



Classification and Certification of Floating Offshore Wind Turbines

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**Rule Note
NI 572 DT R02 E**

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GENERAL CONDITIONS

1. INDEPENDENCE OF THE SOCIETY AND APPLICABLE TERMS

- 1.1 The Society shall remain at all times an independent contractor and neither the Society nor any of its officers, employees, servants, agents or subcontractors shall be or act as an employee, servant or agent of any other party hereto in the performance of the Services.
- 1.2 The operations of the Society in providing its Services are exclusively conducted by way of random inspections and do not, in any circumstances, involve monitoring or exhaustive verification.
- 1.3 The Society acts as a services provider. This cannot be construed as an obligation bearing on the Society to obtain a result or as a warranty. The Society is not and may not be considered as an underwriter, broker in Unit's sale or chartering, expert in Unit's valuation, consulting engineer, controller, naval architect, designer, manufacturer, shipbuilder, repair or conversion yard, charterer or shipowner; none of them above listed being relieved of any of their expressed or implied obligations as a result of the interventions of the Society.
- 1.4 The Society only is qualified to apply and interpret its Rules.
- 1.5 The Client acknowledges the latest versions of the Conditions and of the applicable Rules applying to the Services' performance.
- 1.6 Unless an express written agreement is made between the Parties on the applicable Rules, the applicable Rules shall be the Rules applicable at the time of entering into the relevant contract for the performance of the Services.
- 1.7 The Services' performance is solely based on the Conditions. No other terms shall apply whether express or implied.

2. DEFINITIONS

- 2.1 "Certificate(s)" means classification or statutory certificates, attestations and reports following the Society's intervention.
- 2.2 "Certification" means the activity of certification in application of national and international regulations or standards, in particular by delegation from different governments that can result in the issuance of a Certificate.
- 2.3 "Classification" means the classification of a Unit that can result or not in the issuance of a classification Certificate with reference to the Rules. Classification is an appraisalment given by the Society to the Client, at a certain date, following surveys by its surveyors on the level of compliance of the Unit to the Society's Rules or to the documents of reference for the Services provided. They cannot be construed as an implied or express warranty of safety, fitness for the purpose, seaworthiness of the Unit or of its value for sale, insurance or chartering.
- 2.4 "Client" means the Party and/or its representative requesting the Services.
- 2.5 "Conditions" means the terms and conditions set out in the present document.
- 2.6 "Industry Practice" means international maritime and/or offshore industry practices.
- 2.7 "Intellectual Property" means all patents, rights to inventions, utility models, copyright and related rights, trade marks, logos, service marks, trade dress, business and domain names, rights in trade dress or get-up, rights in goodwill or to sue for passing off, unfair competition rights, rights in designs, rights in computer software, database rights, topography rights, moral rights, rights in confidential information (including know-how and trade secrets), methods and protocols for Services, and any other intellectual property rights, in each case whether capable of registration, registered or unregistered and including all applications for and renewals, reversions or extensions of such rights, and all similar or equivalent rights or forms of protection in any part of the world.
- 2.8 "Parties" means the Society and Client together.
- 2.9 "Party" means the Society or the Client.
- 2.10 "Register" means the public electronic register of ships updated regularly by the Society.
- 2.11 "Rules" means the Society's classification rules and other documents. The Society's Rules take into account at the date of their preparation the state of currently available and proven technical minimum requirements but are not a standard or a code of construction neither a guide for maintenance, a safety handbook or a guide of professional practices, all of which are assumed to be known in detail and carefully followed at all times by the Client.
- 2.12 "Services" means the services set out in clauses 2.2 and 2.3 but also other services related to Classification and Certification such as, but not limited to: ship and company safety management certification, ship and port security certification, maritime labour certification, training activities, all activities and duties incidental thereto such as documentation on any supporting means, software, instrumentation, measurements, tests and trials on board. The Services are carried out by the Society according to the applicable referential and to the Bureau Veritas' Code of Ethics. The Society shall perform the Services according to the applicable national and international standards and Industry Practice and always on the assumption that the Client is aware of such standards and Industry Practice.
- 2.13 "Society" means the classification society 'Bureau Veritas Marine & Offshore SAS', a company organized and existing under the laws of France, registered in Nanterre under number 821 131 844, or any other legal entity of Bureau Veritas Group as may be specified in the relevant contract, and whose main activities are Classification and Certification of ships or offshore units.
- 2.14 "Unit" means any ship or vessel or offshore unit or structure of any type or part of it or system whether linked to shore, river bed or sea bed or not, whether operated or located at sea or in inland waters or partly on land, including submarines, hovercrafts, drilling rigs, offshore installations of any type and of any purpose, their related and ancillary equipment, subsea or not, such as well head and pipelines, mooring legs and mooring points or otherwise as decided by the Society.

3. SCOPE AND PERFORMANCE

- 3.1 Subject to the Services requested and always by reference to the Rules, the Society shall:
- review the construction arrangements of the Unit as shown on the documents provided by the Client;
 - conduct the Unit surveys at the place of the Unit construction;
 - class the Unit and enter the Unit's class in the Society's Register;
 - survey the Unit periodically in service to note whether the requirements for the maintenance of class are met.
- The Client shall inform the Society without delay of any circumstances which may cause any changes on the conducted surveys or Services.
- 3.2 The Society will not:
- declare the acceptance or commissioning of a Unit, nor its construction in conformity with its design, such activities remaining under the exclusive responsibility of the Unit's owner or builder;
 - engage in any work relating to the design, construction, production or repair checks, neither in the operation of the Unit or the Unit's trade, neither in any advisory services, and cannot be held liable on those accounts.

4. RESERVATION CLAUSE

- 4.1 The Client shall always: (i) maintain the Unit in good condition after surveys; (ii) present the Unit for surveys; and (iii) inform the Society in due time of any circumstances that may affect the given appraisalment of the Unit or cause to modify the scope of the Services.
- 4.2 Certificates are only valid if issued by the Society.
- 4.3 The Society has entire control over the Certificates issued and may at any time withdraw a Certificate at its entire discretion including, but not limited to, in the following situations: where the Client fails to comply in due time with instructions of the Society or where the Client fails to pay in accordance with clause 6.2 hereunder.
- 4.4 The Society may at times and at its sole discretion give an opinion on a design or any technical element that would 'in principle' be acceptable to the Society. This opinion shall not presume on the final issuance of any Certificate or on its content in the event of the actual issuance of a Certificate. This opinion shall only be an appraisal made by the Society which shall not be held liable for it.

5. ACCESS AND SAFETY

- 5.1 The Client shall give to the Society all access and information necessary for the efficient performance of the requested Services. The Client shall be the sole responsible for the conditions of presentation of the Unit for tests, trials and surveys and the conditions under which tests and trials are carried out. Any information, drawing, etc. required for the performance of the Services must be made available in due time.
- 5.2 The Client shall notify the Society of any relevant safety issue and shall take all necessary safety-related measures to ensure a safe work environment for the Society or any of its officers, employees, servants, agents or subcontractors and shall comply with all applicable safety regulations.

6. PAYMENT OF INVOICES

- 6.1 The provision of the Services by the Society, whether complete or not, involve, for the part carried out, the payment of fees thirty (30) days upon issuance of the invoice.

6.2 Without prejudice to any other rights hereunder, in case of Client's payment default, the Society shall be entitled to charge, in addition to the amount not properly paid, interests equal to twelve (12) months LIBOR plus two (2) per cent as of due date calculated on the number of days such payment is delinquent. The Society shall also have the right to withhold Certificates and other documents and/or to suspend or revoke the validity of Certificates.

- 6.3 In case of dispute on the invoice amount, the undisputed portion of the invoice shall be paid and an explanation on the dispute shall accompany payment so that action can be taken to solve the dispute.

7. LIABILITY

- 7.1 The Society bears no liability for consequential loss. For the purpose of this clause consequential loss shall include, without limitation:
- Indirect or consequential loss;
 - Any loss and/or deferral of production, loss of product, loss of use, loss of bargain, loss of revenue, loss of profit or anticipated profit, loss of business and business interruption, in each case whether direct or indirect.
- The Client shall defend, release, save, indemnify, defend and hold harmless the Society from the Client's own consequential loss regardless of cause.
- 7.2 Except in case of wilful misconduct of the Society, death or bodily injury caused by the Society's negligence and any other liability that could not be, by law, limited, the Society's maximum liability towards the Client is limited to one hundred and fifty per-cents (150%) of the price paid by the Client to the Society for the Services having caused the damage. This limit applies to any liability of whatsoever nature and howsoever arising, including fault by the Society, breach of contract, breach of warranty, tort, strict liability, breach of statute.
- 7.3 All claims shall be presented to the Society in writing within three (3) months of the completion of Services' performance or (if later) the date when the events which are relied on were first discovered by the Client. Any claim not so presented as defined above shall be deemed waived and absolutely time barred.

8. INDEMNITY CLAUSE

- 8.1 The Client shall defend, release, save, indemnify and hold harmless the Society from and against any and all claims, demands, lawsuits or actions for damages, including legal fees, for harm or loss to persons and/or property tangible, intangible or otherwise which may be brought against the Society, incidental to, arising out of or in connection with the performance of the Services (including for damages arising out of or in connection with opinions delivered according to clause 4.4 above) except for those claims caused solely and completely by the gross negligence of the Society, its officers, employees, servants, agents or subcontractors.

9. TERMINATION

- 9.1 The Parties shall have the right to terminate the Services (and the relevant contract) for convenience after giving the other Party thirty (30) days' written notice, and without prejudice to clause 6 above.
- 9.2 In such a case, the Classification granted to the concerned Unit and the previously issued Certificates shall remain valid until the date of effect of the termination notice issued, subject to compliance with clause 4.1 and 6 above.
- 9.3 In the event where, in the reasonable opinion of the Society, the Client is in breach, or is suspected to be in breach of clause 16 of the Conditions, the Society shall have the right to terminate the Services (and the relevant contracts associated) with immediate effect.

10. FORCE MAJEURE

- 10.1 Neither Party shall be responsible or liable for any failure to fulfil any term or provision of the Conditions if and to the extent that fulfilment has been delayed or temporarily prevented by a force majeure occurrence without the fault or negligence of the Party affected and which, by the exercise of reasonable diligence, the said Party is unable to provide against.
- 10.2 For the purpose of this clause, force majeure shall mean any circumstance not being within a Party's reasonable control including, but not limited to: acts of God, natural disasters, epidemics or pandemics, wars, terrorist attacks, riots, sabotages, impositions of sanctions, embargoes, nuclear, chemical or biological contaminations, laws or action taken by a government or public authority, quotas or prohibition, expropriations, destructions of the worksite, explosions, fires, accidents, any labour or trade disputes, strikes or lockouts.

11. CONFIDENTIALITY

- 11.1 The documents and data provided to or prepared by the Society in performing the Services, and the information made available to the Society, are treated as confidential except where the information:
- is properly and lawfully in the possession of the Society;
 - is already in possession of the public or has entered the public domain, otherwise than through a breach of this obligation;
 - is acquired or received independently from a third party that has the right to disseminate such information;
 - is required to be disclosed under applicable law or by a governmental order, decree, regulation or rule or by a stock exchange authority (provided that the receiving Party shall make all reasonable efforts to give prompt written notice to the disclosing Party prior to such disclosure).
- 11.2 The Parties shall use the confidential information exclusively within the framework of their activity underlying these Conditions.
- 11.3 Confidential information shall only be provided to third parties with the prior written consent of the other Party. However, such prior consent shall not be required when the Society provides the confidential information to a subsidiary.
- 11.4 Without prejudice to sub-clause 11.1, the Society shall have the right to disclose the confidential information if required to do so under regulations of the International Association of Classifications Societies (IACS) or any statutory obligations.

12. INTELLECTUAL PROPERTY

- 12.1 Each Party exclusively owns all rights to its Intellectual Property created before or after the commencement date of the Conditions and whether or not associated with any contract between the Parties.
- 12.2 The Intellectual Property developed by the Society for the performance of the Services including, but not limited to drawings, calculations, and reports shall remain the exclusive property of the Society.

13. ASSIGNMENT

- 13.1 The contract resulting from to these Conditions cannot be assigned or transferred by any means by a Party to any third party without the prior written consent of the other Party.
- 13.2 The Society shall however have the right to assign or transfer by any means the said contract to a subsidiary of the Bureau Veritas Group.

14. SEVERABILITY

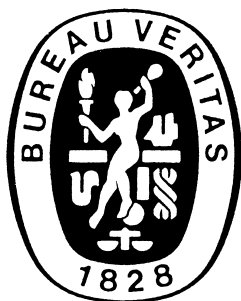
- 14.1 Invalidity of one or more provisions does not affect the remaining provisions.
- 14.2 Definitions herein take precedence over other definitions which may appear in other documents issued by the Society.
- 14.3 In case of doubt as to the interpretation of the Conditions, the English text shall prevail.

15. GOVERNING LAW AND DISPUTE RESOLUTION

- 15.1 These Conditions shall be construed and governed by the laws of England and Wales.
- 15.2 The Parties shall make every effort to settle any dispute amicably and in good faith by way of negotiation within thirty (30) days from the date of receipt by either one of the Parties of a written notice of such a dispute.
- 15.3 Failing that, the dispute shall finally be settled under the Rules of Arbitration of the Maritime Arbitration Chamber of Paris ("CAMP"), which rules are deemed to be incorporated by reference into this clause. The number of arbitrators shall be three (3). The place of arbitration shall be Paris (France). The Parties agree to keep the arbitration proceedings confidential.

16. PROFESSIONAL ETHICS

- 16.1 Each Party shall conduct all activities in compliance with all laws, statutes, rules, economic and trade sanctions (including but not limited to UN sanctions and EU sanctions) and regulations applicable to such Party including but not limited to: child labour, forced labour, collective bargaining, discrimination, abuse, working hours and minimum wages, anti-bribery, anti-corruption, copyright and trademark protection, personal data protection (<https://personal.dataprotection.bureauveritas.com/privacypolicy>).
- Each of the Parties warrants that neither it, nor its affiliates, has made or will make, with respect to the matters provided for hereunder, any offer, payment, gift or authorization of the payment of any money, directly or indirectly, to or for the use or benefit of any official or employee of the government, political party, official or candidate.
- 16.2 In addition, the Client shall act consistently with the Bureau Veritas' Code of Ethics. <https://group.bureauveritas.com/group/corporate-social-responsibility>



GUIDANCE NOTE NI 572

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SECTION 1 GENERAL

1 General

1.1 Application

1.1.1 This Guidance Note provides specific guidance and recommendations for the classification and certification of Floating platforms designed as support of Floating Offshore Wind Turbine (FOWT).

Note 1: Requirements and recommendations of this Guidance Note may be applied in compliance to requirements from the IEC 61400 series standards.

1.1.2 This Guidance Note is intended to cover floating platforms supporting single or multiple turbines with horizontal or vertical axis.

1.1.3 This Guidance Note does not cover top structure, i.e. tower, rotor, blades and nacelle design (their influence on floating platform and mooring system is however considered).

Guidelines on mechanical components of the turbine are given in App 4.

1.1.4 In general, FOWT can be considered as unmanned structures. For manned FOWT, special considerations may apply on a case by case basis.

Note 1: In the present note, FOWT is considered unmanned when no personnel are on board in normal working condition, even if some personnel are on board for short time period (e.g. maintenance operation).

1.2 Documents

1.2.1 Recognized standards and rules

Recognized Standards are listed in Tab 1, and Society Rules are listed in Tab 2.

1.2.2 Other Standards

Technical Standards, other than those stated in Tab 1 or Tab 2, may be used for the purpose of certification on a case-by-case basis, upon the acceptance of the Society.

1.2.3 Combined use of technical Standards

The full list of standards which are specified and used for a given project are to be submitted to the Society before the review of documents is started.

The Society will give a particular attention to combined use of technical standards, when technical requirements from different standards are mixed together.

Note 1: Attention is drawn to compliance with possible national regulations which may not allow the mix of different Standards.

1.3 Floating platforms

1.3.1 Four categories of floating platforms are considered in this Guidance Note:

- Column Stabilized Units. When the FOWT is a column stabilized unit, general guidance may be found in NR571 (see Tab 2).

Note 1: Semi submersible units are part of Column Stabilized units.

- SPAR platform: Ballast floating platforms that achieve stability by using ballast weights placed below a global buoyancy centre, which creates a righting moment and high inertial resistance to pitch and roll and usually enough draft to offset heave motion.
- TLP: Tension Leg Platforms (TLP), that achieve stability through the use of tendons. When the FOWT is a Tension Leg Platform, general guidance are given in the NR578 (see Tab 2).
- Barge (ship shape platform): Buoyancy floating platforms, that achieve stability by the use of distributed buoyancy, taking advantage of weighted water plane area for righting moment. When the FOWT is a ship shape platform, general guidance is given in Offshore Rules (see Tab 2).

Any other type of floating platform is to be considered by the Society on a case by case basis.

1.4 Station keeping systems

1.4.1 The following station keeping systems are considered:

- catenary mooring system
- taut mooring system
- tension leg system (tendon system).

Other station keeping systems are considered on a case by case basis.

2 Definitions

2.1 General

2.1.1 Administration

Administration means the Government of the State responsible for or managing the area in which the floating offshore wind turbine is operating.

2.1.2 Owner

Owner means the registered Owner or the disponent Owner or the Manager or any other party having the responsibility to keep the floating offshore wind turbine seaworthy, having particular regard to the provisions relating to the maintenance of class or certificate.

2.1.3 Approval

Approval means the review by the Society of documents, procedures or other items related to classification / certification, verifying solely their compliance with the relevant Rules requirements, or other referential where requested. The reviewed plans and documents receive a formal approval with or without comments.

2.2 Technical definitions

2.2.1 Unmanned unit

Unmanned unit means unit where no personnel are on board in normal working condition, even if some personnel are on board for short time period (e.g. maintenance operation).

2.2.2 Floating Offshore Wind Turbine (FOWT)

The FOWT means an electricity production unit using wind power, installed on a floating support, located off the coast.

The main components of the FOWT (see Fig 1) are:

- rotor-nacelle assembly (RNA)
- sub-structure, including the floating structure and the transition piece
- station keeping system, including mooring system, tendons or active thrusters
- foundation.

Axes of the FOWT are defined as given in Fig 2.

2.2.3 Top-structure

The tower and the RNA constitute together the top-structure of the FOWT.

2.2.4 Support structure

The support structure consists of the foundation, station keeping system, sub-structure and the tower.

Table 1 : Recognized Standards

Reference	Title	Main interest
ISO 19900	Petroleum and natural gas industries - General requirements for offshore structures	General requirements applicable for offshore floaters
ISO 19901	Petroleum and natural gas industries - Specific requirements for offshore structures	Specific requirements applicable for offshore floaters
ISO 19901-1	Petroleum and natural gas industries — Specific requirements for offshore structures — Part 1: Metocean design and operating considerations	Specific requirements for Met-ocean design for offshore structures
ISO 19901-2	Petroleum and natural gas industries — Specific requirements for offshore structures — Part 2: Seismic design procedures and criteria	Specific requirements on seismic design procedures and criteria
ISO 19901-4	Petroleum and natural gas industries — Specific requirements for offshore structures — Part 4: Geotechnical and foundation design considerations	Specific requirements for geotechnical and foundation design for offshore structures
ISO 19902	Petroleum and natural gas industries — Fixed steel offshore structures	General requirements applicable for offshore structures
ISO 19903	Petroleum and natural gas industries — Fixed concrete offshore structures	Concrete requirements
ISO 19904	Petroleum and natural gas industries — Floating offshore structures	Requirements and guidance for the structural design and/or assessment of floating offshore platform
ISO 2394	General principles on reliability for structures	Principles of structural assessment
EN 1993-1	Eurocode 3: Design of steel structures	General rules and rules for Buildings
IEC 61400-3	Wind Turbines - Design requirements for offshore wind turbines	Design requirement applicable for offshore wind turbines
IEC 61400-22	Wind Turbines - Conformity testing and certification	Certification scheme for wind turbines
IEC 61400-1	Wind Turbines - Design requirements	Design requirements for wind turbines
API RP 2A	Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms	Design and construction of offshore fixed platform
API RP 2T	Recommended Practice for Planning, Designing and Constructing Tension Leg Platforms	Design of a Tension Leg Platform system
AISC	American Institute of Steel Construction Specifications for the Design, Fabrication and Erection of Structural Steel Buildings	Steel Construction Manual
AWS D1.1	Structural Welding Code - Steel	Welding
IMO MSC 267(85)	International Code on Intact Stability (IS Code 2008)	General requirements for stability
IMO MSC/Circ.884	Guidelines for safe ocean towing	Towing
IMO A765(8)	Guidelines on the safety of towed ships and other floating objects including installations, structures and platforms at sea	Towing
EN 1992	Eurocode 2: Design of concrete structures	Concrete structure requirements
EN 206	Concrete - Specification, performance, production and conformity	Concrete specifications

2.2.5 Sub-structure

The sub-structure is the part of the support structure which connect the station keeping system to the tower.

Note 1: The sub-structure of FOWT can be referred as a hull.

2.2.6 Access platform

The access platform comprises any walkway and platform mounted above the splash zone. The access platform may

be integrated to the sub structure and is to be considered as sub-structure in this case. Access platform may be non integrated to the sub structure and is to be considered as top-structure in this case.

2.2.7 Station keeping system

The station keeping system is a system capable to maintain the FOWT in position within specified limits.

Table 2 : Society documents

Reference	Title	Main interest
NR266	Requirements for survey of materials and equipment for the classification of ships and offshore units	General requirements for survey of material and equipment
NR216	Rules on materials and welding for the classification of marine units	General requirements for material
NI 423	Corrosion Protection of Steel Offshore Units and Installations	General guidance on corrosion protection of steel offshore units
NR 426	construction survey of steel structures of offshore units and installations	Guidance on the construction of steel structures of mobile offshore units and fixed offshore installations
NI 432	Certification of fiber ropes for deepwater offshore services	General requirements for fiber ropes
NR445 (1)	Rules for the classification of offshore units	General requirements for offshore units
NR467 (2)	Rules for the classification of steel ships	General requirements for steel ships
NR493	Rules for the classification of mooring systems for permanent and mobile offshore units	General requirements for mooring systems
NR494	Rules for the classification of offshore loading and offloading buoys	General requirements for buoys
NI 525	Risk based qualification of new technology - Methodological guidelines	General guidance on qualification of new technology
NR526	Rules for the classification of lifting appliances onboard ships and offshore units	General requirements for lifting appliances
NR530	Coating performance standard	General requirements for coating performance
NR546	Hull in composite materials and plywood, material approval, design principles, construction and survey	General requirements for hull in composite material
NR561	Hull in aluminium alloys, design principles, construction and survey	General requirements for hull in aluminium
NR571	Rules for the classification of column stabilized units	General requirements for column stabilized units
NR578	Rules for the classification of tension leg platform	General requirements for tension leg platforms
NI 594	Design and construction of offshore concrete structures	General guidance on concrete structure
NR595	Classification of offshore handling systems	General requirements for Offshore Handling Systems
NR600	Hull structure and arrangement for the classification of cargo ships less than 65m and non cargo ships less than 90 m	General requirements for hull structure
NI 604	Fatigue of top chain of mooring lines due to in-plane and out-of-plane bendings	General guidance for fatigue of top chain mooring lines
NI 605	Geotechnical and foundation design	General guidance on foundations and soil investigations
NI 611	Guidelines for fatigue assessment of steel ships and offshore units	General guidance for fatigue of units
NI 615	Buckling assessment of plated structures for offshore units	Strength criteria for buckling and ultimate strength of structure
NI 631	Certification scheme for Marine Renewable Energy technologies	Certification scheme
NI 638	Long term calculations	General guidance on direct hydro-structure calculations
(1) Hereafter referred to Offshore Rules		
(2) Hereafter referred to Ship Rules.		

2.2.8 Foundation

Foundations are installations at the seabed or in the seabed serving as anchoring of station keeping system and providing the transfer of loads to soil.

Different types of foundations can be encountered, such as:

- anchors: drag anchors, vertically loaded (plate) anchors torpedo anchors
- gravity solutions: dead man anchors
- piled solutions: long piles, short piles and caisson.

2.2.9 Tension Leg Platform (TLP)

Tension leg platforms are floating offshore units connected to the seabed through a tendon legs system (TLS). The TLS ensure the station keeping and restrains the motion of the unit due to wind, waves, current and tidal effects within specified limits.

Tendons are pre-tensioned. Generally very stiff in axial direction, the tendons limit heave, pitch and roll responses to very small amplitudes.

2.2.10 Column stabilized unit

Column stabilized units are units with the main deck connected to underwater hull or footings by columns or caissons. Bracings may be provided between the lower hull or footings, the columns and the deck structure.

2.2.11 Semi-submersible units

Semi-submersible units are column stabilized units for which the deck structure is above the water level and the columns are partially underwater.

A semi-submersible unit is intended for use in the floating mode, unit's stability in working and storm conditions being afforded by the column water plane area.

2.2.12 Yaw misalignment

The yaw misalignment means the horizontal deviation of the wind turbine rotor axis from the wind direction.

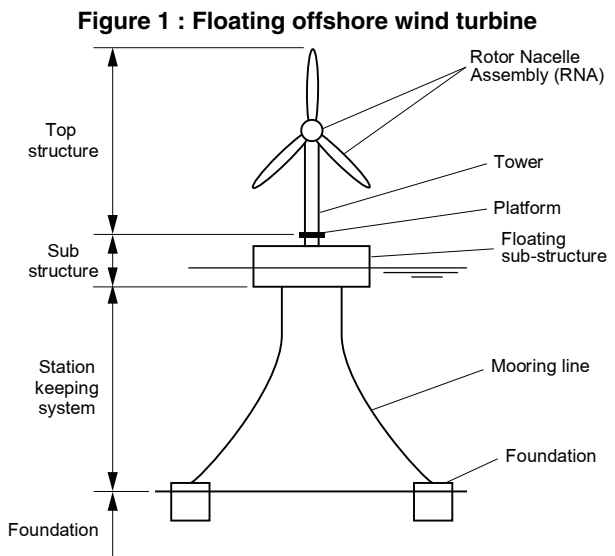
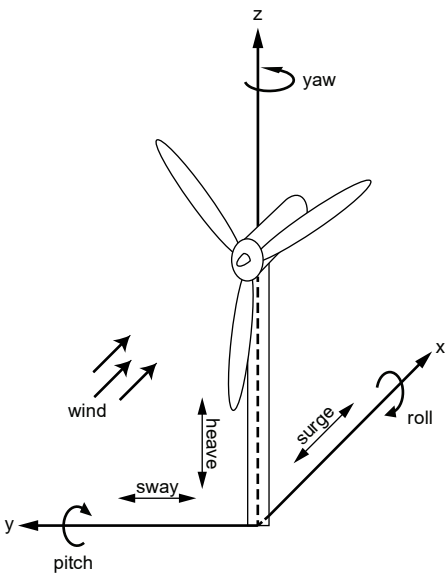


Figure 2 : Axes



3 Principles of classification and certification

3.1 Classification

3.1.1 Classification results in issuance of classification certificate attesting the level of compliance of the FOWT with the classification rules of the Society.

3.1.2 Class notation

Units complying with the requirements of this note are eligible for the assignment of the service notation **FOWT** as defined in Offshore Rules, Pt A, Ch 1, Sec 2.

3.2 Certification

3.2.1 Certification results in issuance of certificates attesting the compliance of FOWT and/or its components with Rules or standards.

3.2.2 The certification process of a Floating Offshore Wind Turbine consists of review of plans and calculations, surveys, checks and tests intended to demonstrate that standards/national Regulations are met.

3.2.3 Certification in compliance with special national rules

It is reminded that certification of FOWT in compliance with specific national regulations can be delivered by the Society only when it is authorized to do so by the competent National Authority.

3.3 National and International Regulations

3.3.1 FOWT operating in national waters are to comply with the Administration rules in addition to the Society rules.

3.3.2 In case of disagreement between rules, the Administration rules will prevail on the Society rules, except when the later provide a higher safety level. In this case, decision will be taken in agreement between the Society and the Owner, on a case by case basis.

3.3.3 In case of application of statutory requirements, attention is drawn upon the necessary agreement of the flag and/or coastal Authorities.

3.4 Alternative

3.4.1 Risk based approach

The risk based approach may be considered as an alternative or as a complement to Rules to support the adoption of deviations or modifications from the rules requirements. In such a case, the risk assessment documents are to be submitted and agreed by the Society.

4 Documents to be submitted

4.1 Plans and documents to be submitted for review

4.1.1 Documents to be submitted for review include, at least:

- general arrangements drawings
- structural drawings of the floating platform and of top-structures, RNA excluded
- operating manual
- stability calculations
- details of anchoring system
- inspection, maintenance and test plan.

4.1.2 The Society reserves the right to request the submission of the following documents related to the different life cycle phases of the FOWT (see App 5):

- manufacturing documentation
- commissioning manual.

4.1.3 Structural plans of sub-structure are to show details of connections of the various parts and, in general, are to specify the materials used, including their manufacturing processes, welding procedures and heat treatments.

4.2 Plans and documents to be submitted for information

4.2.1 Documents submitted for information are not directly concerned by Rules, but providing information useful for the review of the submitted plans and documents. The documents are not subjected to any assessment by the Society.

4.2.2 When direct calculation analyses are carried out by the Designer according to the rule requirements, they are to be submitted to the Society for information.

4.2.3 Documents to be submitted for information are:

- general description of the offshore wind turbine
- client's specifications
- reports on site specific conditions (soil data, Met-ocean report, etc.)
- basic engineering documents, specifications of the installation
- detailed engineering documents
- documents related with the wind turbine primary components (blades, rotor, bearings, gearbox, brakes, generator, etc.), providing, at least, data on their masses, inertias and stiffness
- description of principles used on the control and safety systems
- calculation notes covering design load cases and other relevant parameters (including unit's installation conditions)
- supporting calculations as necessary to demonstrate the adequacy of the design for all relevant conditions.

4.3 Additional documents

4.3.1 The Society may request any additional document found relevant, during the course of the approval process.

SECTION 2 GENERAL ARRANGEMENT

1 Clearance / Air gap

1.1 Air gap

1.1.1 Unless the structures are designed to withstand wave impact loading, the underside of structure part is to be clear of passing wave crests under all design conditions.

1.1.2 When wave impacts are permitted to occur on the underside of structure part it is to be demonstrated that the safety of personnel is not significantly impaired.

1.1.3 The following air gaps are to be maintained:

- positive air gap for extreme conditions
- 1,5 m for all others design conditions.

Note 1: At least, clearance is to be checked for extreme conditions with return period of 50yrs.

1.1.4 Air gaps are to be checked at various points on the underside of the structure part.

1.1.5 Air gaps are normally determined by appropriate model tests. Detailed hydrodynamic analysis are accepted, provided that the following items are taken into account:

- relative motions between the FOWT and waves
- generally, the non-linearity of wave profile
- maximum and minimum draughts
- various environmental headings.

1.2 Rotor clearance

1.2.1 At least, the lowest blade tip position is to be clear of passing wave crests under all conditions.

1.2.2 Attention is to be paid on local regulation.

Note 1: To minimize the risk of collision, it is recommended to consider a rotor clearance suitable for vessel types as identified in the traffic survey. Generally clearance between rotor and sea level at mean high water springs should be taken not less than 22 meters.

1.3 Platform clearance

1.3.1 Any walkway and platform access are to be mounted above the splash zone (as defined in Sec 4) and clearance with rotor is to be suitable to provide safe access for personnel.

2 Access means

2.1 General

2.1.1 Mean of access

The means of access are to allow inspection of the critical structure connections.

2.1.2 The number of inaccessible areas is to be limited and clearly identified on the structure drawings. The Society reserves the right to require additional corrosion allowances for these areas. Special attention is to be paid to fatigue strength.

2.1.3 Web frame numbers are to be attached to structure or walkway inside of tanks to the satisfaction of the attending Surveyor.

2.1.4 Equipment on deck are to be arranged to allow inspections of the deck plating and to avoid permanent concentration of dust and remaining water.

2.1.5 Limitation of accessibility

Accessibility of ladders and platforms is to be limited under icing conditions.

2.1.6 Means are to be provided to prevent the access of the FOWT by any unauthorized person, where appropriate.

2.2 Escape route

2.2.1 Nacelle escape

Alternative escape route from the nacelle is to be provided.

2.2.2 FOWT escape

Alternative escape route from the FOWT is to be provided in case of emergency.

2.3 Guards

2.3.1 Guards are to be designed to protect personnel from accidental contact with moving components.

2.4 Access systems - boat landing

2.4.1 Access system structure (such as fenders, boat loading, ladders) is to be designed such that the vertical movement of service ship approaching the FOWT is not restrained.

3 Access platform

3.1 Control system

3.1.1 A tagged, local, manual override on the automatic/remote control system is to be provided at the platform to allow the personnel to perform normal operation of the FOWT.

SECTION 3 MATERIAL

1 General

1.1 Application

1.1.1 This Section provides general guidance for selection of materials used on construction of FOWT.

2 Temperature

2.1 Design temperature

2.1.1 Design temperature of structural elements is to be taken as follows:

- air temperature for emerged part
- water temperature for immersed part.

2.1.2 Air temperature

Air temperature is to be taken as the mean air temperature of the coldest day (24h) of the year of area of operation.

Where no particular value is specified, the following air temperature is considered:

- 0°C for FOWT not intended to operate in cold area
- -10°C for FOWT intended to operate in cold areas.

2.1.3 Water temperature

Water temperature is to be taken as the mean water temperature of the coldest day (24h) of the year of area of operation.

Where no particular value is specified, water temperature upon 0°C is to be considered.

3 Steel and aluminium material

3.1 General

3.1.1 Material properties are to comply with the Rule Note NR216 Rules on Materials and Welding for Classification of Marine Units, and Offshore Rules, Pt B, Ch 3, Sec 2.

3.1.2 Selection of steel grade

The steel grade for a structural element is to be selected in accordance with Offshore Rules, Pt B, Ch 3, Sec 2, on the basis of:

- the design temperature, as defined in [2.1]
- the structural category, as defined in [3.1.3]
- the reference thickness of the element, as defined in Offshore Rules, Pt B, Ch 3, Sec 2.

3.1.3 Structural categories

Structural elements in welded steel constructions are classed into three categories:

- second category (secondary application structure): structural elements of minor importance, the failure of which might induce only localized effects
e.g. secondary beams not contributing to overall integrity, sea fastening, access system (boat landing, ladders, fenders,...), J-tube, crane resting support ...
- first category (primary application structure): main load carrying elements essential to the overall structural integrity of the FOWT
e.g. main deck beams, tubular columns, bracing members, welded beams, crane pedestal and its foundation...
- special category (special application structure): portions of the first category elements located in way or at the vicinity of critical load transmission areas and of stress concentration locations.
e.g. major intersections of bracing members, external shell structure in way of intersections of vertical columns, decks and lower hulls, insert plate of deck plating in way of crane pedestal...

Note 1: Guidance is provided in NR426 for classification of elements into categories, according to their nature and to the structural type of unit.

Structural categories are to be indicated on the drawings submitted to the Society for review.

The Society may, where deemed necessary, upgrade any structural element to account for particular considerations such as novel design features or restrictions regarding access for quality control and in-service inspections.

3.1.4 Weld category

A weld is to be classed in the same category as the category of the element on which welding is performed (see [3.1.3]).

In case of a weld connecting two elements classed in different categories, the weld is to be classed in the category of the higher classed element.

3.2 Material strength

3.2.1 Reference stress of material R_f

The reference stress of material, R_f , in N/mm², to be considered for strength calculation, is defined by:

$$R_f = \min\left(R_{eG}, \frac{R_m}{1,2}\right)$$

with:

R_{eG} : Minimum specified yield stress of the material,
in N/mm²

R_m : Tensile strength of the material, in N/mm².

For steel having a yield stress above 690 N/mm², special consideration will be given by the Society.

Note 1: Refer to NR 216 Materials and Welding.

4 Concrete

4.1 General

4.1.1 For concrete material of the FOWT, reference is made to the applicable requirements of standards for the design of concrete structures, such as:

- EN 1992 - Design of concrete structures
- EN 206 - Concrete - Specification, performance, production and conformity
- ISO 19903 - Fixed concrete offshore structures
- NI 594 - Design and Construction of Offshore Concrete structure.

SECTION 4 CORROSION

1 General

1.1 Zone exposed to corrosive environment

1.1.1 Corrosion process is dependent on the relationship between the structure and its environment. The structure of FOWT is divided into different zones: atmospheric, splash and submerged zones, as defined hereafter.

1.1.2 Atmospheric zone

The atmospheric zone means zone which extends upwards from the splash zone (i.e. exposed to air, sun, wind, spray and/or rain).

1.1.3 Splash zone

The splash zone means zone alternatively in and out of water because of wind, wave, tide, FOWT motions, draft variation or water level change.

- For external surface, the splash zone is generally taken as extending from the deepest draught in combination with the highest still water level with a return period of 1 year increased by the crest height of a wave with height equal to the significant wave height with a return period of 1 year, to the lowest draught in combination with the lowest still water level with a return period of 1 year reduced by the trough depth of a wave with height equal to the significant wave height with a return period of 1 year.
- For internal surface, the splash zone is generally taken as extending from the lowest operational ballast water level to the highest operational ballast water level in the compartment

Note 1: The exact location and vertical extent of the splash zone is generally determined at the design stage as it depends upon environmental and operating conditions at site location.

1.1.4 Submerged zone

The submerged zone means zone permanently under water (below the splash zone).

1.2 Corrosion protection

1.2.1 Plan for the corrosion protection

An overall plan for the corrosion protection of the structure is to be prepared covering the following surfaces of the structure:

- all external surfaces (submerged, splash and atmospheric zone, boat landing, J-tube,...)
- internal surfaces (atmospheric and splash zone, ballast, storage tanks,...).

The plan for the corrosion is to take into account:

- the intended duration of operations and conditions of maintenance

- the design life (including installation life)
- the particular conditions in each zone.

1.2.2 Corrosion protection

Structure of the FOWT is to be effectively protected against corrosion damage using either one or a combination of the following methods:

- cathodic protection
- application of protective coatings
- selection of material.

General requirements are given in Offshore Rules, Pt B, Ch 3, Sec 5 and in NI 423.

1.2.3 Protection against galvanic corrosion is to be provided when metallic and composite material, such as carbon fibre, are used together.

1.2.4 A corrosion addition is to be considered, if necessary:

- in special areas subjected to mechanical wastage due to abrasion (e.g. boat landing, access ladders)
- when the concerned structural members are left unprotected
- when the concerned structural members are not sufficiently protected against corrosion
- in areas of difficult maintenance and inspection
- in watertight compartments.

1.2.5 Corrosion protection method is to be adapted to the concerned zone (Tab 1 and Fig 1):

- In atmospheric zone, external and internal surfaces of steel structures are to be protected by coating.
- In splash zone, use of coating is mandatory for external surfaces of primary structures. Coating of primary structure is to be combined with a corrosion addition.
- In submerged zone, cathodic protection is mandatory for external surfaces of steel structures. Use of coating is recommended and is then primarily intended to reduce the required cathodic protection capacity.

Internal surfaces of the submerged zone are to be protected by either cathodic protection or corrosion addition, with or without coating in combination.

Note 1: For areas of difficult access for maintenance and inspection, and for sealed compartments, corrosion addition is recommended.

1.2.6 Mooring chains

Corrosion protection of mooring chains is to be considered as given in NR493.

1.2.7 Foundations

Corrosion protection of foundation is to be considered as given in NI 605.

Table 1 : Corrosion protection

Zone	Internal surface	External surface	Areas of difficult access or maintenance
Atmospheric	Coating	Coating	Coating + CA
Splash	Coating or CA	Coating + CA	Coating + CA
Submerged	CP or CA (+ coating recommended)	CP (+ CA (1) + coating recommended)	CP + CA (+ coating recommended)
Boat landing	NA	Coating (+ CA recommended)	Coating + CA
Watertight compartment	NA		CA (2)

For secondary structures, corrosion addition may be considered on case by case basis according to the risk of human life, the possibility of replacement and the maintenance and repair process.

CA : Corrosion addition

CP : Cathodic protection, i.e. sacrificial anodes system or impressed current system (impressed current system is only permitted on external surface of the structure).

NA : Not Applicable

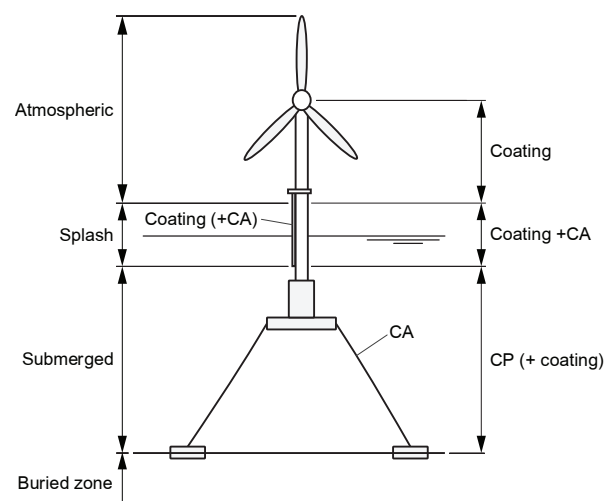
(1) Impressed current system is to be supplemented by corrosion addition (to take into account loss of current).

(2) A corrosion addition is recommended for watertight compartments where maintenance and inspection may be difficult, and/or where loss of tightness is possible. Corrosion rate is to be specified according to the compartment volume and the oxygen level (as a guidance, a reference corrosion rate of 0,10 mm/yr may be consider).

Other methods of corrosion control such as control of humidity, control of oxygen level, overpressure (by nitrogen) to prevent air ingress, biocid, etc. may also be considered when relevant.

A corrosion addition is required for sealed compartment (no maintenance or inspection possible).

Figure 1 : Corrosion protection for external surface



1.3 Corrosion allowance

1.3.1 Net scantling approach

The scantlings obtained by applying the criteria specified in this Note are net scantlings (i.e. based on net thickness t_{net}), except when otherwise specified.

For new steel structure, the net thickness is to be taken as:

$t_{net} = t_{gross} - t_{ca}$

where:

- t_{net} : net thickness, in mm
- t_{gross} : gross thickness, in mm
- t_{ca} : corrosion allowance, in mm
defined as a function of t_c , see [1.3.2]
- t_c : corrosion addition, in mm

1.3.2 Corrosion allowance, t_{ca}

Corrosion allowance is to take into account possible thickness reductions during the expected life of the structure according to corrosion exposure.

Appropriate corrosion allowances are to be applied for computation of global stress, local stress or fatigue. The minimum recommended corrosion allowances are:

- 0.5 t_c for fatigue calculations and global FEM.
- t_c for local scantling (yielding and buckling calculations)

where t_c is the corrosion addition as defined below.

1.3.3 Corrosion addition, t_c

The values of the corrosion additions are to be applied in relation to the relevant protective coatings given in [1.2].

The Designer may define greater values of corrosion additions.

1.3.4

At a design stage, the current practise is to consider a corrosion addition according to the design life:

$t_c = C_R T_{expo}$

where:

- t_c : corrosion addition, in mm
- C_R : corrosion rate, in mm/yr

T_{expo} : exposure time, in years,
i.e. time during which the considered element is exposed to corrosive environment.

T_{expo} could consider the maintenance plan and the effectiveness of the corrosion protection.

In general: $T_{\text{expo}} = T_{\text{DL}} - T_{\text{prot}}$

where:

T_{DL} : design life of the considered element (installation time included), in years

T_{prot} : time during which the protection against corrosion is effective, in years.

Note 1: For example, T_{prot} means the design life of the coating qualified by recognized method (such as ISO 12944 or NORSOK M-501).

Note 2: When non corrosion protection is used, T_{prot} is to be taken as 0.

1.3.5 Corrosion rates, c_R

Corrosion rate is to be determined according to the site conditions and the zone exposed to the corrosive environment. It is recommended to perform in situ test measurements (ISO 11306, ISO 9226, ASTM G1). Values given in Tab 2 may be used as a general guidance only and should be adapted to the site parameters such as:

- oxygen content
- salinity
- temperature
- abrasion
- mineral fillers
- bacteria and biological activity
- hydrocarbon content
- pH.

In particular, the following site conditions may affect the corrosion rate:

- proximity with an estuary: mixed of fresh water with sea water, mineral fillers and debris
- wind induced upwelling effect
- marine growth and its maintenance
- sand entrained by wind (or rain)
- polluted area
- current, ice, condensation.

Table 2 : Corrosion rates

Zone	Climate	Corrosion rate on one side [mm/yr]	
		Internal	External
Splash	Temperate	0,10	0,30
	Mediterranean	0,15	0,35
	Tropical	0,20	0,50
Submerged		0,15	
Note 1: For mooring chains, corrosion rates are given in NR493.			
Note 2: For foundations, corrosion rates are given in NI605.			

2 Alternative according to classification maintenance and survey plan

2.1 General

2.1.1

When classification maintenance and survey plan, as given in NR445, Part A, is followed, the following corrosion additions may be used instead those indicated in Article [1]:

a) Steel other than stainless steel

In general, the corrosion addition to be considered for plating forming the boundary between two compartments of different types is equal to:

- for plating with a gross thickness greater than 10 mm, the sum of the values specified in for one side exposure to each compartment
- for plating with a gross thickness less than or equal to 10 mm, the smallest of the following values:
 - 20% of the gross thickness of the plating
 - sum of the values specified in Tab 3 for one side exposure to each compartment.

For an internal member within a given compartment, or for plating forming the boundary between two compartments of the same type, the corrosion addition to be considered is twice the value specified in for one side exposure to that compartment.

When, according to Tab 3, a structural element is affected by more than one value of corrosion additions, the scantling criteria are generally to be applied considering the maximum value of corrosion addition applicable.

b) Stainless steel:

For structural members made of stainless steel, the corrosion addition t_c is to be taken equal to 0.

c) Non alloyed steel clad with stainless steel:

For plates made of non-alloyed steel clad with stainless steel, the corrosion addition t_c is to be taken equal to 0 only for the plate side clad with stainless steel.

d) Aluminium alloys:

For structural members made of aluminium alloys, the corrosion addition t_c is to be taken equal to 0.

Table 3 : Corrosion additions t_c , in mm, for each exposed side

Compartment type		General (1)	Special cases
Ballast tank		1,00	1,25 in upper zone (2)
Fuel oil tank	Plating of horizontal surfaces	0,75	1,00 in upper zone (2)
	Plating of non-horizontal surfaces	0,50	1,00 in upper zone (2)
	Ordinary stiffeners and primary supporting members	0,75	1,00 in upper zone (2)
Tanks for fresh water		0,50	
Moonpool		1,25	
Accommodation space		0,00	
Compartments other than outside sea and air		0,50	
(1) General: corrosion additions t_c are applicable to all members of the considered item with possible exceptions given for upper and lower zones.			
(2) Upper zone: area within 1,5 m below the top of the tank. This is to be applied only to tanks with weather deck as the tank top.			

SECTION 5

DESIGN CONDITIONS AND LOADS

1 General

1.1 Principles

1.1.1 Application

This Section provides guidance for design loads applied for structural assessment of FOWT.

1.1.2 Direct calculations and model tests

Direct calculations are to be carried out as required in this Note. Direct calculations may be calibrated based on model tests. In such a case, testing procedures and method used for the extrapolation of model tests to full scale data are to be at the satisfaction of the Society.

1.2 Operating Manual

1.2.1 The operating manual includes instructions regarding the safe operation of the FOWT and of the systems and equipment fitted on the unit. It is to be placed at the base of maintenance of the unit and made available to all concerned. A copy of the operating manual is to be retained ashore by the Owners of the FOWT or their representatives.

Note 1: Base of maintenance may be located offshore or onshore.

The operating manual is to incorporate a dedicated section containing information relating to:

- all design conditions on which the design of the FOWT is based
- all permissible limits and operational limits applied for the design
- all allowable local loadings for the hull, decks and foundations.
- any areas where vessels are not permitted to operate in proximity to the FOWT
- maximum significant wave height for vessel operation near the FOWT

1.2.2 The Operating Manual of the FOWT is to be submitted for review to the Society.

2 Design conditions

2.1 General

2.1.1 Design conditions on the basis of which the structural checks are performed cover all stages of FOWT's life entering under the scope of the Society.

2.1.2 A design condition is defined by a combination of the following main conditions:

- operating conditions
- system conditions
- environmental conditions.

2.2 Operating conditions

2.2.1 Production conditions

Production conditions corresponds to the situation where the FOWT is running and is connected to the electrical network. Production of electricity is performed.

2.2.2 Parked conditions

Parked conditions correspond to the situation where the RNA is in a standstill or idling condition. Turbine is stopped.

2.2.3 Transient conditions

Transient conditions correspond to temporary situation between production conditions and parked conditions, such as:

- start up
- normal shut-down
- emergency shut-down.

2.2.4 Transit, Installation and Maintenance conditions

Transit, Installation and Maintenance conditions correspond to the conditions assumed for the transportation, assembly, maintenance and repair on site of the FOWT.

2.3 System conditions

2.3.1 Intact conditions

Intact conditions of the FOWT correspond to the normal state of the FOWT.

Intact conditions may consider minor fault which are expected to occur frequently during the FOWT life time.

2.3.2 Abnormal conditions

Abnormal conditions of the FOWT corresponds to a design condition with severe fault that result in activation of protection system.

- a) for the structural part, abnormal conditions include:
 - structure damage
 - flooding
 - station keeping damage
 - fire and explosion.
- b) for the electrical part, abnormal conditions include:
 - loss of electrical network
 - internal electrical fault
 - control system fault
 - external electrical fault
 - protection system fault.

2.4 Environmental conditions

2.4.1 Environmental conditions are external conditions due to wind, sea and ice. More details on external conditions are given in App 2.

2.4.2 Wind conditions

Wind conditions correspond to the description of wind on the FOWT site. Wind conditions are grouped into two main categories:

- a) Normal wind conditions occur frequently during the life time of the FOWT and include:
 - normal wind
 - operating gust
 - wind turbulence
 - direction change
 - coherent gust with direction change
 - wind shear.

Note 1: Normal wind conditions correspond to the wind conditions acceptable to perform electricity production. Range of wind speed is given by the turbine manufacturer.

- b) Extreme wind conditions occur rarely during the life time of the FOWT. Return period of 50 years is generally to be considered.

Note 2: During extreme wind conditions, no electricity is produced, the turbine has to be stopped.

Additional guidelines are given in App 2.

2.4.3 Marine conditions

Marine conditions correspond to the description of the sea state on the FOWT site. It includes:

- a) Wave conditions correspond to the description of wave of the intended site of the FOWT. Sea state is given in term of wave height:
 - normal wave height (NWH) corresponds to the wave height conditioned to the normal wind
 - severe wave height (SWH) corresponds to the maximum wave height for which the FOWT produce electricity. The combination wind and wave has a return period of 50 years (see App 2, [3])
 - extreme wave height (EWH) corresponds to the wave height associated to extreme conditions. Return period of 50 years is generally considered App 2, [3]).
- b) Current conditions
- c) Tidal conditions
- d) Sea ice conditions
- e) Marine growth conditions.

Additional guidelines are given in App 2.

2.4.4 Ice conditions

Ice conditions correspond to the description of the ice state on the FOWT site.

Additional guidelines are given in App 2.

3 Design loads

3.1 General

3.1.1 The design of FOWT structures is considering the following categories of loads:

- fixed
- operational
- external (environmental and electrical)
- accidental.

Note 1: Categories of loads are also defined in Offshore Rules Pt B, Ch 2, Sec 3.

3.2 Fixed loads

3.2.1 Fixed load or lightweight is the weight of the complete FOWT with all permanently attached machineries, equipment and other items of outfit.

3.2.2 Fixed loads include, for example:

- weight of the structure (rotor, nacelle, mast, floater,...)
- weight of permanent ballast to their normal working level
- weight of permanent liquids (lubricating oil in generator).

3.2.3 Fixed loads exclude weight of liquids or other fluids contained in supply, reserve or storage tank.

3.2.4 Load distribution

For the purpose of overall structural calculations, a complete description of load distribution is to be provided.

3.3 Operational loads

3.3.1 Operational loads are loads associated with the operation of the FOWT, corresponding to the specified operating condition. They include:

- hydrostatic loads (buoyancy)
- static and installation mooring loads (e.g. pretension)
- static and installation power cable loads
- loads resulting from liquids in tanks
- variable ballast loads
- loads resulting from lifting or handling appliances in operation
- actuation loads
- vessel impact loads due to normal operation
- variable loads of consumable supplies weights
- dynamic loads induced by equipment in operation.

Note 1: For the purpose of local scantling, design distributed deck loads including deck self-weight are given in NR445, Pt B, Ch 2, Sec 3, Tab 1.

3.3.2 Hydrostatic loads

The maximum and minimum draughts in each loading condition are to be considered for calculation of hydrostatic loads on outer shell. If the shell forms tank boundary, the maximum or minimum differential pressure between internal and external pressure is to be considered as well.

Note 1: Mooring tendon and power cable loads can have an important effect on hydrostatic loads.

3.3.3 Vessel impact loads

Vessel impact loads are loads resulting from the normal service of the vessel (e.g. transfer of personnel).

Note 1: Vessel colliding loads due to accidental situation are to be considered as accidental loads, see [3.5].

Vessel impact loads are to be considered as horizontal force in frontal and side directions relative to the access system.

Note 2: Forces are not to be applied simultaneously in both direction.

Vessel impact loads are to be applied in combination with the most severe environmental loads corresponding to the operation of the vessel.

Vessel impact loads may be assessed by different methods:

a) dynamic analysis of vessel approach considering:

- vessel displacement and added mass
- vessel speed according to the sea state
- deformation properties of the vessel, fender and access system.

b) prescriptive method:

The impact force F_{imp} , in kN/m, may be taken in relation to impact energy and spring energy:

$$F_{imp} = \sqrt{2kE_c}$$

where:

k : total spring stiffness of the structure at the impact point in the impact direction, in kN/m

Note 3: It is conservative to consider the vessel is rigid and the total energy is transferred to the structure.

E_c : approaching vessel energy, in kJ

Taken equal to:

$$E_c = 0,5 (M + M_a)V^2$$

M : displacement of the approaching vessel, in tons

M_a : added mass of the approaching vessel, in tons

Taken equal to 0,25M

V : specific maximum approach speed of the approaching vessel, in m/s

Note 4: Maximum approaching vessel data and its specific approach speed are usually given in the design basis.

c) when no data are available, the contact area may be designed for an impact force F_{imp} , in kN, given by:

$$F_{imp} = 2,5 M$$

where:

M : displacement of the approaching vessel, in tons

Maximum environmental conditions (maximum significant wave height) and areas allowed close to the FOWT for vessel operation are to be stated in the operation manual.

Note 5: Considering the vessel operates on the FOWT because of maintenance, the FOWT is considered as in parked condition, the turbine is stopped.

3.4 External loads

3.4.1 External loads are mainly constituted by environmental loads and electrical loads.

For external conditions, general guidances are given in App 2.

3.4.2 Environmental loads

Environmental loads are loads resulting from the action of the environment on the FOWT, corresponding to the specified environmental condition. They include:

- wind loads
- wave, current, tidal and marine growth loads
- snow and ice loads, when relevant
- inertia loads
- dynamic mooring loads
- dynamic power cable loads.

Note 1: Reactions to environmental loads are to be considered as environmental loads

Note 2: Dynamic loads induced by unit's motions or by dynamic response to environment action are to be considered as environmental loads.

3.4.3 Wind loads

Wind loads are loads due to the wind effect on the FOWT corresponding to the specified wind condition.

Wind loads are to be defined in terms of wind conditions for the specific site.

For FOWT, wind loads may be divided into two components:

- wind loads acting on the tower and the substructure
- wind loads acting on the rotor.

a) Wind loads on the substructure and the tower

Wind loads acting on the substructure and the tower can be considered as steady loads and determined by the following formula:

$$F_w = 0,5 \rho C_s S_w V_w^2$$

where:

ρ : Air specific mass, in kg/m³
Generally, $\rho = 1,222$ kg/m³

S_w : Projected area of the structural element on a plane normal to the direction of the force, in m²

V_w : Mean wind speed at the considered elevation, in m/s

C_s : Shape coefficient, values given in Tab 1 may be used in absence of data.

b) Wind loads on the rotor

For determination of the overturning moment (stability analysis), the wind drag force, F_D in N, acting on the rotor may be calculated by the following formula:

$$F_D = 0,5 \rho C_D S V_{hub}^2$$

where:

ρ : Air density, in kg/m³

C_D : Drag coefficient

S : Swept area of the blades, in m²