Certification of
Fixed Offshore Substations for
Renewable Energy Projects

April 2022

Guidance Note
NI 682 DT R00 E

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BUREAU VERITAS MARINE & OFFSHORE

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 the above listed being relieved from any of their expressed or implied obligations as a result of the interventions of the Society.

1.4 Only the Society 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 ("Applicable Referential"), 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 (or Certification as defined in clause 2.2) is an appraisement 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 and/or to Applicable Referential 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 (available online on veristar.com), guidance notes 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 Rules and/or 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, and/or to the Applicable Referential, 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 appraisement 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 nor on its content in the event of the actual issuance of a Certificate. This opinion shall only be an appraisement 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, involves, 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, interest 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 resolve 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-cent (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 The Services shall be automatically and immediately terminated in the event the Client can no longer establish any form of interest in the Unit (e.g. sale, scrapping).

9.3 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, or immediately in the event of termination under clause 9.2, subject to compliance with clause 4.1 and 6 above.

9.4 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, will be 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, other 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 in accordance with and governed by the laws of England and Wales.

15.2 Any dispute shall be finally 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.

15.3 Notwithstanding clause 15.2, disputes relating to the payment of the Society's invoices may be submitted by the Society to the *Tribunal de Commerce de Nanterre*, France, or to any other competent local Court, at the Society's entire discretion.

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 US 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://personaldataprotection.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 and, when applicable, Business Partner Code of Conduct both available at https://group.bureauveritas.com/group/corporate-social-responsibility/operational-excellence.

GUIDANCE NOTE NI 682

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Section 1 General Principles

Section 2 Structural Design

Section 3 Safety

Section 4 Manufacturing Surveillance

Section 5 Transport and Installation

SECTION 1 GENERAL PRINCIPLES

1 Scope

1.1 Application

1.1.1 Purpose of the document

This Guidance Note provides minimum technical requirements, based on recognized international standards and the Society rules, for the certification of Offshore Substations (OSS) for renewable energy projects like wind field developments.

1.1.2 Covered structures

This Guidance Note is intended to cover fixed steel offshore substations including topside and support structure.

It does not cover the renewable energy production systems and the power cables.

This document is not applicable to floating offshore substations.

1.2 Project certification scheme

1.2.1 General

The project certification scheme applicable to the OSS is described in NI 631, Sec 5 or can be given in the design basis.

1.2.2 Certification phases

This document contains requirements for the following certification phases:

- structural design basis evaluation
- structural design assessment
- safety assessment, including risk assessment if required
- manufacturing surveillance
- transport and installation surveillance.

This document does not address the site condition assessment and the electrical design. In particular, requirements for the certification of the electrical design should be agreed with local regulatory stakeholders.

1.3 Recognized standards and Society's rules

1.3.1 General

The requirements of the international standards and the Society's documents referenced in this document provide minimum acceptable requirements, but the specific standards or documents to be applied in the certification project are those agreed by the stakeholders and specified in the design basis (see Article [2]).

Applicability of these agreed standards and documents are reviewed by the Society as part of design basis certification phase.

1.3.2 References

Recognized international standards and the Society's documents that are referenced in this Guidance note are respectively listed in Tab 1 and Tab 2.

Table 1 : Recognized standards

Reference		Main interest
STRUCTURAL DESIGN		
ISO 19900	General requirements for offshore structures	General requirements and recommendations for the design and assessment of offshore structures
ISO 19901-1	Specific requirements for offshore structures — Part 1: Metocean design and operating considerations	General requirements for the determination and use of metocean conditions for the design, construction and operation of offshore structures
ISO 19901-2	Seismic design procedures and criteria	Requirements for defining the seismic design procedures and criteria for offshore structures
ISO 19901-3	Specific requirements for offshore structures — Part 3: Topsides structure	Requirements for the design, fabrication, installation, modification and structural integrity management for the topsides structure
ISO 19901-4	Specific requirements for offshore structures — Part 4: Geotechnical and foundation design considerations	Provisions for those aspects of geoscience and foundation engineering that are applicable to a broad range of offshore structures
ISO 19901-5	Specific requirements for offshore structures — Part 5: Weight management	Requirements for managing and controlling the weight and centre of gravity (CoG) of offshore facilities

Reference		Main interest
ISO 19901-8	Marine soil investigations	Requirements and recommendations for marine soil investigations
ISO 19902	Fixed steel offshore structures	Requirements and recommendations for design, fabrication, transportation and installation of fixed steel offshore structures
EN 12495	Cathodic protection for fixed steel offshore structures	Means to be implemented to ensure cathodic protection of the submerged parts of fixed steel structures
EN 1993-1	Design of steel structures	Requirements for the design of civil engineering structures made of steel.
SAFETY		
CAP 437	Standards for offshore helicopter landing areas	Criteria applied by the Civil Aviation Authority in assessing the standards of offshore helicopter landing areas
FSS Code	International code for fire safety systems	Provide international standards of specific engineering specifications for fire safety systems required by chapter II-2 of the International Convention for the Safety of Life at Sea (SOLAS) and other associated Codes (e.g. IMO MODU Code)
FTP Code	International code for application of fire test procedures	Fire test procedures for materials and products to be installed on marine and offshore units
ISO 12100	Safety of machinery — General principles for design — Risk assessment and risk reduction	Basic terminology, principles and a methodology for achieving safety in the design of machinery
ISO 13702	Petroleum and natural gas industries — Control and mitigation of fires and explosions on offshore production installations — Requirements and guidelines	0bjectives and functional requirements for the control and mitigation of fires and explosions on offshore installations
ISO 14122 all parts	Safety of machinery — Permanent means of access to machinery	Requirements for access to stationary machines and guidance about the correct choice of means of access
ISO 31010	Risk management – Risk assessment techniques	Guidance for the selection and application of systematic/ methodical techniques for risk assessment
MANUFACTURING SURVEILLANCE		
ISO 14732	Welding personnel — Qualification testing of welding operators and weld setters for mechanized and automatic welding of metallic materials	Requirements for qualification of welding operators and also weld setters for mechanized and automatic welding.
ISO 17637	Non-destructive testing of welds — Visual testing of fusion-welded joints	Standard for visual testing of fusion welds in metallic materials; also applicable to visual testing of the joint prior to welding
ISO 17638	Non-destructive testing of welds — Magnetic particle testing	Techniques for detection of surface imperfections in welds in ferromagnetic materials, including the heat affected zones, by means of magnetic particle testing
ISO 17640	Non-destructive testing of welds — Ultrasonic testing — Techniques, testing levels, and assessment	Techniques for the manual ultrasonic testing of fusion-welded joints in metallic materials
ISO 23277	Non-destructive testing of welds — Penetrant testing — Acceptance levels	Acceptance levels for indications from surface breaking imperfections in metallic welds detected by penetrant testing.
ISO 23278	Non-destructive testing of welds — Magnetic particle testing — Acceptance levels	Acceptance levels for indications from imperfections in ferromagnetic steel welds detected by magnetic particle testing
ISO 3452-1	Non-destructive testing — Penetrant testing — Part 1: General principles	Method of penetrant testing used to detect discontinuities, e.g. cracks, laps, folds, porosity and lack of fusion
ISO 9712	Non-destructive testing — Qualification and certification of NDT personnel	Requirements for principles for the qualification and certification of personnel who perform industrial non-destructive testing
EN 1090 all parts	Execution of steel structures and aluminium structures	Technical requirements for the execution of structures in all kind of steel and aluminium

Table 2 : Society's documents

Reference		Main interest
CERTIFICATION SCHEME		
NI 631	Certification scheme for Marine Renewable Energy technologies	Certification scheme applicable to marine renewable energy systems
STRUCTURAL DESIGN		
NR526	Rules for the certification of lifting appliances onboard ships and offshore units	Requirements for the certification of lifting accessories and the verification of lifting pad eyes
NI 423	Corrosion Protection of Steel Offshore Units and Installations	Guidelines for the prevention and control of corrosion on steel structures, appurtenances and equipment of offshore units
NI 605	Geotechnical and Foundation Design	Methodologies, requirements and recommendations for the certification of the design of foundations of offshore structures
NI 611	Guidelines for fatigue assessment of ships and offshore units	Guidelines for the assessment of fatigue capacity of marine and offshore structures throughout their entire life
SAFETY		
NI 525	Risk-based qualification of new technology - methodological guidelines	Guideline to qualify a technology using a risk based approach.
MANUFACTURING SURVEILLANCE		
NR216	Rules on Materials and Welding for the Classification of Marine Units	Requirements for the manufacture, inspection and certification of steel and iron products, non-ferrous metals, various finished products and equipment entering in the construction or repair of Marine Units
NR426	Construction survey of steel structures of offshore units and installations	Requirement for the construction of steel structures of mobile offshore units and fixed offshore installations intended to be certified by the Society
NR476	Approval testing of welders	Requirements for a qualification scheme for welders intended to be engaged in fusion welding
NR480	Approval of the manufacturing process of metallic materials	The procedure to be followed to obtain the Society's approval certificate of material for manufacturing process of metallic products

2 Design basis

2.1 Definition and purpose

2.1.1 Definition

The design basis is an engineering document which defines the conditions, the requirements and the engineering procedures needed to design the OSS.

2.1.2 Purpose

The design basis aims at identifying all requirements, assumptions and methodologies o be applied during the project for the design, manufacturing, transportation and installation, as well as the corresponding documentation.

2.2 Content requirements

2.2.1 Applicable codes and standards

The design basis is to reference the applicable codes and standards. It is also to indicate, if applicable, any additional requirements or deviations from these and specific requirements for elements which are not covered otherwise.

2.2.2 Design data

The design basis is to set out the design parameters, assumptions, methodologies and principles that are applied. It is to include structural design and safety design data.

2.2.3 Other data requirements

The design basis is to cover all phases of the OSS life cycle, namely manufacturing, transportation and installation. The applicable requirements for each phase are to be provided, and the procedures applied are to be described.

3 Definitions and acronyms

3.1 General definitions

3.1.1 Certification

Certification results in issuance of certificates validating the design basis and attesting the compliance of the OSS with the technical requirements defined in that document.

3.1.2 Offshore substation

Offshore substation is an offshore fixed steel platform intended for electrical high voltage associated with marine renewable energy project (e.g. offshore wind farms).

3.1.3 Exposure level

Classification system used to define the requirements for a structure based on consideration of life-safety and of environmental and economic consequences of structural failure.

3.2 Structural elements definitions

3.2.1 Support structure

The support structure includes foundations and sub-structure and is intended to support the topsides facilities and structure.

3.2.2 Foundation

Foundations are parts of support structure which transfer the loads acting on the sub-structure into the seabed.

3.2.3 Sub-structure

The sub-structure is part of support structure which extends upwards from the seabed and connects the foundations to the topsides. Sub-structure includes for example, the cable deck, the top deck or transition piece, if any. Different sub-structure concepts exist, such as:

- monopile
- jacket
- combination of above structures (e.g. tripods,…).

The structures which are part of the interface between the sub-structure and the topside are to be included in the structural assessment of the sub-structure and the topside, depending on design and installation considerations.

3.2.4 Topsides

Topsides mean the operational structure and equipment located on support structure to provide substation's functions. Topsides include electrical systems and facilities (including accommodation, if any).

3.2.5 Machinery space

Machinery space is any enclosed space that either contains an installed internal combustion engine, machinery, or systems that would raise the ambient temperature above 45 degrees Celsius (113 degrees Fahrenheit) in all environments the unit operates in.

3.3 Loads definitions

3.3.1 Design situation

Set of loads and combination of loads representing real conditions during a certain time interval, for use in a specific limit state verification.

3.3.2 Pre-service situation

Pre-service situation denotes the loading conditions to which the structure is subjected during loadout, transportation and installation until early-production phase.

3.3.3 In-place situation

In-place situation denotes the loading conditions, including permanent loads, variable loads, environmental loads, repetitive loads and accidental loads, to which the structure is subjected during its service life.

3.3.4 Accidental situation

Accidental situation denotes the loading conditions corresponding to an accidental event (e.g. impact, fire, explosion, etc.) which may affect the structure during its service life.

3.3.5 Representative value

Value assigned to a basic physical parameter (e.g. load, strength) for verification of a limit state in a design/assessment situation.

3.3.6 Design load

The design load is the value of the load corresponding to a specific design situation and is derived from selected representative load values and their associated partial factors.

3.4 Acronyms

3.4.1 List of acronyms

ALE : Abnormal Level Earthquake
ALS : Accidental Limit State
CoG : Centre of Gravity
DAF : Dynamic Amplification Factor
ELE : Extreme Level Earthquake
ER : Emergency Response
FEA : Finite Element Analysis
FMEA : Failure Modes and Effects Analysis
FMECA : Failure Modes Effects and Criticality Analysis
FLS : Fatigue Limit State
GSR : Geometric Stress Range
HAZID : HAZard IDentification
JF : Joint Flexibility
LRFD : Load and Resistance Factor Design
NDT : Non Destructive Test
OSS : Offshore SubStation
PFP : Passive Fire Protection
QA : Quality Assurance
QC : Quality Control
SCF : Stress Concentration Factor
SLS : Serviceability Limit State
SRC : Seismic Risk Category
ULS : Ultimate Limit State
VIV : Vortex Induced Vibration.

SECTION 2 STRUCTURAL DESIGN

1 General requirements

1.1 Recognized standards

1.1.1 The design of the substructure should follow requirements and guidance given in ISO 19902.

1.1.2 The design of the foundation should follow requirements and guidance given in the Society rule NI 605 or ISO 19901-4 and in clause 17 of 19902.

1.1.3 The design of the topside structure should follow requirements and guidance given in ISO 19901-3.

1.1.4 Seismic design should follow requirements and guidance given in ISO 19901-2.

1.2 Structural design assessment

1.2.1 General

The structural design assessment consists in checking compliance of:

- material and corrosion protection system
- structural strength against the applicable limit states.

1.2.2 Limit states

The limit states to be considered include:

- Ultimate Limit State (ULS) refers to the structural strength against, on one hand, pre-service loads, on the other hand, in-place loads
- Serviceability Limit State (SLS) refers to the structural strength against operating load representing the loads occurring during normal platform operation
- Fatigue Limit State (FLS) refers to structural strength against repeated loads
- Accidental Limit State (ALS) refers to structural strength against accidental loads such as impact load (e.g. vessel collision) or abnormal environmental load (e.g. seismic load).

1.3 Documents to be submitted

1.3.1 Structural design basis

The documents to be submitted include as a minimum:

- design basis of the support structure, and the corresponding drawings
- design basis of the topside structure, and the corresponding drawings.

The design basis report is to list applicable standards, design and manufacturing requirements and computation methodologies that will be used for the design and procurement.

1.3.2 Structural design evaluation

In addition to design briefs and drawings, corresponding calculation notes are to be provided (see [1.4.4]).

1.4 Design basis

1.4.1 General

The purpose of the Design basis is to set:

- design review applicable standards
- design and analysis methodology
- design criteria
- material and corrosion protection specifications
- manufacturing and testing constraints to design.

The items which are to be addressed in the design basis documents are listed in [1.4.2] to [1.4.4].

1.4.2 Site condition data

- bathymetry and tide
- waves: extreme wave conditions, breaking waves, abnormal waves, fatigue wave loads
- currents
- wind
- temperature
- air and water density
- ice and snow, if applicable
- marine growth
- soil data
- scour and morphodynamic data
- earthquake, if applicable
- geophysical risks.

Storm surge and sea level rise may also have to be accounted in design and addressed in site condition assessment. This may be added in a note.

1.4.3 Design requirements

- air gap
- limit states: ULS, SLS, FLS and ALS
- partial factors
- construction constraints
- corrosion allowance.

1.4.4 Design procedures

- material specifications
- corrosion protection system
- in-place analyses
- fatigue analysis
- dynamic analyses: natural frequency and vortex analyses
- lifting analysis
- loadout analysis
- transportation analysis
- installation analysis
- foundation analysis
- accidental condition analysis
- seismic design analysis, if applicable
- other structural parameters: Stress Concentration Factors (SCF), Dynamic Amplification Factor (DAF) and Joint Flexibility (JF).

2 Materials and corrosion protection

2.1 Materials

2.1.1 General

Materials are to be selected in accordance with design requirements and are to be suitable for marine environment. Selection is to be suitable with reference to local corrosion phenomena in order to avoid electro-potential degradation of the material. This is to be particularly accounted when selecting alloy steel, stainless steel or other metallic materials connected to the mild steel structure.

Particular attention is to be made for stainless steel for their suitability under marine environment or under cathodic protection to avoid local corrosion effects such as crevices corrosion.

2.1.2 Structural steel

Structural steels are to be in accordance with the requirements of NR216 Rules on materials and welding for the classification of marine units or the material requirements in ISO 19902, clause 19, or equivalent.

Mill certificates or certified reports of tests made by the fabricator or a testing laboratory in accordance with the Society requirements, may constitute evidence of conformity with the specification.

2.1.3 Other metallic materials

Metallic materials, other than steel, are to be of a type suitable for use in a marine environment, and are to be specified following recognised standards. Material requirements may be found also in NR216 Rules on materials and welding for the classification of marine units.

2.1.4 Grout material

Grout material selection is to meet requirement from ISO 19902 clause 19.6.

2.2 Corrosion protection

2.2.1 General

The metallic structure of the OSS is to be effectively protected against corrosion damage using either one or a combination of the following methods:

- cathodic protection
- application of protective coatings.

The corrosion protection system should be selected in accordance with EN 12495 or NI 423 Corrosion protection of steel offshore units and installation.

3 Air gap

3.1 Requirements

3.1.1 Deck elevation

A safety margin, or air gap, of at least 1,5 m should be added to the crest elevation to allow for platform settlement, water depth uncertainty, and for the possibility of extreme waves in order to determine the minimum acceptable elevation of the bottom beam of the lowest deck to avoid waves striking the deck. An additional air gap should be provided for any known or predicted long term sea-floor subsidence.

3.1.2 Wave-in-deck load

If the air gap condition is not met, wave-in-deck loads should be included in the extreme environmental design load.

4 Design loads

4.1 General

4.1.1 The OSS is designed to withstand all loads covering the different stages of its service life and relevant for the site of its operation.

4.1.2 The loads are classified in accordance with ISO 19900.

4.2 Pre-service loads

4.2.1 Pre-service design situations

Loads on the structure are to be calculated for the following phase of the pre-service:

- loadout
- transportation
- installation.

4.2.2 Loadout

There are two main types of loadout operations each of which resulting in different loads on the substation structure

a) direct lift loadout operation where the structures are lifted onto the transportation vessel

b) skidded loadout operation where the structures onto the transportation barge are subjected to loads resulting from horizontal and/or vertical movement of the barge due to tidal fluctuations, nearby marine traffic, environmental conditions and/or changes in draught, as well as loads derived from the location, slope, and/or settlement of supports onshore and the flexibility of the barge, at all stages of the skidding operation.

4.2.3 Transportation

Loads on a structure or structural part during transportation on barges is to be considered in the design of the structure. Such loads result from the response of the towing arrangement (structure, tugboats, tow lines) to environmental conditions encountered en route to the site.

4.2.4 Installation

The installation operations of a fixed steel OSS include the following steps:

a) lifting or launching the substructure from the transport barge
b) upending the substructure in air or in sea water
c) setting the substructure to the vertical position on the sea-floor
d) piles installation (e.g. piles hammering)
e) topsides lifting and positioning on the substructure.

4.2.5 Load combinations for pre-service design

The temporary load conditions occurring during load-out, transport, installation are to consider combinations of dead loads, maximum variable loads and appropriate environmental loads.

The dead loads include the weight of structural components, appurtenances and equipment and the variable loads include the weight of temporary components, such as buoyancy aids, mooring supports or sea fastenings attached to the structure for pre-service.

The type of loads to be considered for the pre-service design situations and their evaluation methods are to follow requirements from ISO 19902, clause 8.

4.3 Loads for in-place situations

4.3.1 Permanent loads

The type of loads included in this category are:

a) the load imposed on the structure by the self weight of the structure, including:
   - weight of the structure in air (e.g. weight of piles, grout and solid ballast)
   - weight of equipment and other objects permanently mounted on the structure whatever the mode of operation
   - hydrostatic actions acting on the structure below the waterline and resulting buoyancy.
b) the load imposed on the structure by the self weight of equipment and other objects that remain constant for long periods of time, but which can change from one mode of operation to another or during a mode of operation (e.g. living quarters, heliport and other life-support equipment; driving equipment and utilities equipment).

4.3.2 Variable loads

The type of loads included in this category are:

a) the load imposed on the structure by the weight of consumable supplies, the weight of transportable vessels and containers used for delivering supplies, and the weight of personnel and their personal effects. Where appropriate, the weight of marine fouling and ice must be included. The weight of scaffolding or other temporary access systems used during operations and maintenance of the platform should also be included
b) the short duration load imposed on the structure from operations, such as lifting by cranes, machine operations, helicopters and life saving appliance operations.

4.3.3 Operational environmental loads

Operational environmental load conditions are those, which are not severe enough to restrict normal platform operation. They represent a moderately severe condition at the platform location: typically, a 1-year return period wave, current and wind is to be used for operational environmental load.

The methods for determine the operational environmental loads are described in [4.5.1].

4.3.4 Extreme environmental loads

The extreme environmental loads that are considered for the design are the following:

- extreme quasi-static load due to wind, waves and current
- extreme quasi-static load caused by waves only or by waves and currents
- loads caused by current only
- loads caused by wind
- equivalent quasi-static load representing dynamic response caused by extreme wave conditions.

The methods for evaluation of the extreme environmental loads are described in [4.5].

4.3.5 Loads combinations

The design of the OSS is to consider loads conditions defined by the following loads combinations:

a) operational environmental load combined with permanent loads and maximum variable loads appropriate to normal operation of the platform
b) operational environmental load combined with permanent loads and minimum variable loads appropriate to normal operation of the platform
c) extreme environmental load combined with permanent loads and maximum variable loads appropriate for combination with extreme environmental condition
d) extreme environmental load combined with permanent loads and minimum variable loads appropriate for combination with extreme environmental condition.

When directional wave, current and wind are used, each direction of the operational and environmental loads is to be considered. Thus, when the minimum of 8 directions are involved, at least 32 loads combinations are to be investigated.

4.4 Accidental loads

4.4.1 General

The accidental load situations that are faced by an offshore structure include:

- vessel collisions
- dropped objects
- fires and explosions.

For the purpose of checking the structure design under accidental loads, two main design situations are to be considered:

- the accidental loads under consideration
- post damage design situation.

The post damage design situation is only necessary if the strength of the structure is reduced by the structural damage caused by the accidental load.

The requirements for damage tolerance depend on the environmental conditions in the geographic area, regulatory requirements, and the owner's specifications. Examples of such requirements are set out in ISO 19902 Subclause 7.10.

4.4.2 Vessel collision

For the assessment of vessel impact load, all operations in the platform vicinity are to be taken into account (e.g. vessels servicing the platform, fishing vessels working in the area, and passing vessels).

Two types of vessel collisions are to be addressed:

- extreme vessel collision representing a rare event, based on the type of vessel that would operate in the platform vicinity, drifting out of control in the worst sea state in which it would be allowed to operate close to the platform
- operational vessel collision representing the most frequent condition, based on the type of vessel that would routinely approach alongside the platform (e.g. a supply boat) and that would have a velocity representing normal manoeuvring of the vessel approaching, leaving, or standing alongside the platform.

The collision loads are to be established using an impact analysis which is to account for the vessel's mass, its added mass, orientation and velocity, representing normal manoeuvring of the vessel approaching, leaving, or standing alongside the platform.

The vertical height of the impact zone is to be established, based on the dimensions and geometry of the structure and the vessel, and is to account for tidal ranges, operational sea state restrictions, vessel draught, and motions of the vessel.

Depending on the probability of collision and the consequences for the structural integrity of the structure, a rigorous impact analysis can be required. In this case, accidental design situations is to be established representing bow, stern and beam-on impacts on all exposed components, and a dynamic time simulation is to be used.

Details on the evaluation of the collision loads are provided in ISO 19902, clause 10.

4.4.3 Dropped object

Relevant dropped object loads are to be defined and evaluated based on the nature of all crane operations in the platform vicinity.

Depending on the risk of collision, the need for a rigorous impact analysis is to be determined.

4.4.4 Fires and explosions

ISO 19901-3 contains specific requirements for topsides structure for fires and explosions.

4.5 Estimation of environmental loads

4.5.1 Typical procedure for quasi-static load caused by waves only or by waves and currents

The procedure for estimating the quasi-static load caused by waves and current assumes negligible distortion of the incident wave by the structure and negligible dynamic structural response.

This procedure is as follows:

a) Determine the intrinsic wave period, taking into account the Doppler effect of the current on the wave length and period, in accordance with ISO 19901-1.

b) Determine the two-dimensional wave kinematics for the specified wave height, storm water depth, and intrinsic period, using an appropriate wave theory.

c) The horizontal components of the wave induced water particle velocities and accelerations may be reduced by the wave directional spreading factor.

d) Determine the effective local current profile by multiplying the specified current profile by the current blockage factor.

e) Determine the locally incident fluid velocities and accelerations for use in Morison's equation by vectorially combining the effective local current profile from step d) after stretching it to the instantaneous water surface elevation with the wave kinematics from step c).

f) Increase the member diameters to account for marine growth.

g) Determine drag and inertia coefficients for use in Morison's equation in accordance with the relevant wave and current parameters, as well as member shape, size, orientation and roughness (including marine growth). Typical values of these coefficients are given in ISO 19902, clause 9.

h) Determine hydrodynamic models for loads appurtenances in accordance with ISO 19902, clause 9.

i) Calculate local loads caused by waves and current for all structural components and appurtenances using Morison's equation, taking the requirements of steps e) to h) into account.

j) Calculate the extreme global load caused by waves and current as the vector sum of all the local loads from step i).

Table 1 : Shape coefficients for perpendicular wind approach angles

Component		Shape coefficient CS
Flat walls of buildings		1,50
Overall projected area of structure		1,00
Beams		1,50
Cylinders	Smooth (Reynolds number Re > 5 10^5)	0,65
	Smooth (Reynolds number Re < 5 10^5)	1,20
	Rough (all Reynolds number)	1,05
	Covered with ice (all Reynolds number)	1,20

4.5.2 Loads caused by current only

Where current acts alone, the local load due to current can be calculated in accordance with the procedure in [4.5.1] (as far as relevant) by putting the component of the local water particle acceleration in the Morison equation to 0.

Where current acts together with waves, the current velocity should be stretched and vectorially added to the wave particle velocity before the total local load due to waves and current is calculated.

4.5.3 Loads caused by wind

The wind load on an object is given by the following basic equation:

$$F = \frac{1}{2}\rho_a U_w^2 C_S A$$

where

F : Wind load on the object

ρ_a : Mass density of air (at standard temperature and pressure)

U_w : Wind speed

C_S : Shape coefficient

A : Projected area of the object.

The wind velocity, vertical wind profile and time averaging duration in relation to the dimensions and dynamic sensitivity of the structure's components is to be determined in accordance with ISO 19901-1.

Increased exposure area if applicable (due to ice for example) is to be taken into account in estimating the area to be used.

In the absence of data indicating otherwise, the shape coefficients given in Tab 1 are recommended for perpendicular wind approach angles with respect to each projected area.

In the special cases where dynamic response to wind load is significant, this is to be taken into account in accordance with ISO 19901-1.

Computational models are to be used when wind loads are important for the structural design.

The extreme quasi-static global load caused by wind is to be calculated as the vector sum of the above wind loads on all objects.

4.5.4 Equivalent quasi-static load for dynamic response caused by extreme wave conditions

See [4.6.7].

4.5.5 Direction of waves, wind and current

Directional sectors should generally not be larger than 45°.

A minimum of 8 directions are to be used for symmetrical, rectangular, and square platforms, and a minimum of 12 directions are to be used for tripod jackets. For unsymmetrical platforms or structures with skirt piles, the calculation of the environmental forces from additional directions may also be required.

When different approach directions may occur for wind, waves and/or current magnitudes, the environmental conditions should be scaled up such that the most severe directional sector is no less severe than the omni-directional condition.

When reliable directional data are not available, the directions of the wind, waves and current are to be assumed to coincide when determining the environmental load.

4.6 Additional considerations on design loads

4.6.1 Extreme global environmental loads

The extreme global environmental loads given by the total base shear and overturning moment are calculated by a vector summation of:

- local hydrodynamic drag and inertia loads due to waves and currents integrated over the whole structure
- dynamic amplification of wave and current loads (see [5.4.7])
- loads on the structure and the topsides caused by wind.

4.6.2 Extreme environmental loads for the local design of structural components

In local design of components it is to be considered that:

- maximum local loads can be caused by environmental loads different in magnitude and direction from those causing global extreme loads
- slamming loads on horizontal components and slapping loads on inclined components can occur.

4.6.3 Extreme quasi-static load due to wind, waves and current

ISO 19902, clause 9 allows three approachs to be used for defining an environment that generates the extreme direct load and the extreme load effect, caused by the combined extreme wind, wave and current conditions:

a) 100 year return period wave height (significant or individual) with associated wave period, wind and current velocities

b) 100 year return period wave height and period combined with the 100 year return period wind speed and the 100 year return period current velocity, all determined by extrapolation of the individual parameters considered independently

c) any reasonable combination of wave height and period, wind speed and current velocity that results in
   - the global extreme environmental action on the structure with a return period of 100 years
   - or a relevant action effect (global response) of the structure (e.g. base shear or overturning moment) with a return period of 100 years.

The approach a) is suitable when the environmental load is dominated by wave. The approach b) provides a conservative estimate the extreme environmental load where joint probability information for the environmental conditions is not available. The most general approach for correctly estimating extreme environmental load due to combinations of waves, wind and current is the method c).

4.6.4 Vortex-Induced Vibration

All slender members are to be investigated for the possibility of in-line and/or cross-flow vibrations due to vortex shedding resulting from the flow of water or air past the member, as appropriate.

4.6.5 Lifting load

The magnitude of the lifting load is to be based on the weight of the (part of the) structure to be lifted and is to be determined considering static and dynamic equilibrium during the lift.

Guidance for determining design lifting load is provided in ISO 19901-6 Subclause 18.3.

4.6.6 Weight control

During the design situations, the behaviour of the structure and the distribution of the load effects can be sensitive to the distribution of the weight in the structure and the position of the centre of gravity (CoG). Therefore, the weight and the CoG of the structure or part of the structure are to be evaluated for all design situations.

Requirements for controlling weight and CoG are presented in ISO 19901-5.

4.6.7 Dynamic effects

Dynamic effects which may be caused by the applied loads or the structure's motion, are to be considered when they are significant.

The following design situations may cause dynamic effects:

a) Lifting

   The dynamic effects due to lift loads, the resulting motion of the crane or the lifted element are to be accounted for by the use of the relevant dynamic amplification factor specified in ISO 19901-6, Table 15

b) Extreme metocean loads

   Jacket structure with fundamental natural periods or having one or more components with natural periods greater than 2,5 s to 3 s usually respond dynamically to wave action during in-place situations. This dynamic effect can be accounted for by:
   - the use of a DAF on the quasi-static base shear (see [5.4.7]) when dynamic effects remain limited in magnitude
   - a dynamic analysis otherwise.

c) Accidental loads

   Impact, explosion and seismic event can cause dynamic effects of significant magnitude. They can be accounted for using a time-domain dynamic analysis.

4.6.8 Loads with varying position and magnitude

Where loads positions can move and/or their magnitudes can vary, it is conservative to apply the maximum values over the whole area of their influence.

5 Structural strength

5.1 Design criteria

5.1.1 Minimum strength against a simple load

The requirement for the strength of tubular members or tubular joints subjected simple loads (e.g. tension, compression, bending,...) is given in general form by:

$$S \leq \frac{R}{\gamma_R}$$

where R is the strength of the structural component, γ_R is the strength partial factor (see [6.2]) and S is the internal force resulting from the factored design loads (see [6.3]).

5.1.2 Utilization ratio

The strengths of tubular members and joints are checked using the utilization ratio, which is the maximum absolute value of the ratio of the factored load effects to the factored representative strength for all design situations being considered.

Only utilizations smaller than or equal to 1 satisfy the design criteria for a particular limit state.

5.2 Strength of tubular members

5.2.1 Members utilization factors

The equations from which the utilization ratio of the structural members is to be determined are set out in ISO 19902 Clause 13.

5.2.2 Types and combinations of loads

The requirements address the following types of loads:

- axial tension
- axial compression
- bending
- shear
- hydrostatic pressure.

The following combinations of loads are also addressed:

- axial tension and bending without hydrostatic pressure
- axial compression and bending without hydrostatic pressure
- axial tension and bending with hydrostatic pressure
- axial compression and bending with hydrostatic pressure.

For another particular load or internal force component, the strength is to be assessed on a case-by-case basis.

5.3 Strength of tubular joints

5.3.1 General requirements

a) The chord material is to have adequate through-thickness toughness to avoid possible cracking or lamellar tearing from large strain concentrations due to welds from several brace connection in close proximity.

b) Chord cans are to have a minimum axial capacity of at least 50% of the effective strength of each incoming brace for each design situation (e.g. in-place, load-out, etc).

c) For earthquake loads, the chord can capacity is to be at least 100% of the brace effective strength of each incoming brace for in-place situation (the effective strength of a brace is defined as the representative yield strength for braces where the axial component is tensile or the compression buckling strength where the axial component is compressive).

d) Welds in fabricated joints are to be designed to develop a strength at least equal to both the yield strength of the nominal brace cross section and the full strength of the joint.

5.3.2 Joint classification

There are three basic planar joint types, namely Y-, K- and X-joints. Any joint is to be classified as combination of these basic joint types following the process described in ISO 19902, Subclause 14.2.4.

For the braces of any joint with a mixed classification, the strength is to be calculated by weighting the contributions from Y-, K- and X-joint behaviour by the proportions of that behaviour in the joint.

5.3.3 Joints utilization ratio

The equations from which the utilization ratio of the structural joints is to be determined are set out in ISO 19902 Clause 14.

The strength of most joints can be determined from the strengths of the three basic planar joint types.

The strengths of the basic tubular joints subjected to axial brace forces or moments only are to be calculated for each brace, for each individual force component of tension, compression, in-plane bending and out-of-plane bending, and for each load case consisting of a combination of forces. They are to be calculated using the parametric formulae given in ISO Subclause 14.3.

5.4 Structural modelling and analysis

5.4.1 Purpose

The structural modelling and analysis are performed to assess the load effects, including:

- internal section forces, which must not exceed the allowable strength
- displacements and vibrations, which must remain within acceptable limits for operation of the structure
- support reactions, from which the required foundation capacity can be determined.

5.4.2 Extent of analyses to be performed

Extent of analyses to be performed for this certification scheme should cover the pre-service and in-place stages of the lifetime of the structure.

5.4.3 Calculation methods

Various calculation methods may be used including, hand calculations and computer methods, such as spreadsheet, finite element analysis (FEA).

Where FEA is performed, consideration must be given to the type and accuracy of the element formulations, to ensure that sufficient elements are used to predict the structural behaviour, particularly in areas where the load effects change rapidly.

5.4.4 Modelling requirements

The modelling of a structure, its structural components, their interactions and support conditions for the purpose of structural analysis should follow the requirements given in ISO 19902 Subclause 12.3.

5.4.5 Types of analysis

The types of analysis to be performed include:

a) Natural frequency analysis:

It aims at checking whether dynamic behaviour is significant. It assesses the natural frequencies of the structural system and compares it to the frequencies of any excitations. Dynamic behaviour is likely to be significant if any natural frequency is similar to the frequency of an excitation.

b) Static analysis:

Static analysis is appropriate when dynamic effects are minimal and can be assumed to be covered by the partial load and strength factors.

c) Quasi-static linear analysis:

It is appropriate when dynamic effects can be assumed to be approximately uniform throughout the structural systems and so small that one static analysis or a series of static analyses, with a small correction for dynamic effects (e.g. DAF see [5.4.7]), is adequate.

d) Dynamic linear analysis:

It is required when dynamic response is considered significant. The type of dynamic linear analysis to be performed depends on the form of the applied loads:

- spectral analysis requires harmonic loads
- transient analysis for arbitrary time-history loads (e.g. accidental loads and waves or earthquake induced non-linear loads).

For both types of analysis, the behaviour of the structure and the foundation are assumed to be linear elastic.

e) Non-linear analysis:

It may be performed when, for example, the structure is subjected to abnormal environmental loads due to wind, wave and current or an earthquake, or to accidental loads from ship impact, fire, and when a linear analysis predicts:

- displacements of a magnitude that are likely to cause P-Δ effects (second order bending effect due to axial compressive force, P, and lateral deflection, Δ)
- joint failure
- member buckling
- stresses that exceed the yield strength of the material.

Requirements applicable to the modelling and the analyses specific to each type of analysis are given in ISO 19902 Subclause 12.5.

For the non-linear soil-structure interaction, the foundations are to be modelled with T-Z and P-Y curves given in ISO 19901-4 subclauses 8.4 and 8.5 respectively.

5.4.6 Applicability of the analysis types

a) Pre-service situations:

- for loadout and installation, static linear elastic analysis is adequate
- for sea transportation or towing, quasi-static analysis representing the motion of the structure due to the most onerous combination of heave, sway, surge, pitch and roll acceleration, may be applied
- for installation, quasi-static analysis employing representative loads to cover motions of the structure and crane vessel, load due to “snatching” as structure is lifted off the barge and due to impact between structure and sea floor, etc
- for pre-service conditions after landing, prior and during pile driving, the provisions of b) below apply.

b) In-place situations:

For in-place situation analysis can generally be based on:

- a static analysis
- quasi-static analysis where dynamic behaviour is likely to be significant (see [5.4.5]), using a linear elastic model of the structure coupled with a non-linear foundation model
- dynamic linear analysis where there is a likelihood of significant dynamic or non-linear response to a given type of load.

c) Fatigue analysis (see Article [7]).

d) Accidental situations:

Linear elastic redundancy analysis may be used to demonstrate that removal of a damaged member does not initiate progressive collapse. Non-linear analysis may be used to simulate the redistribution of load effects as section resistances are exceeded. The global analysis may be based on a simplified representation of the structure that is sufficient to simulate progressive collapse.

e) Seismic situations (see Article [9])

Further requirements on the analysis to be performed at each phase of the design lifetime of the structure are provided in ISO 19902 Subclause 12.4.

5.4.7 Dynamic amplification factor (DAF)

The DAF, k_{DAF} is calculated for a single degree of freedom for each frequency of excitation within a range of frequencies for which some influence of dynamic effects is expected to occur:

$$k_{DAF}(\omega_e) = \frac{1}{\sqrt{(1-\Omega^2)^2 + (2\cdot\xi\cdot\Omega)^2}}$$

where

$\Omega = \omega_e / \omega_n$

ω_e : Frequency of excitation for which a static analysis is performed

ω_n : Relevant natural frequency of the structural system, or structural part, that is responsible for the dynamic effect

ξ : Damping ratio associated with the dynamic effect

k_{DAF} should not be smaller than 1 which corresponds to:

$\Omega \leq \sqrt{2}$

6 Partial factors

6.1 General

6.1.1 LRFD method

The design of the OSS is to follow the load and strength factor design (LRFD) method.

6.1.2 Factored design loads

The factored design loads is given by:

$$F_d = \sum_i \gamma_i F_i$$

where F_i are the representative values of the different types of loads and γ_i are their respective partial factors.

6.1.3 Factored design strength

The factored design strength of tubular members or tubular joints is given in general form by:

$$R_d = \frac{R}{\gamma_R}$$

where R is the representative value of the strength of the structural component, γ_R is the strength partial factor.

Table 2 : Strength partial safety factors.

Component	Load	Partial safety factor
Tubular member	Axial tension	1,05
	Axial compression	1,10
	Bending	1,05
	Shear	1,05
	Hydrostatic pressure	γ_{G1} or γ_{fT} **(1)**
	Hoop buckling	1,25
Grouted tubular member	Axial tension	1,05
	Axial compression	1,18
	Bending	1,05
Tubular joint	Axial tension	1
	Bending	1
All	Fatigue	1

(1) For installation conditions.

Table 3 : Partial factors of loads for pre-service design

	$\gamma_{f,GT}$	$\gamma_{f,QT}$	$\gamma_{f,T}$
Situation 1 **(1)**	1,3	1,3	1,0
Situation 2	1,1	1,1	1,35
Situation 3	0,9	0,9	1,35

(1) Situation 1 governs for components in which permanent and variable load effects are dominant. Situation 2 governs for components in which transient load effects are dominant and in which the permanent and variable loads increase the magnitudes of the internal forces. Situation 3 governs for components in which transient load effects are dominant but in which the permanent and variable loads decrease the magnitudes of the internal forces

Table 4 : Partial safety factors of load for in-place situation.

Design situation **(1)**	$\gamma_{f,G1}$	$\gamma_{f,G2}$	$\gamma_{f,Q1}$	$\gamma_{f,Q2}$	$\gamma_{f,Eo}$	$\gamma_{f,Ee}$
Permanent and variable loads only	1,3	1,3	1,5	1,5	0,0	0,0
Operating situation with corresponding wind, wave, and/or current conditions **(2)**	1,3	1,3	1,5	1,5	0,9 $\gamma_{f,E}$	0,0
Extreme conditions when the load effects due to permanent and variable loads are additive **(3)**	1,1	1,1	1,1	0,0	0,0	$\gamma_{f,E}$
Extreme conditions when the load effects due to permanent and variable loads opposed **(4)**	0,9	0,9	0,8	0,0	0,0	$\gamma_{f,E}$
Fatigue loads	1	1	1	1	1	1

(1) A value of 0 means that the load is not applicable to the design situation
(2) For this, check that G2, Q1 and Q2 are the maximum values for each mode of operation
(3) For this, check that G1, G2 and Q1 include those parts of each mode of operation that can reasonably be present during extreme conditions.
(4) For this, check that G2 and Q1 exclude any parts associated with the mode of operation considered that cannot be ensured of being present during extreme conditions.

6.2 Material / Strength partial safety factors

6.2.1 General

The partial safety factors provided by ISO 19902 for the strength of the tubular members and tubular joints either made of steel material or grouted material should be used for the verification of OSS structural components (see Tab 2).

For accidental situation accounting for accidental events or abnormal environmental loads, all partial strength factors may be set to 1.

For the design of piles for the extreme level earthquake (ELE) event, a partial strength factor of 1,25 must be used to determine the axial pile capacity and a partial strength factor for the p-y curves of 1,0 must be used to determine the lateral pile performance.

Alternatively, the partial factors given in Eurocode ENV 1993-1 could be used for steel structures.

ENV 1992-1 provide also partial factors to be used for grouted material.

6.3 Design loads partial safety factors

6.3.1 Partial load factors for pre-service design

The design load for pre-service load is given in accordance with ISO 19902, clause 8, by the following equation:

$$F_d = \gamma_{f,GT} G_T + \gamma_{f,QT} Q_T + \gamma_{f,T} T$$

where

- G_T : The load imposed by the self-weight of the structure during the transient situation being considered, including any permanent equipment or other objects and any piles installed on the structure, as well as any ballast installed in or carried by the structure
- Q_T : The load imposed by the weight of the temporary equipment or other objects, including any rigging installed or carried by the structure, during the transient situation being considered
- T : The loads from the transient situation being considered, including environmental loads and dynamic effect when appropriate and:
  - for lifting, the effects of fabrication tolerances and variances in sling length
  - for loadout, allowances for misalignment
  - for transportation, any hydrostatic and hydrodynamic loads on the structure, including any inertial loads resulting from accelerations of the structure
  - for installation, the lifting loads and hydrostatic pressure loads on the structure.

$\gamma_{f,GT}$, $\gamma_{f,QT}$, $\gamma_{f,T}$:Partial load factors given in Tab 3.

6.3.2 Load partial factors for in-place situation

The partial safety factors for the loads are based on ISO 19902 requirements.

For in-place situations, the design load is given by the following equation in terms of the different types of loads involved and their respective partial safety factors given in Tab 4:

$$F_d = \gamma_{f,G1} G_1 + \gamma_{f,G2} G_2 + \gamma_{f,Q1} Q_1 + \gamma_{f,Q2} Q_2 + \gamma_{f,Eo}(E_o + \gamma_{f,D} D_o) + \gamma_{f,Ee}(E_e + \gamma_{f,D} D_e)$$

where:

- G_1,G_2 : Permanent loads defined in [4.3.1]
- Q_1,Q_2 : Variable loads defined in [4.3.2]
- E_o : Environmental load due to owner-defined operating wind, wave and current parameters
- D_o : Quasi-static load equivalent to dynamic response caused by wave condition of E_o
- E_e : Extreme quasi-static load due to wind, wave and current defined in [4.6.3]
- D_e : Duasi-static load equivalent to the dynamic response caused by extreme wave conditions
- $\gamma_{f,G}$,$\gamma_{f,Q}$: Partial load factors for the various permanent and variable loads
- $\gamma_{f,Eo}$,$\gamma_{f,Ee}$: Partial load factors applied to the total quasi-static environmental load plus quasi-static load equivalent to dynamic response for operating and extreme wave conditions.
- $\gamma_{f,E}$,$\gamma_{f,D}$: Partial load factors for environmental loads with: $\gamma_{f,E}$ = 1,35 and $\gamma_{f,D}$ = 1,25.

6.3.3 Partial factors for accidental situation

For accidental situation accounting for accidental events or abnormal environmental loads, all partial load factors may be set to 1.

7 Fatigue design

7.1 Fatigue loads

7.1.1 General

The main fatigue loads on the OSS are:

a) wave loads in the in-place situation, which is the predominant source of fatigue damage

b) wave loads arising during the tow of the substation from the fabrication yard to the in-place location

c) dynamic loads as a result of the pile driving during installation.

The loads are not the direct input in the fatigue assessment but the stress range due to a full load cycle. The resulting stress cycle at a particular location consists of contributions from an axial and a bending stress cycle.

7.1.2 Description of the long-term wave loads condition

The wave loads are characterised by the hydrodynamic load variations over the design service lifetime due to the wave environment. The procedure for computing the hydrodynamic load variations is the same as the one described in [4.5.1] but uses different parameter values.

The wave environment is described with respect to its short-term and long-term conditions.

- The short-term condition is the stationary state in a statistical sense of the sea and it is referred to as a sea state. It can be realistically described by a theoretical model in the form of a wave spectrum.
- The long-term condition describes the changing states of the sea and therefore consists of a succession of sea states. It is suitably described by a scatter diagram which is an empirical representation of the joint probability density of the sea state's parameters, namely the significant wave height, a representative wave period and the mean wave direction.

Alternatively, the long-term wave environment can be specified by the long-term statistical distribution of the individual wave heights, which is derived from the wave scatter diagram.

The requirements to be applied, in specifying the long-term wave environment whether by a scatter-diagram along with a wave spectrum or by the statistics of the individual waves, are provided in ISO 19902 Subclause 16.3.

7.1.3 Fatigue loads design situations

The fatigue loads are to be evaluated and fatigue assessment is to be undertaken for all the structural locations that are sensitive to fatigue (e.g. welded connections, connections joined by other means than welding, attachments, structural discontinuities, and structural locations where some form of stress concentration is present).

The fatigue wave loads are to be computed for a sufficient number of wave directions to adequately capture the influence of wave direction on local stress variations. For typical steel frame structures a minimum of 8 to 12 directions are to be considered.

7.2 Determination of the long-term stress range history

7.2.1 General

Structural modelling and stress analysis for fatigue assessment should follow guidance given in ISO 19902 Subclause 16.4.

7.2.2 Partial load factor

In determining stress variations for a fatigue analysis, the partial load factors are to be taken as 1.

7.2.3 Long-term stress range history

The long-term stress range history is determined from the short-term distribution of the stress range for each individual sea state. Then to account for the long-term situation, this short-term distribution is weighted by the joint probability of occurrence the associated sea state.

The short-term distribution of the stress range can be obtained by:

a) a spectral analysis method, where the sea state is represented by a wave frequency spectrum and the a stress response is obtained from a stress transfer function

b) a deterministic method using a direct computation of the stress responses due to the individual periodic waves.

Guidance for implementing the spectral method and the deterministic method are given respectively in ISO 19902 Subclauses 16.7 and 16.8.

7.2.4 Stress concentration factors

The stress to be used to evaluate fatigue damage at any structural location where local stress concentration may occur (e.g. weld, attachment, etc) is the geometric stress range (GSR). The GSR at specific locations of the area of interest is determined by multiplying the nominal stress component computed at the member's end with a SCF.

The SCF may be derived from FEA, model tests or empirical equations.

For welded tubular joints subjected to all three types of variable forces and moments, a minimum SCF of 1,5 should be used. For ring-stiffened joints, the minimum SCF for the brace side of the weld and brace axial forces or brace out-of-plane bending moments should be taken as 2,0.

Further requirements on SCF can be found in ISO 19902 Subclause 16.10.

7.3 Fatigue strength

7.3.1 S-N curve

The fatigue strength of the material is represented by a so called S-N curve of the form:

$$\log N = \log k - m \log S$$

where

- N : Predicted number of cycles to failure under constant amplitude stress range S
- k : Parameter of the S-N curve
- m : Another parameter of the S-N curve representing the inverse slope of the curve
- S : Constant amplitude stress range S.

For some fatigue details, the values of the parameters k and m change beyond a certain number of cycles to failure, which thus results in a two slopes S-N curve.

7.3.2 Partial strength factor

The partial strength factor on the fatigue resistance is to be taken as 1.

7.3.3 Representative S-N curves

The representative S–N curves to be used are the mean minus two standard deviations in logN from the database of test results. The corresponding parameters values are given in ISO 19902 Subclause 16.11 with respect to the class of steel material and some types of fatigue details and they are applicable in both air and sea water media (with adequate corrosion protection).

7.4 Fatigue damage assessment

7.4.1 Cumulative damage

Fatigue damage assessment is based on the hypothesis of a linear accumulation of fatigue damage under constant amplitude stress ranges, according to the Palmgren-Miner rule:

$$D = k_{LE} \gamma_{FD} \cdot \sum_i \frac{n_i}{N_i}$$

where

- D : Accumulated damage ratio for a given period of time
- k_{LE} : Local experience factor, which account for the actual experience with existing structures
- γ_{FD} : Fatigue design factor (see Tab 5)
- n_i : Number of cycles of stress range S_i occurring in the given period of time
- N_i : Number of cycles to failure under constant amplitude stress range S_i taken from the relevant S-N curve (see [7.3]).

The local experience factor can be larger or lower than 1, the default value being 1. It intends to apply trends on the fatigue damage of similar existing structure in order to reduce the considerable uncertainties that affect the fatigue assessment.

Table 5 : Fatigue design factor

Failure Critical	Inspectable	Not Inspectable
No	2	5
Yes	5	10

7.4.2 Fatigue life

The fatigue life L is derived from the fatigue damage D by:

$$L = \frac{T}{D}$$

where T is the time period over which D was calculated.

8 Foundation design

8.1 General

8.1.1 This article addresses the design of pile foundations and shallow water foundations.

8.1.2 The foundation of the OSS is to be designed with regards to the provisions and requirements in NI605, Sec 3 or requirements and recommendation in ISO 19901-4.

8.2 Pile foundations

8.2.1 Types of pile foundation

The types of pile foundation used to support OSS and considered in this article are:

- driven piles
- drilled and grouted piles
- belled piles, and
- vibro-driven piles.

Requirements specific to their design are provided in the Subclause 17.2 of the ISO19902.

8.2.2 Pile capacity

The pile capacity is the lower of the pile strength and the pile axial resistance in soil.

The pile strength should be verified using the steel tubular strength checking whether the strength requirements for combined axial force and bending without and with hydrostatic pressure are satisfied (see [5.2]).

The equations to be applied for pile axial resistance in soil especially under axial compression and axial tension are set out respectively in Subclauses 17.4 and 17.5 of the ISO 19902.

8.2.3 Soil reaction for piles

The equations for the assessment of soil reactions for piles under axial compression and piles under lateral loads are given with respect to the types of soil in Clause 8 of the ISO19901-4.

8.3 Shallow foundation

8.3.1 Detailed requirements on the design of shallow foundations, such as mudmats, is contained in ISO 19901-4.

9 Seismic design

9.1 General considerations

9.1.1 Where applicable, loads due to earthquake are to be considered.

9.1.2 The procedures in ISO 19901-2 for design against seismic events should be followed.

9.1.3 As outlined in ISO 19901-2, a two-level seismic design procedure should be followed:

a) the structure should be designed to the ULS for strength and stiffness when subjected to extreme level earthquake (ELE), from which it should sustain little or no damage

b) the structure is next checked when subjected to abnormal level earthquake (ALE) to ensure that it meets reserve strength and energy dissipation requirements, and from which it may sustain considerable damage.

9.2 Seismic design procedures

9.2.1 Procedure selection

ISO 19901-2 gives many alternative procedures for determining seismic loads and many alternative methods of evaluation of seismic activity. The selection of the procedure and the method of evaluation of activity depend on a structure's seismic risk category (SRC), which depends on the platform's exposure level and the seismic zone in which it stands.

9.2.2 Requirements

The design against seismic loads should comply with the ISO 19901-2 following requirements:

a) either the simplified seismic load procedure or the detailed seismic load procedure is to be used to determine seismic loads

b) either ISO maps, regional maps or a site-specific seismic hazard analysis is to be used to evaluate seismic activity and the associated response spectra for the design of a structure against excitation of its base by ground motions

c) demonstrate the ALE performance of the structure, which can require a non-linear analysis.

9.2.3 Seismic reserve capacity factor

Both simplified and detailed seismic load procedures require an estimate of the seismic reserve capacity factor, which represents a structure’s ability to sustain ground motions due to earthquakes beyond the level of ELE. It is defined as the ratio of spectral acceleration which causes structural collapse or catastrophic system failure to the ELE spectral acceleration.

Representative values of this factor are provided in ISO 19901-2 with respect to the characteristics of structure design.

9.3 Recommendations for ductile design

9.3.1 General

In seismically active areas, sufficient system redundancy is to be provided to ensure that structural foundations planned for such areas remain stable in the event of a rare, intense earthquake at the site.

9.3.2 Vertical frame configuration for seismic conditions

ISO 19901-2 gives recommendations for vertical frame configurations to provide redundancy system for seismic conditions.

9.4 ELE requirements

9.4.1 General

Design for ELE condition should follow requirements given in Subclause 9.1 of ISO19901-2.

9.4.2 Partial load factors

For seismic situation, the design load is given in the following equations:

$$F_d = \gamma_{S,G1} G_1 + \gamma_{S,G2} G_2 + \gamma_{S,Q1} Q_1 + \gamma_{S,E} E$$

where E is the inertia load induced by the ELE ground motion and G_1, G_2 and Q_1 are defined in [6.3.2]. The partial load factors to be applied are set out in Tab 6.

9.5 ALE requirements

9.5.1 General

Design for ALE condition should follow requirements given in Subclause 9.2 of ISO19901-2.

9.5.2 Partial load factors

The partial action factor to be applied for ALE situation on the foundation joints and members is 1 if required.

Table 6 : Partial factor for seismic load.

Component	Situation	$\gamma_{S,G1}$	$\gamma_{S,G2}$	$\gamma_{S,Q1}$	$\gamma_{S,E}$
Foundation joints and members	ELE	1,1	1,1	1,1	0,9
	ELE **(1)**	0,9	0,9	0,8	0,9
Topside **(2)**	ALE	1,1	1,1	1,1	1,15

(1) When contributions to the internal weight-induced forces oppose earthquake-induced inertia effects

(2) Safety critical structures of seismically sensitive topsides are to be designed against ALE event, but in lieu of performing an ALE analysis, they are to be designed with an increased partial load factor on E of 1,15 rather than 0,9.

SECTION 3 SAFETY

1 General

1.1 Scope

1.1.1 Safety objective

Safety aims at protecting the people present on the OSS from injuries and fatalities when an hazardous event occurs. This includes:

- minimizing the risks of occurrence and escalation of an hazardous event
- allowing people on board to leave safely the platform when a hazardous event happens.

1.1.2 Safety aspects covered

This section addresses safety requirements related to:

- the OSS general layout
- the means of access and escape
- the fire and explosion protection.

1.2 Documents to be submitted

1.2.1 General

The documents to be submitted for approval are:

- detail of the means of access and escape, escape route signage
- general arrangement plan showing the number and location of portable fire-fighting equipment and personal protection devices
- arrangement and technical specifications of the fixed fire detection and fire alarm system
- arrangement and technical specifications of fixed fire-extinguishing systems, see Note 1.

Note 1: Plans are to be schematic and functional and to contain all information necessary for their correct interpretation and verification such as:

- service pressures
- capacity and head of pumps and compressors, if any
- materials and dimensions of piping and associated fittings
- volumes of protected spaces, for gas and foam fire-extinguishing systems
- surface areas of protected zones for automatic sprinkler and pressure water-spraying, low expansion foam and powder fire-extinguishing systems
- capacity, in volume and/or in mass, of vessels or bottles containing the extinguishing media or propelling gases, for gas, automatic sprinkler, foam and powder fire-extinguishing systems
- type, number and location of nozzles of extinguishing media for gas, automatic sprinkler, pressure water-spraying, foam and powder fire-extinguishing systems.

All or part of the information may be provided, instead of on the above plans, in suitable operation manuals or in specifications of the systems.

The documents to be submitted for information are:

- risk assessment report: the document is to demonstrate the procedure that has been followed and the results that have been achieved
- risk assessment outcomes implementation report: standards or other specifications used to select protective measures referred should be referenced
- general substation layout showing the cable fixing point and direction, the helicopter landing area if any, boat landing area etc
- instruction handbooks for safe use of the machineries.

The Society reserves the right to request the submission of additional documents in the case of non-conventional design or if it is deemed necessary for the evaluation of the system, equipment or components.

The list of documents requested is intended as a guidance for the complete set of information to be submitted, rather than an actual list of titles.

1.3 Risk assessment

1.3.1 General

The Society may require a risk assessment covering the whole installation to be performed to demonstrate that the safety objective detailed in [1.1.1] is achieved. Then, the outcomes and provisions of the risk assessment and studies are to be submitted to the Society for information and to be implemented on the design and drawings which are listed in [1.2].

1.3.2 Technique

The risk assessment is to be carried out using recognized risk analysis techniques and is to cover fire scenarios in all spaces where a fire cannot be excluded. FMEA/FMECA or HAZID type analysis can be used for this purpose. Guidance on those techniques can be found in ISO 31010 or in NI 525 Appendix 1.

For each scenario, the means of escape for persons located on or inside the sub-station is to be considered and it is to be shown that the escape routes will remain available long enough for those persons to escape.

The risk assessment is to take into account the active or passive fire protection measures provided all along the escape routes.

1.3.3 Process

Risk assessment involves the following steps:

- identifying the hazard
- evaluating the risk
- introducing preventive and protective measures to reduce or eliminate the risk.

1.3.4 Hazards identification

Hazard identification is to take into account the following:

- the operations to be performed by the OSS equipment
- the tasks to be performed by persons who interact with them
- the different parts, mechanisms or functions of the OSS
- the materials to be processed, if any
- the environment in which the equipment can be used.

1.3.5 Risk estimation

Risk estimation is to be carried out for each identified hazard by determining:

a) the probability of occurrence of the hazard, taking into account:
   - accidental historical or statistical data
   - how often persons are exposed to the hazard.

b) the consequence of the hazard occurrence, taking into account:
   - the severity of injuries or damage to health
   - the number of affected persons
   - the extent of the damage to the environment
   - the cost of the damage to the asset.

1.3.6 Risk evaluation

Risk evaluation is to be carried out to determine if risk reduction is required. If risk reduction is required, then appropriate protective measures is to be selected and applied.

1.3.7 Risk reduction

The mitigation measures and provisions identified during the risk assessment are to be implemented accordingly in the design, construction, installation and testing of the offshore sub-station.

2 General layout

2.1 Basic principles

2.1.1 Purpose

This article provides general principle of the OSS layout with the aim of:

- providing safety
- ensuring sufficient structural strength and robustness
- reducing the impact of hazardous event
- allowing safe and easy in-service operations such as inspection and maintenance.

2.1.2 Layout plan drivers

The layout plan is to be established taking into account the following:

- weight distribution
- structural framing
- high fire risk areas
- manning level
- means of access for emergency evacuation and for safe operations
- meteomast location, if any
- helideck, if any
- cranes
- davits
- laydown areas.

2.2 Elements to be included in the layout

2.2.1 Main elements

a) Topside
   - crane
   - equipment
   - helideck
   - electrical transformer
   - topside structure.

Note 1: Topside layout should take manning level into account.

b) Substructure: monopod, tripod or jacket

c) Foundation
   - permanent: piles
   - temporary: mudmat.

2.2.2 Other elements

a) Utilities

b) J-tube

c) Cables

d) Stairways

e) Meteomast

f) Diesel storage tank

g) Laydown area.

2.3 General requirements

2.3.1 OSS orientation

The OSS orientation is to be defined based on:

- environmental conditions e.g. wave, currents and wind directions
- access for helicopter approach and take-off
- supply vessel approach for maintenance and repair operations.

2.3.2 High fire risk areas

Location of high fire risk areas is to be based on the following considerations:

a) location of storage areas is to be selected using a risk based approach with the aim to ensure segregation of high risk areas to hazardous materials

b) control room adjacent to transformer room require blast and fire wall

c) control room located over a power transformer requires blast and fire events

d) where cables and or services pass through penetrations in walls/floor/ceiling between one zone and another, penetrations should be sealed against fire.

2.3.3 Cable routes

Cables routes are to be set in order to allow supply vessel approach and avoid dropped objects risks.

No J-tube or I-tubes for the cables is to be positioned where fendering takes place, to avoid tubes damage during vessel approach.

2.3.4 Boat landing

Position of boat landing is to take into account the cables layout.

2.3.5 Helideck

Helideck position is to comply with relevant standard such as CAP 437 (Standards for offshore helicopter landing areas).

2.3.6 Markings

Appropriate marking is to be implemented to facilitate safe inspection and maintenance operations and emergency evacuation.

Additional marking may be set in order to facilitate installation.

3 Fixed means of access

3.1 Access

3.1.1 Recognized standards

Permanent means of access are to be provided for each enclosed space and are to comply with ISO 14122 series or with other standards deemed acceptable by the Society.

3.2 Escape ways

3.2.1 Safe evacuation

The means of access for each enclosed space are also to allow escape from these spaces and are to be prominently marked.

3.2.2 Ways to safe refuge

Escape ways are to be continuously marked and are to lead to safe refuge (e.g. muster area, life raft, the helicopter landing area).

3.3 Information for use

3.3.1 Instruction handbook content

The instruction handbook of the machinery under consideration is to state clearly the following:

a) what are the fixed access means provided by the manufacturer of the machinery

b) the conditions of use e.g. the maximum load and number of persons allowed on fixed access systems when appropriate

c) instructions necessary for correct assembly of the fixed access systems on site, e.g. method of fixing

d) an instruction that a horizontal, flat and solid surface should be provided at access points to each fixed access system

e) repeat any warnings provided on the fixed access system related to their use for access

f) any maintenance and inspection requirements e.g. to identify excessive deterioration when operating in aggressive environments, wear in movable elements.

3.3.2 Warnings

The maximum load including, for example, the number of persons and additional loads such as tools and equipment, are to be marked at suitable positions, where access is gained (entry and exit points).

It is preferable to direct users by signs instead of written instructions.

4 Fire and explosion protection measures

4.1 General

4.1.1 Recognized standard

The selection of control and mitigation measures for fires and explosions is to follow requirements and guidance given in ISO 13702 or other standard deemed acceptable by the Society.

Statutory requirements, rules and regulations can in addition be applicable for the individual OSS under consideration.

4.1.2 Types of fire protection systems

There are three main types of fire protection systems:

- Passive fire protection (PFP)
- Fire and gas detection systems
- Fire-fighting systems.

The substation layout (see Article [2]) is also appropriate means to minimize fire and explosion hazards consequence.

4.2 Fire detection

4.2.1 Recognized approval standard

The selection of detectors is to comply with the requirements of the Fire Safety Systems (FSS) Code Chapter 9 which specify components of fire detection and alarm systems, requirements for their interconnection and installation and the performance, testing, and servicing of parts or of complete systems.

4.2.2 Location

A fixed fire alarm and fire detection system is to be provided, covering each machinery space on-board with risk of fire.

The space to be equipped with fire detection system are to be identified by the risk assessment.

4.3 Passive and active fire protection

4.3.1 General

Fixed fire extinguishing systems, fire insulation, portable fire equipment or personnel protection devices are to be provided in line with the outcomes of the risk assessment required in [1.3]. Some of these systems or equipment may not be needed if the result of the risk assessment is satisfactory.

4.3.2 Recognized approval standards

Fire insulation are to meet safety requirements of the International Code for Application of Fire Test Procedures (FTP) Code or other standard deemed acceptable by the Society.

Fire fighting systems are to meet safety requirement of the FSS Code or other standard deemed acceptable by the Society.

SECTION 4 MANUFACTURING SURVEILLANCE

1 General

1.1 Overview

1.1.1 Scope

This article provides the surveillance activities and requirements of the Society for the certification of all the manufacturing phases of the OSS project.

1.1.2 Applicable standards

Technical requirements on the manufacturing of the steel structures of the installation are provided in the Society rule NR426.

The Society may accept reference to recognized international standard such as EN 1090 series.

1.1.3 Surveillance activities

The surveillance activities include:

- documentations review before manufacturing
- inspections and tests witnessing during the manufacturing process
- quality system evaluation.

1.2 Documents review

1.2.1 General

As a general rule, the preliminary manufacturing documents giving all the necessary information on the manufacturing process are to be provided to the Society before manufacturing starts.

1.2.2 Documents to be submitted

The following documents are to be submitted to the Society for review before the manufacturing starts:

- customer specifications and applicable codes and standards
- quality management system document
- quality control plans
- manufacturing drawings
- receiving inspection procedures
- fabrication procedures, such as:
  - manufacturing fabrication standards
  - welding procedure specifications and existing qualifications
  - welding sequences (plan or details)
  - welders existing qualifications (records)
  - procedures for consumable handling and storage
  - material tracing procedures
  - cutting procedures and specifications
  - dimensional control/survey procedures
  - forming procedures and existing qualifications
  - straightening procedures
  - heat treatment procedures.
- examination and testing procedures, such as:
  - NDT procedures
  - NDT Plan
  - NDT personnel qualification (records)
  - inspection equipment calibration procedures and certificates
  - inspection test plans
  - hydraulic testing procedures
  - functional testing procedures (equipment operability test procedures).
- material certificates, if any
- non-conformance/remedial procedures.

2 Surveillance requirements

2.1 Steel structures

2.1.1 Materials

The requirements for the manufacture, inspection and certification of steel used for the structure's manufacturing are provided in the Society's rule NR216.

The society may accept reference to recognized international standard such as ISO 19902.

Mill certificates or certified reports of tests made by the fabricator or a testing laboratory in accordance with the Society requirements may be used for the certification of the steel used.

2.1.2 Personnel qualification

a) Welders

Requirements to be applied for the qualification scheme of welders are set out in the Society's rule NR476.

b) Welding operators

The qualification test and approval range of the welding operator are left to the discretion of the Society with reference to ISO 14732.

c) NDT personnel

The qualification and certification of NDT personnel is to comply with ISO 9712 standard.

2.1.3 Manufacturing procedures qualification

The requirements for the qualification of forming, cutting and welding procedures and the production tests are to follow the Society's rule NR426, where applicable.

For aspects not covered by the NR216, the Society may accept reference to recognized international standards like the EN 1090 series for the qualification of forming procedure and like the ISO 15609 series for the qualification of the welding procedure.

2.1.4 Welding inspection

The inspections carried out on welds during manufacturing are set out in Tab 1 with indication of typical standards where requirements for testing procedure and equipment as well as acceptance levels are to be found.

Table 1 : Applicable standards for welding inspection.

Technique	Applicable standard
Visual testing	ISO 17637
Magnetic particle testing	ISO 17638 and ISO 23278 **(1)**
Ultrasonic testing	ISO 17640 and ISO 23227 **(1)**
Penetrant testing	ISO 3452-1
(1) Specifies acceptance levels	

2.2 Other metallic structures

2.2.1 Materials

The manufacture, inspection and certification of other iron structures and non-ferrous alloys (e.g. copper, copper alloys and aluminium alloys) are to comply with the Society rule NR216 or other recognized international standard.

2.2.2 Manufacturing, inspection and testing

For the requirements for manufacture, inspection and testing procedures reference is made to the general provisions given in the NR216, Sec 1.

2.3 Testing of safety systems

2.3.1 General

Before the unit leaves port and before commissioning, all the safety systems are to be properly tested to ensure they fulfil their intended performance if an hazard occurs.

Testing methods are to be based on relevant standards.

2.3.2 Tests to be carried out

a) gas detection systems, fire protection systems, fire fighting systems and appliances are to be tested

b) all life saving appliance are to be tested to ensure they are in working order and ready for immediate use

c) means of access systems and appliances are to be tested to ensure they are operational if a hazard occurs

d) alarm systems, communication systems and shutdown systems are to be tested to ensure they are in working order

e) the presence of all safety markings (e.g. emergency signs, provisions on the OSS) is to be checked.

3 Quality system evaluation

3.1 General requirements

3.1.1 Quality management system

The construction of the OSS is to be performed under a documented quality management system (QMS).

3.1.2 Quality management requirements

The QMS is to, as a minimum, address the following items:

- quality assurance manual
- organizational chart
- quality control plans
- documentation and drawing control procedures
- subcontractor quality procedures
- procurement procedures for materials/services
- receiving inspection procedures
- material tracing control procedures
- fabrication procedures
- dimensional control/survey procedures
- welding consumable storage and handling procedures
- NDT procedures
- inspection equipment calibration procedures and certificates
- examination and testing procedures
- equipment operability test procedures.

SECTION 5 TRANSPORT AND INSTALLATION

1 General

1.1 General

1.1.1 Purpose

The transport and installation of the platform aim at loading out and transporting its various components from the fabrication site to the installation location, positioning the structure on location, and assembling the various components into a stable structure in accordance with the design drawings and specifications.

1.1.2 Applicable standard

The requirements for the marine operations during transport and installation as well as the required records and documentations are based on ISO 19901-6.

1.1.3 Transport and installation surveillance

The transport and installation surveillance consists in verifying compliance of transportation procedures and test plans and the installation process with requirements of the applicable reference standards. It includes:

- transportation and installation documentation review
- onshore survey at the harbour of the conformity of the procedures for transportation
- witness of offshore installation
- installation records review (e.g. pile driving records, grouting and grout tests reports)
- commissioning survey to ensure safe operation of the OSS, including checks of safety systems, general appearance and presence of damage, control system settings and corrosion protection.

1.2 General requirements

1.2.1 Sea transportation and offshore installation plan

A transport and installation plan is to be prepared for the OSS. This plan should include the methods and procedures developed for the loadout, the sea-fastenings, the transportation of all components, the complete installation of the structure, with piles and topsides, as well as the equipment used in executing the procedures.

The information may be provided in the form of written descriptions, specifications, and/or drawings.

1.2.2 Health and Safety (HSE)

All the operational activities required during transport and installation are to be performed with minimum risk of accidents or incidents to personnel, environment and the platform.

A HSE plan is to be established in order to:

- document the HSE standards, processes and procedures that apply to the work
- identify, assess and manage hazards and risks arising from the work, reducing them to as low as reasonably practicable
- ensure that safety is inherent in planning and design of the work
- ensure minimal impact on the environment
- protect the health of the workforce.

The plan is to include HSE activities during all phases of the work, from planning and design through to execution of the transport and installation operations.

1.2.3 Personnel qualification

Personnel is to be qualified, trained and assessed for the work they are expected to carry out so as to ensure that they can perform that work competently.

1.2.4 Quality management system

A quality management system is to be in place and all activities are to be managed through it. A system such as the ISO 9000 series, or any other equivalent system, may be used.

2 Operational requirements

2.1 Tolerances

2.1.1 Weight and CoG

The weight and the CoG of the OSS Topside and support structure are to be determined before load out to ensure that they are within the tolerances stated in the design documents.

2.1.2 Orientation

The as-installed orientation of the platform is to be within the acceptable orientation tolerances, which are to be shown on the drawing and set out in the installation plan.

2.1.3 Topside alignment

The topsides parts are to be aligned within the tolerance specified in the design documents.

2.2 Structural integrity

2.2.1 Sea-fastening

Sea-fastening is to prevent shifting while in transit and is to be described in the installation plan.

2.2.2 Environmental conditions

The transport and installation period and weather conditions are not to cause degradations on the OSS components.

3 Documentations

3.1 Transportation manual

3.1.1 The transportation manual may include:

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

3.2 Installation manual

3.2.1 The installation manual may include:

- personnel qualifications and skills
- interface points and any required technical specifications for civil and electrical construction works
- specialized tooling and required lifting fixtures or equipment
- limiting environmental conditions
- quality control check points, measurements and inspections, required by the design
- installation loads and load conditions
- description of safety instructions and planned environmental protection measures
- quality recording and record keeping processes.

3.3 Commissioning manual

3.3.1 The commissioning manual is to include at least:

- procedures to commission the OSS
- test plans to be followed to verify that all components of the OSS operate safely.

The commissioning survey is to be followed up by a final commissioning report to be approved by the Society.

Shaping a World of Trust

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