
- Review of the design calculations for dimensioning the sub-structure
- Review of the procedures for implementation of the sub-structure
- Independent review of design analysis of the sub-structure

An independent analysis may be performed to verify the structural design of the sub-structure.

Calculation reports are to be based on set of reference defined in the Design Basis and are to provide justification of resistance, stability and sustainability sections in the main combinations of load cases, as well as a fatigue verification.

As the installation process is specific, special care is devoted to the review of the transportation and installation documentation, including the intended installation procedures, the installation tolerances, the planned measurements and inspections. The calculations of the loads sustained by the sub-structure during transportation and installation are carefully reviewed.

Note 1: When concrete structure are used, particular care is taken for the review of the concrete / steel interface, especially at the connections with the mooring equipment. The sustainability of the sub-structure is to be ensured in all these phases and must be justified. The following parameters impact the sustainability: formulation of concrete, type of reinforcing steel, coating, cathodic protection, protective coating…

b) Floating stability analysis

For floating units, stability analysis in intact conditions and, if relevant in damaged conditions, is performed with loading cases, covering all lifecycle phases.

For bottom-fixed units, stability of the foundation is to be checked in all loading and operating conditions.

This stability analysis review includes:

- review of the documentation and information on conformity to international standards applicable on stability matters
- verification of a complete stability model of the sub-structure according to criteria defined and agreed in the design basis documentation.

c) Machinery and electrical equipment

Machinery and electrical equipment evaluation is based on a review of documentation related to the machinery and electrical devices installed in the sub-structure (bilge, trim/ballast, piping mechanical integrity and the electrical safety of the sub-structure's systems).

d) Safety - detection, firefighting and escape

Safety evaluation is based on a review of documentation describing and explaining the systems of detection, firefighting and route escape in the floater compartments, if relevant.

7.3.5 Tower design evaluation

For FOWT, in addition to [7.3.4], the design evaluation includes tower design evaluation to confirm that the design of the tower correspond to the design assumptions specified in the Design Basis. This include the review of:

- material properties
- tower structure:
  - ultimate strength, Buckling, Fatigue
  - door opening reinforced with frame
  - bolted connections.
- natural frequency
- manufacturing procedures
- transportation procedures
- installation procedures
- maintenance procedures.

In addition, independent calculation may be performed and may cover the following aspects depending on the dimensioning criteria (strength, fatigue, stiffness):

- data base set up
- ultimate strength, fatigue, buckling, bolted connections
- natural frequency.

7.3.6 Station keeping system design evaluation (if relevant)

The station keeping system design evaluation consists of:

- independent analyses
- review of documentation

  Documentation is to include (if relevant):
  - diffraction radiation analysis
  - global loads analysis
  - hydrodynamic model calibration report
  - mooring system ultimate strength verification and fatigue verification
  - anchors holding capacity verification
  - mooring connectors verification
  - anchors structural strength verification.

7.4 Design evaluation auxiliaries installations (Part D) (optional)

7.4.1 General

When requested, design evaluations of MRE power plant auxiliaries' installations such as the inter-array cables and offshore substations, are based on:

- structural design evaluation, including review of documentation and independent analysis
- electrical design evaluation: verification of the compliance with the standards and other specifications in the approved design basis as well as project specific parameters including electrical loads and site conditions.

For offshore sub-stations, reference is made to NI682.

For inter-array cables, the applicant is invited to contact the Society for further details.

8 Manufacturing survey

8.1 General

8.1.1 Manufacturing survey ensures that the intended quality requirements are met for the specific project. As part of the manufacturing survey, the quality system of the manufacturer is to be evaluated and manufacturing inspections are to be planned. See general requirements in Sec 1, [2.4.7].

8.2 Manufacturing survey

8.2.1 The manufacturing inspection and survey includes:

- An initial audit to evaluate the ability of the supplier to produce the component under consideration according to the approved design specifications and with the intended quality level.

- Periodical on-site inspections covering all critical phases of the fabrication process, including the non-destructive testing (NDT) when applicable, including:
  - Verification that design specifications are properly documented in workshop drawings, workshop instructions, purchase specifications, fabrication methods and procedures, including in particular special processes, and welding and NDT procedures when applicable
  - Review of manufacturing records
  - Visual inspection of ongoing manufacturing processes for compliance with the approved manufacturing procedures.

The sampling rate for inspections is determined individually for each component and each manufacturer. If necessary, several inspections are performed in order to witness multiple phases of the manufacturing process.

8.2.2 Manufacturing Evaluation Plan

The survey activities are detailed in a Manufacturing Evaluation Plan. This specific plan is prepared once detailed information about the manufacturing activities are available, and before the start of the manufacturing survey activities.

8.2.3 Review of fabrication documents

The following fabrication documents are to be submitted for review:

- quality control plans
- construction drawings
- welding procedures specifications and existing qualifications, if applicable
- existing qualifications of welding operators, if applicable
- existing qualifications of non destructive test operators
- fabrication procedures
- testing procedures
- contractor quality assurance/quality control (qa/qc) manual
- coordination procedure and planning
- list of sub-contractor and vendors.

8.2.4 Survey of fabrication

The survey of fabrication includes the following activities:

- materials traceability
- visual random checks
- identification of non destructive test operators
- for welded structures:
  - cuttings and welding preparations
  - main fit-ups
  - identification of welders
  - preheating
  - welding consumables
  - welding parameters
  - heat treatment
  - witnessing of dimensional inspection
- for concrete structures:
  - radial and tangential reinforcement
  - embedment
  - concrete casting
  - curing conditions
  - construction joints, grouting
  - measuring and testing equipment
  - material tests
- witnessing of non-destructive testing
- final visual inspection
- contractor's site queries
- contractor's non conformity reports.

8.3 Type certified units

8.3.1 Suppliers may have been evaluated as part of the Type Certification process. However, the manufacturing inspection during Type Certification is based on one specimen only. For project Certification, additional survey activities are included in order to verify that the manufacturing of units for the specific project is carried out according to the approved design and with the intended quality, in particular with regards to modified components.

Note 1: For unit with type certified RNA, the hub and nacelle assembly is subjected to inspections based on random sampling. These inspections cover both the assembly process and the final assembled hub and nacelle. Focus is given in particular on the welded and bolted connections and the electrical installations. These inspections take place at the Hub and Nacelle assembly plant. During these inspections, the incoming good inspections for the other components of the hub and nacelle assembly is verified.

9 Transportation and installation (T&I) survey

9.1 General

9.1.1 The objective of the transport and installation survey is to check that no excessive loading is sustained by the units during the transportation and the installation, and to prevent any damage on the components. The transport and installation documents are only considered in so far as they may affect the safety or integrity of the completed installation on site.

A detailed inspection of the first transport and installation is performed, after which the T&I survey will not be systematic but based on random sampling. The exact sampling rate will be determined based on the project specificities and on the findings from the first inspections.

Note 1: In addition to this transport and installation survey plan, Marine Warranty Surveyor (MWS) activities may be also performed to ensure the safety of operations. An interface matrix between certification and MWS may be developed jointly with the MWS contractor.

9.1.2 Attendance of a Surveyor during transportation and installation is decided at the convenience of the Society, in order to checl that the hull and systems are in apparent good condition after transportation or installation stages, without visible damage.

9.1.3 T&I evaluation plan

The survey activities are detailed in a Transportation & Installation Evaluation Plan, as part of the global evaluation. This specific plan is prepared once detailed information about the transportation and installation activities are available, in particular the corresponding Integrated Transportation Plans, and before the start of the survey activities.

9.2 Transportation survey

9.2.1 The transportation survey aims to verify that the proposed transportation procedures and test plans are documented in sufficient detail and that they comply with the design basis and the requirements of the reference standards. The description of the transportation process is to include:

- technical specifications for the transportation
- limiting environmental conditions
- safety instructions
- transportation arrangement including required fixtures, tooling and equipment
- transportation loads and load conditions.

In addition, an onshore survey is performed at the harbour with the aim to verify compliance with the design requirements and approved procedures for transportation. The survey covers in particular the following aspects:

- lifting operations during preparation
- monitoring of the fastening of the different components
- follow-up procedure on transportation damages and non-conformities.
- compliance with the requirements for acceptable weather conditions.

9.3 Installation survey

9.3.1 The installation survey covers the offshore operations during installation and includes:

- documentation review:

  to verify that the proposed installation process is documented in sufficient detail in the installation documentation and that it complies with the design basis and the requirements of the reference standards.

- witness of offshore installation:

  to verify the compliance with the design requirements and approved procedures for installation. The procedures are only considered in so far as they may affect the safety or integrity of the completed installation on site. The survey activities cover in particular the following aspects:

  - compliance with the requirements for acceptable weather conditions during sea transportation and installation
  - survey related to seabed preparation
  - verification for damage to the structure prior to installation
  - survey related to lifting operations
  - survey related to load-out of major components
  - for floating units, survey related to:

    float-off of major components

    hook-up operations

    mooring lines pre-lay operations.
  - survey related to welding, bolting, non-destructive testing, etc.
  - survey related to scour protection installation
  - final visual inspection after installation
  - follow-up procedure on installation damage and non-conformities.
- installation records review (pile driving records, grouting and grout tests reports, etc.).

Any deviation from the intended procedures is to be justified, and may involve subsequent inspections.

10 Commissioning survey

10.1 General

10.1.1 The commissioning of the project is to be surveyed by the Society, on the basis of an agreed program, to ensure that the procedures described in the commissioning manual are implemented. It is verified that the proposed procedures and test plans are documented in sufficient details and comply with the design basis. The procedures are only considered in so far as they may affect the safety or integrity of the completed installation on site.

10.1.2 The commissioning survey activities consist of:

- surveys to verify that the commissioning is performed according to the procedures, focus on:
  - conformity of the main components with the certified design documents
  - general appearance of the unit
  - witnessing of the safety and function tests
  - visual inspection of the corrosion protection
  - check for potential damage.
- review of the commissioning records and the final commissioning reports on a spot check basis.

  any deviation from the intended procedures is be justified, and may involve subsequent inspections.

The following inspection/ witness testing activities need to be carried out during the onsite inspection following the commissioning manual:

- test of the emergency stop buttons
- triggering of the brakes and witnessing of energy converter's (e.g.turbine) behaviour
- behaviour at grid loss
- behaviour at over speed
- test of automatic operation
- visual inspection for the entire installation.

The following tests are also to be conducted, if applicable:

- test operation of ballast system and bilge pumps
- test on draught and stability for floating structures.

Note 1: For wind turbine, the commissioning of the first turbine has to be witnessed, plus one additional turbine for every fifty turbines in the project. The minimum number of commissioning inspections is therefore one. The Society reserves the right to request additional inspection if deemed necessary.

Note 2: For CTT, the first series of CTT is to be witnessed by the Society to ensure that the structure and system are in apparent good condition after transportation or installations stages, without visual damages.

11 Project characteristics measurements (optional)

11.1 General

11.1.1 The Project characteristics measurements are optional. They aim to determine performance related characteristics of the project at the specified site. These measurements may include:

- grid connection compatibility
- power performance assessment
- acoustic noise emission assessment.

11.1.2 Grid connection compatibility

Grid connection compatibility measurements are to verify the grid codes specified for the site. The evaluation is based on:

- comparison between site measurements and grid codes conditions
- verification of measurement procedures
- review of test report describing measurement conditions, instrumentation, equipment and calibrations.

11.1.3 Power performance assessment

The Power performance assessment concerns one or more units at the project site. The evaluation is based on:

- comparison of site measurements and test with reference data of the individual units
- verification of measurement procedures
- test report.

11.1.4 Acoustic noise emission assessment

The acoustic noise emission assessment aims to verify the compliance with the local requirements and/or the client criteria. The evaluation is based on verification of measurement procedures.

12 Final evaluation

12.1 General

12.1.1 The Final Evaluation is the final step of the Project Certification scheme. The objective is to ensure the completeness of all evaluations performed and to document all relevant findings and observations. It is verified that all findings have been closed out properly. The verification activities and results are documented in the Final Evaluation Report.

12.1.2 Particular attention is devoted to the interface between the different modules and especially between modules performed by different certification bodies.

The evaluation activities performed on modules not evaluated by the Society and the corresponding certification documentation are reviewed to an extent sufficient for the acceptance of the conformity statements and, their integration in the final Project Certificate.

12.2 Final evaluation report

12.2.1 The final evaluation report issued by the Society consists of:

- reference list of all documentation relevant to the Project Certificate
- report of all conformity statements issued by the Society for the Project Certification modules for outstanding issues.

12.2.2 A final assessment is carried out on this basis and the decision whether or not to issue a Project Certificate is made. In all cases, the final evaluation report is delivered to the Client.

13 Operation and maintenance survey (optional)

13.1 General

13.1.1 The operation and maintenance survey activities aim to check that operation and maintenance activities are performed according to the requirements described in the respective manuals included in the design documentation. It includes documentation review and inspections of installations covered by the Project Certificate.

13.2 Reports and records review

13.2.1 Monitoring, maintenance and repair reports are to be presented to the Society annually. At the convenience of the Society, additional tests and inspections may be required.

13.2.2 Operation and maintenance review is to verify that:

- maintenance is performed by authorized and qualified personnel
- maintenance is performed according to maintenance manual
- control parameters are in accordance to the limit specified in design documentation
- repair, modification and replacement are carry out in accordance to the certificate.

13.3 Inspections

13.3.1 Inspections are to be planned at regular intervals, the interval being agreed on a case by case basis with the Society.

13.3.2 The general condition of the installations covered by the Project Certificate are inspected.

The inspection may be performed by random sampling. The exact sampling rate will be determined on a case by case basis depending on the evaluation of the operation and maintenance procedures, monitoring, inspection and test plan and on the results from previous inspections.

Units that are under performing or that have been subject to anomalies will be investigated as a priority.

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