



BSI Standards Publication

Ships and marine technology — Offshore wind energy — Port and marine operations

National foreword

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Ships and marine technology — Offshore wind energy — Port and marine operations

*Navires et technologie maritime — Énergie éolienne offshore —
Opérations portuaires et maritimes*



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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*.

This second edition cancels and replaces the first edition (ISO 29400:2015), which has been technically revised.

The main changes compared to the previous edition are as follows:

- [Clause 3](#): terms and definitions revised; new entries inserted;
- [Clause 7](#), “Metocean requirements”: fully revised;
- [Clause 20](#), “Cable loadout and offshore transfer”: new subclause added;
- revisions made throughout most other clauses;
- [Annex A](#): revised.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document applicable to the offshore wind industry constitutes a comprehensive and common basis covering port and marine operations of all offshore structures installed and maintained by the offshore wind industries worldwide. Through its application, the intention is to achieve reliability levels appropriate for offshore wind farm components, whatever the type of structure and the nature or combination of materials used.

It is important to recognize that during port and marine operations the structural integrity of the component is an overall concept comprising models for describing actions, structural analysis, design rules, safety elements, workmanship, quality control procedures and national requirements, all of which are mutually dependent. The modification of one aspect of design in isolation can disturb the balance of reliability inherent in the overall concept or structural system. It is necessary, therefore, to consider the implications involved in modifications in relation to the overall reliability of structures in offshore wind farms.

This document applicable to offshore wind farms is intended to provide a wide latitude in the choice of structural configuration, material and techniques without hindering innovation. Sound engineering judgment is, therefore, necessary in the use of this document.

This document was developed to provide comprehensive requirements and guidance for the planning, engineering and safe execution of port and marine operations for all types of offshore wind farm components including cable-laying and burial operations and installation and operation of floating turbines moored to the seabed.

Port operations for installation of components of offshore wind farms cover all component transport to the ports, whether marine or via inland waterways, any intermediate storage, as well as preassembly activities at the ports until placing the components close to any quayside for subsequent marine operations to start.

Marine operations for offshore wind farm structures cover loadout from the quayside, offshore transportation and installation phases when the structure is at risk from the marine environment including any marine logistics during offshore commissioning works, operation and maintenance, component exchange, repair operations and decommissioning or redeployment.

This document describes the principles of, and provides requirements and guidance for, port and marine operations associated with foundations, substructures, WTG, cables and topsides installed in offshore wind farms, from the point of view of planning, engineering, construction and documentation. Alternative requirements, methods and provisions can fulfil the intention of this document and may be applied, provided it can be demonstrated that they achieve at least the same level of assurance and reliability. The overall objective of this document is to ensure that port and marine operations are conducted within defined and recognized safety and reliability levels, wherever they are performed. Additional standards, codes and guidelines should also be taken into account, where applicable. Special attention should be paid to national regulations governing the area in which the port and marine operations are performed.

It is not the intent of this document to govern the design of structures, systems and components used in port and marine operations, beyond the principles given. Recognized codes and standards are normally accepted as the basis for the detailed design and the fabrication requirements of such components.

[Annex A](#) provides some background and some additional information to the main body of the document and it is intended that it be read in conjunction with the main body of the document.

This document is based on ISO 19901-6 while adapting it extensively to the specific requirements of the offshore wind industry.

NOTE Port and marine operations of offshore wind farms are covered in local, national and international regulations.

Ships and marine technology — Offshore wind energy — Port and marine operations

1 Scope

This document provides comprehensive requirements and guidance for the planning and engineering of port and marine operations of offshore wind farms, encompassing all documents and works related to such operations, e.g. the design and analysis of the components, systems, equipment and procedures required to perform port and marine operations, as well as the methods or procedures developed to carry them out safely.

This document is intended to be comprehensive, covering all relevant information related to port and marine operations necessary for loadout, offshore transport, installation, offshore commissioning works, operation and maintenance, component exchange, repair operations and decommissioning or redeployment of offshore wind farms.

This document is applicable to port and marine operations for offshore structures including:

- lattice structure foundations made from steel;
- concrete gravity base structures (GBS);
- piled steel foundation or mixed steel and concrete foundation structures;
- subsea templates and similar temporary structures or installation aids;
- steel or mixed material towers, nacelles and blades forming part of the wind turbine generators (WTG);
- floating turbines moored to the seabed;
- self-elevating offshore units for offshore substations or offshore accommodations platforms;
- launching systems at sea from quay side or onshore;
- array cables within the wind farms as well as export cables connecting the wind farm to the grid.

This document is also applicable to modifications of existing structures, e.g. installation of additional modules, exchange of components or decommissioning, and to marine operations during the service life of the windfarm related to the technical maintenance works.

It is not applicable to the following operations:

- construction activities, e.g. in a fabrication yard onshore, where there is no exposure to the marine environment;
- road transport onshore;
- diving.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 19901-1, *Petroleum and natural gas industries — Specific requirements for offshore structures — Part 1: Metocean design and operating considerations*

ISO 19901-7, *Petroleum and natural gas industries — Specific requirements for offshore structures — Part 7: Stationkeeping systems for floating offshore structures and mobile offshore units*

ISO 19905-1, *Petroleum and natural gas industries — Site-specific assessment of mobile offshore units — Part 1: Jack-ups*

IMCA LR 008, M 179, *Guidance on the Manufacture and Safe Use of Cable Laid Slings and Grommets*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

3.1 action

external load applied to the *structure* (3.153) (direct action) or an imposed deformation or acceleration (indirect action)

Note 1 to entry: An imposed deformation can be caused by fabrication tolerances, settlement, temperature change or moisture variation.

Note 2 to entry: An earthquake typically generates imposed accelerations.

[SOURCE: ISO 19904-1:2006, 3.5]

3.2 action effect

effect of *actions* (3.1) on structural components

EXAMPLE Internal forces, moments, stresses, strains, rigid body motions or elastic deformations.

[SOURCE: ISO 19904-1:2006, 3.5]

3.3 adverse weather

meteorological and oceanographic conditions which can affect people, operations, equipment or facilities, to such an extent that precautionary measures must be taken to safeguard the facility to maintain a safe system of work

Note 1 to entry: Adverse weather includes, snow, ice, hail, lightning, heavy rain, high wind, low cloud base, poor visibility, severe sea states and strong *currents* (3.32). Weather conditions can change quickly and the effects of short-term variations such as wind gusts must be considered.

3.4 air cushion

air pumped into underbase compartments of the *structure* (3.153)

Note 1 to entry: An air cushion is normally applied in order to reduce the draught and increase the freeboard and/or to alter the structural loading.

[SOURCE: ISO 19903:2006, 3.10, modified - Note 1 to entry has been slightly reworded for clarity.]

3.5**alpha factor****metocean reduction factor**

maximum ratio of operational criteria/design environmental condition for weather restricted *marine operations* (3.82) to allow for weather forecasting inaccuracies

Note 1 to entry: See also 3.91.

Note 2 to entry: [SOURCE: Reference [56], modified for clarity.]

3.6**array cable**

cable between *wind turbine generators* (3.176) (WTG) and between a WTG and the *offshore substation* (3.102) connecting the WTGs with the *offshore substation* (3.102)

3.7**as-built data****as-laid data**

data coming from final as built survey once every cable or *structure* (3.153) have been connected and tested and possibly corrected or repaired

Note 1 to entry: Final as built report includes final status of the field.

Note 2 to entry: “as-laid data” are coming from survey performed just after laying the cable or after structure installation before any test and connection. Data includes position in 3D, status, possible damages location and picture if possible, possible debris location around within target box or corridor including picture if possible.

3.8**assembly**

designed and fabricated group of bulk and equipment items that form one unit

[SOURCE: ISO 19901-5:2016, 3.1.1]

3.9**ballast**

variable solid or fluid content in order to change the draught, stability, trim and/or heel of a *structure* (3.153) afloat

[SOURCE: ISO 19901-5:2016, 3.1.2, modified for clarity.]

3.10**ballast system**

system used to change the draught, stability, trim and/or heel of a *structure* (3.153) afloat

3.11**barge**

simple floating vessel, normally non-propelled, on which material components of an *offshore wind farm* (3.103), material, people and equipment can be transported

3.12**basic variable**

one of a specified set of variables representing physical quantities that characterize *actions* (3.1), environmental influences, geometrical quantities or material properties, including soil properties

[SOURCE: ISO 19900:2013, 3.7]

3.13**bending efficiency factor**

factor by which the calculated breaking strength of a rope is reduced to take account of the reduction in *strength* (3.152) caused by bending around a shackle, *trunnion* (3.165), *padear* (3.108) or crane hook

[SOURCE: ISO 19901-6:2009, 3.9]

**3.14
blade**

one of a number of structural members with aerodynamic lift surfaces assembled around the *hub* (3.70) of a wind turbine

**3.15
bollard pull**

conventional measure of the pulling of a vessel defined as the force by a vessel under full power on a shore-mounted bollard through a tow line

Note 1 to entry: Bollard pull is expressed in kilonewtons.

[SOURCE: ISO 19901-6:2009, 3.10]

**3.16
bolting**

work carried out to join two components of the *wind turbine generator* (3.176) or between *foundation* (3.60) and *tower* (3.160) by means of a bolted connection

**3.17
bridging document
interface document**

document that aligns and co-ordinates the requirements and responses of various parties in relation to a specific aspect of a project

Note 1 to entry: A bridging document is commonly used to align and coordinate the emergency response procedures for *owner* (3.107) and contractors and clarify the interfaces between the various safety management systems used during construction.

[SOURCE: ISO 19901-6:2009, 3.11]

**3.18
bumper**

temporary *structure* (3.153) designed to protect structures or modules during the initial fitting stage of an installation operation

[SOURCE: ISO 19901-6:2009, 3.12]

**3.19
cable burial**

process to bury a cable into the *seabed* (3.128) up to a defined *depth of lowering* (3.37) which is either previously laid on the seabed and then buried, or which is simultaneously laid and buried, or, when a trench is previously made, which is laid into the trench and then buried, using specific equipment

**3.20
cable laying**

operations related to paying out an *array cable* (3.6) or an *export cable* (3.51) from a cable lay vessel onto the *seabed* (3.128)

Note 1 to entry: For array cables, the operations between the *1st-end pull-in* (3.22) and the *2nd-end pull-in* (3.23) if the array cables are not immediately buried.

**3.21
cable pull-in**

activities and equipment to be carried out and used to safely pull *array cables* (3.6) or *export cables* (3.51) through the *J-tubes* (3.74) and/or *foundations* (3.60)

**3.22
1st end pull-in**

pulling the first end of a section of an *array cable* (3.6) or *export cable* (3.51) into the *foundation* (3.60) of a *wind turbine generator* (3.176) or an *offshore substation* (3.102)

3.23**2nd end pull-in**

pulling the second end of an *array cable* (3.6) or *export cable* (3.51) into the *foundation* (3.60) of a *wind turbine generator* (3.176) or an *offshore substation* (3.102)

3.24**cable burial risk assessment****CBRA**

risk based approach to determine the optimal *depth of cover* (3.36) for an *array cable* (3.6) or *export cable* (3.51) taking into account e.g. anchor risks, water depth, frequency and size of vessels in transit in the vicinity of cable routes, changes in *seabed* (3.128) profile

3.25**cable testing**

tests conducted with either *array cables* (3.6) or *export cables* (3.51) and, where relevant, also the fibre optics cables in order to verify the functionality of the cables as well as mechanical and physical properties of the cables

3.26**CoG envelope**

defined constraint volume within which the centre of gravity (CoG) of an *assembly* (3.8) or a module shall remain

[SOURCE: ISO 19901-6:2009, 3.14]

3.27**commissioning**

activities after *mechanical completion* (3.90) including electrical testing and start-up of *wind turbine generators* (3.176), *offshore substations* (3.102), *foundations* (3.60), *array cables* (3.6) and *export cables* (3.51)

3.28**consequence factor**

factor applied to critical structural components in the design of lifting operations to ensure that these components have an increased factor of safety in relation to the consequence of their failure

Note 1 to entry: Consequence factors are additional safety factors, applied to critical structural components of the lifted object over and above the normal safety factors used in a working stress design (WSD) analysis of the lifted object. They are, accordingly, applied to *lift points* (3.76), their attachments to the object and components in the object supporting lift points. They are not intended for application to slings, *grommets* (3.62) and shackles.

[SOURCE: ISO 19901-6:2009, 3.15]

3.29**construction afloat**

addition of material or outfitting to the *structure* (3.153) while afloat

[SOURCE: ISO 19901-6:2009, 3.16]

3.30**crane vessel**

vessel, ship or *barge* (3.11) on which lifting equipment is mounted

Note 1 to entry: For the purposes of this document, this term includes jack-up vessels, crane barges, crane ships, derrick barges, shear-leg barges and semi-submersible crane vessels.

[SOURCE: ISO 19901-6:2009, 3.17]

**3.31
cribbing**

arrangement of timber baulks, secured to the deck of the *barge* (3.11) or vessel, designed to support the cargo

Note 1 to entry: Cribbing is generally arranged at strong points of the deck and/or cargo.

[SOURCE: ISO 19901-6:2009, 3.18]

**3.32
currents**

flow of water past a fixed *location* (3.81) usually described in terms of a current speed and direction

Note 1 to entry: Convention is that direction is that to which a current flows.

[SOURCE: IEC 61400-3: 2009, 3.2]

**3.33
deadweight**

total carrying capacity of a vessel

Note 1 to entry: This includes cargo weight, deck cargo, snow and ice, marine growth, *ballast* (3.9) water, consumables and crew onboard a floating unit.

[SOURCE: ISO 19901-6:2009, 3.1, modified for clarity.]

**3.34
deck mating**

marine operation (3.82) in which the *platform* (3.111) *topsides* (3.158) are floated into position and connected to the *support structure* (3.155)

Note 1 to entry: This operation is normally conducted by ballasting and deballasting of the support structure.

[SOURCE: ISO 19901-6:2009, 3.20]

**3.35
decommissioning**

process of shutting down a *structure* (3.153) in an *offshore wind farm* (3.103) and removing it from its *location* (3.81) at the end of its service life

[SOURCE: ISO 19900:2013, 3.14, modified for clarity.]

**3.36
depth of cover
DOC**

value describing the vertical distance from mean back-fill level to top of cable; i.e. the thickness of material on top of the cable after trenching/burial

**3.37
depth of lowering
DOL**

value describing the vertical distance from mean *seabed* (3.128) level to top of cable

**3.38
design criterion**

quantitative formulation that describes the conditions that shall be fulfilled for each *limit state* (3.77)

[SOURCE: ISO 19901-6:2009, 3.22]

3.39**design value**

value derived from the *representative value* ([3.118](#)) for use in the design verification ([3.169](#)) procedure

[SOURCE: ISO 19900:2013, 3.18]

3.40**determinate lift**

lift where the slinging arrangement is such that the sling forces are statically determinate and not significantly affected by minor differences in sling length or elasticity

[SOURCE: ISO 19901-6:2009, 3.25]

3.41**displacement**

weight of the volume of water displaced by a floating *structure* ([3.153](#))

Note 1 to entry: The weight of the water displaced is the sum of the lightship weight, *deadweight* ([3.33](#)) and anchoring system load including vertical component of the mooring pre-tension.

[SOURCE: ISO 19901-6:2009, modified - Note 1 to entry has been slightly reworded for clarity.]

3.42**drift-off**

unintended lateral move of a dynamically positioned (DP) vessel off of its intended *location* ([3.81](#)) relative to the *platform* ([3.111](#)) or *OWF* ([3.103](#)) asset working with, generally caused by the loss of stationkeeping control or propulsion

[SOURCE: ISO 13624-1:2009, 3.1.25, modified - "wellhead" replaced with "platform or OWF asset working with".]

3.43**dunnage**

arrangement of timber on deck of a *barge* ([3.11](#)) or vessel laid out to support the cargo

[SOURCE: ISO 19901-6:2009, 3.27]

3.44**dynamic action**

action ([3.1](#)) that induces acceleration of a *structure* ([3.153](#)) or a structural component of a magnitude sufficient to require specific consideration

[SOURCE: ISO 19901-7:2013, 3.8]

3.45**dynamic amplification factor****DAF**

ratio of a *dynamic action* ([3.44](#)) effect to the corresponding static action effect provided as a factor to account for the dynamic effects on a crane while lifting an object — where applicable

Note 1 to entry: An appropriately selected DAF can be applied to static actions to simulate the effects of dynamic actions.

[SOURCE: ISO 19902:2007, 3.16]

3.46**dynamic lift weight**

gross weight ([3.63](#)) times the *dynamic amplification factor* ([3.45](#))

[SOURCE: ISO 19901-6:2009, 3.46, modified for clarity.]

3.47

electrical completion

electrical works inside a *wind turbine generator* (3.176) (WTG) conducted after finalization of *mechanical completion* (3.90) in order to allow for energization of the WTG

3.48

emergency response cooperation plan

ERCoP

document bridging emergency response plans of various parties working at an *offshore installation site* (3.100) in order to achieve a mutually aligned procedure in case of emergency

3.49

exclusion zone

area submitted to specific restrictions regarding marine activities

3.50

exclusive cable zone

area within the *offshore installation site* (3.100) designated exclusively for the *array cables* (3.6) of the wind farm and for the offshore installation works of the cable supplier, as well as area around *export cables* (3.51) and interconnector cables between substations exclusively for installation works for export/interconnector cables

Note 1 to entry: The exclusion cable zone can be defined for a specific period of time depending on the project requirements.

3.51

export cable

cables connecting an *offshore wind farm* (3.103) with the shore via a cable connection between one component of the wind farm and the onshore network

3.52

failure mode and effect analysis

FMEA

analysis of possible failures of any component of the safety device and determination of their consequences for the overall safety function, allowing the classification of any failure as safe, dangerous, detected or undetected with respect to the safety function

3.53

fibre rope

rope made of various yarns and various types of construction

EXAMPLE A fibre rope can be a stranded rope consisting of three to eight strands, a parallel strand rope, a single or double-braided rope, etc.

Note 1 to entry: Each combination of yarn and type of construction normally results in different properties and characteristics.

[SOURCE: ISO 19901-6:2009, 3.30]

3.54

fibre rope grommet

FRG

endless loop-shaped sling made up from a single length of *fibre rope* (3.53)

Note 1 to entry: A fibre rope grommet is of similar construction to a *steel wire rope grommet* (3.150).

[SOURCE: ISO 19901-6:2009, 3.31]

3.55**fibre rope sling****FRS**

sling made from a single *fibre rope* (3.53), usually with spliced eye end terminations

[SOURCE: ISO 19901-6:2009, 3.32]

3.56**float-off**

offloading an object from a submersible transport vessel or *barge* (3.11) by means of submerging the vessel or barge deck to a depth that is sufficient to allow the object to float and be removed from the vessel/barge

[SOURCE: ISO 19901-6:2009, 3.34]

3.57**float-on**

loading an object onto a submersible transport vessel or *barge* (3.11) by means of submerging the vessel or barge deck to a depth that is sufficient to allow the floating object to be manoeuvred into position over the vessel/barge

Note 1 to entry: The object is then lifted from the water and onto the vessel/barge deck by deballasting the vessel/barge to its seagoing condition.

[SOURCE: ISO 19901-6:2009, 3.35]

3.58**float-out**

transfer of a floating *structure* (3.153) out of a flooded dry dock

[SOURCE: ISO 19901-6:2009, 3.36]

3.59**float-over**

transfer of a major *assembly* (3.8) supported on *barge(s)* (3.11) onto its temporary or permanent *structure* (3.153) by means of manoeuvring the major assembly over the structure and setting it down by means of ballasting the barge(s) supporting the assembly, deballasting the structure or lowering the supports of this assembly or combination thereof

[SOURCE: ISO 19901-6:2009, 3.37]

3.60**foundation**

offshore wind energy part of an offshore wind turbine *support structure* (3.155) which transfers the loads acting on the structure into the *seabed* (3.128)

EXAMPLE *Monopile* (3.93), *jacket* (3.73) structures, gravity-based structures or floating *foundations* (3.60) structures.

Note 1 to entry: Different foundation concepts are shown in [Figure 1](#) together with other parts of an offshore wind turbine.

Note 2 to entry: While [Figure 1](#) defines the foundation as the part below the substructure which is in the *seabed* (3.128), the term foundation as used in the offshore wind industry usually refers to the substructure and the foundation (terms as used in [Figure 1](#)). Thus, a foundation as usually referred to in the offshore wind industry would be e.g. a monopile or a piled jacket structure. Therefore, when talking about a lift or an installation of e.g. a monopile, this document uses the term “foundation” instead of talking about “foundation and substructure” to be lifted.

[SOURCE: IEC 61400-3: 2010; 3.11, Example modified for clarity.]

3.61

grillage

steel *structure* ([3.153](#)), secured to the deck of a *barge* ([3.11](#)) or vessel, designed to support the cargo and distribute the loads between the cargo and the barge or vessel

[SOURCE: ISO 19901-6:2009, 3.38]

3.62

grommet

endless loop-shaped sling made up from a single length of (fibre or steel wire) rope

Note 1 to entry: See also *fibre rope grommet* ([3.54](#)) and *steel wire rope grommet* ([3.150](#)).

[SOURCE: ISO 19901-6:2009, 3.39]

3.63

gross weight

calculated or weighed weight of the *structure* ([3.153](#)) being lifted, including a weight contingency factor

Note 1 to entry: Sometimes the gross weight is referred to as a *not-to-exceed (NTE) weight* ([3.97](#)).

[SOURCE: ISO 19901-6:2009, 3.40]

3.64

grouting

offshore construction process used to connect some elements by using a special concrete type of mixture which is being pumped into the void between the elements

3.65

guard vessel

special ship attending the *offshore installation site* ([3.100](#)) required to maintain a higher degree of readiness in order to enforce the safety zone around an offshore construction site for non-construction vessels

3.66

gust wind speed

maximum value of the wind speed of a gust averaged over a short (3 s to 60 s) specified duration within a longer (1 min to 1 h) specified duration and at a defined height

Note 1 to entry: For design purposes, the specified duration depends on the dimensions and natural period of the (part of the) *structure* ([3.153](#)) being designed such that the structure is designed for the most onerous conditions; thus, a small part of a structure is designed for a shorter gust wind speed duration (and hence a higher gust wind speed) than a larger (part of a) structure.

Note 2 to entry: In practice, for design purposes, the gust wind speeds for the different durations (e.g. 3 s, 5 s, 15 s, 60 s) are derived from the wind spectrum.

[SOURCE: ISO 19901-1:2005, 3.8, modified for clarity.]

3.67

health, safety, security and environment plan

HSSE plan

plan that includes activities on health, safety, security and environment during planning, design and execution of operations

3.68

heave compensation

system fitted to hoisting/lowering machinery on offshore construction vessels to enable the object being hoisted or lowered to maintain a constant vertical position when the vessel is oscillating in a vertical direction

[SOURCE: ISO 19901-6:2009, 3.41]

3.69**hook load**

sum of the *rigging weight* (3.123), including the *dynamic amplification factor* (3.45), and the nominal lift weight

Note 1 to entry: static hook load is the hook load of the *gross weight* (3.63) or *NTE weight* (3.97) plus the rigging weight; dynamic hook load is the static hook load times DAF; nominal hook load is maximum allowed weight [including *rigging* (3.122)] as per crane chart.

[SOURCE: ISO 19901-6:2009, 3.42]

3.70**hub**

part mounted to the *nacelle* (3.95) of a wind turbine in order to connect the *blades* (3.14) forming the rotor *assembly* (3.8)

3.71**indeterminate lift**

lift where the sling forces are not statically determinate

[SOURCE: ISO 19901-6:2009, 3.43]

3.72**intermediate storage**

area in the staging port where the components for an *offshore wind farm* (3.103) are temporarily stored before *pre-assembly* (3.113) and/or *loadout* (3.80) onto transport vessels

3.73**jacket**

foundation (3.60) type of an *offshore wind farm* (3.103) made of tubular steel members which are usually piled into the *seabed* (3.128)

3.74**J-tube**

tube being part of the *foundation* (3.60) appurtenance designed and to be used for support and protection of the *array cables* (3.6) or *export cable* (3.51) from the *seabed* (3.128) up to the top of the *transition piece* (3.163) or a *topside* (3.158)

3.75**launching**

offloading an object into the water from a *barge* (3.11), other floating unit or fixed infrastructure by means of sliding the object longitudinally, or less commonly, sideways along the floating unit or the fixed infrastructure

[SOURCE: ISO 19901-6:2009, 3.44, modified for clarity.]

3.76**lift point**

connection between the *rigging* (3.122) and the *structure* (3.153) being lifted

Note 1 to entry: Lift points include *padears* (3.108), *padeyes* (3.109) and *trunnions* (3.165).

[SOURCE: ISO 19901-6:2009, 3.45]

3.77**limit state**

state beyond which the *structure* (3.153) no longer fulfils the relevant *design criteria* (3.38)

[SOURCE: ISO 19900:2013, 3.28]

3.78

link beam

connecting beam between the quay and floating unit

Note 1 to entry: The link beam can provide a structural connection, or can solely provide a smooth path for skidding or *trailers* ([3.161](#)).

[SOURCE: ISO 19901-6:2009, 3.49, modified for clarity.]

3.79

load case

compatible load arrangements, sets of deformations and imperfections considered simultaneously with permanent *actions* ([3.1](#)) and fixed variable actions for a particular design or *verification* ([3.169](#))

[SOURCE: ISO 19902:2007, 3.29]

3.80

loadout

transfer of a *foundation* ([3.60](#)) or a wind turbine component, cables, a *topside* ([3.158](#)) module of an *offshore substation* ([3.102](#)) or any other equipment or components from land onto a *barge* ([3.11](#)) or vessel by horizontal movement or by lifting devices

Note 1 to entry: The following types of loadout operation can be distinguished:

- floating: loadout from the quay onto a floating barge or vessel;
- grounded: loadout from the quay onto a grounded barge or jack-up;
- lifted: loadout performed by crane;
- skidded: loadout where the *structure* ([3.153](#)) is skidded, using a combination of *skidways* ([3.139](#)), *skidshoes* ([3.138](#)) or runners, propelled by towing engines, jacks or winches;
- trailer: loadout where the structure is wheeled onto the barge using *trailers* ([3.161](#)) or *self-propelled modular transporters* ([3.133](#)).

[SOURCE: ISO 19901-5:2016, 3.1.30, modified for clarity.]

3.81

location

one of many areas of an offshore construction site where a *foundation* ([3.60](#)) with a wind turbine, an *offshore substation* ([3.102](#)) or *offshore accommodation platform* ([3.99](#)) will be or is located

3.82

marine operation

planned and controlled vertical or horizontal movement of a *structure* ([3.153](#)) or component thereof over, in or on water

Note 1 to entry: Examples for marine operations cover *loadout* ([3.80](#)), *offshore transport* ([3.105](#)), installation, marine operations during *commissioning* ([3.27](#)) as well as operation and maintenance works, component exchange and repair or *decommissioning* ([3.35](#)) or redeployment.

[SOURCE: ISO 19903:2006, 3.36]

3.83

marine spread

fleet of vessels assembled to perform a *marine operation* ([3.82](#))

[SOURCE: ISO 19901-6:2009, 3.53]

3.84**marine warranty surveyor****MWS**

independent expert acting on behalf of a construction-all-risk (CAR) insurance company for *third party* (3.157) review and approval of the planning, design and execution of the *loadout* (3.80), *offshore transport* (3.105) and installation

3.85**marshalling port**

harbour chosen to temporarily store components, to perform *loadout* (3.80) and start the *offshore transport* (3.105) before offshore installation

3.86**mating**

transfer of a major *assembly* (3.8) supported on *barge(s)* (3.11) or vessel(s) to a temporary or permanent *support structure* (3.155)

Note 1 to entry: The following types of mating operation can be distinguished:

- afloat: transfer of the barge supported major assembly to a floating structure by means of submerging the structure sufficiently to allow the assembly to be manoeuvred over it, then lifting the assembly off the barges by deballasting the structure;
- onto structure *foundation* (3.60): transfer of the barge supported major assembly to a foundation by means of manoeuvring it over the foundation, then ballasting the barge supporting the assembly or lowering the supports of this assembly in order to transfer the weight of the assembly onto the structure.

[SOURCE: ISO 19901-6:2009, 3.54]

3.87**maximum wave height** **$H_{\max}$**

largest of all wave crests to adjacent trough values related to a certain time and area

3.88**mean wave period** **T_z**

zero-crossing period of a wave

3.89**mean wind speed**

average velocity of wind commonly measured by anemometer at a defined height and averaged over a certain time frame

3.90**mechanical completion**

stage of the process when the *wind turbine generator* (3.176) (WTG) is firmly bolted to the *foundation* (3.60), before *commissioning* (3.27) and prior to commencing power generation

EXAMPLE Connection of ladders, WTG internal cabling, software installation required.

3.91**metocean reduction factor****alpha factor** **f_{MR}**

maximum ratio of operational criteria/design environmental condition for weather restricted *marine operations* (3.82) to allow for weather forecasting inaccuracies

Note 1 to entry: See also 3.5.

Note 2 to entry: [SOURCE: Reference [56], modified for clarity.]

3.92
minimum breaking strength
MBS

certified *strength* ([3.152](#)) of a chain, wire rope, *fibre rope* ([3.53](#)) or accessories

[SOURCE: ISO 19901-6:2009, 3.55]

3.93
monopile

single pile to be penetrated into the *seabed* ([3.128](#))

3.94
mooring component

general class of component used in the mooring of floating *structures* ([3.153](#))

EXAMPLE Chain, *steel wire rope* ([3.149](#)), synthetic *fibre rope* ([3.53](#)), clump weight, buoy, winch/windlass or anchor.

[SOURCE: ISO 19901-6:2009, 3.56]

3.95
nacelle

housing which contains the drive-train and other elements on top of a horizontal axis wind turbine *tower* ([3.160](#))

[SOURCE: IEC 61400-3:2010, 3.34]

3.96
nominal value

value assigned to a *basic variable* ([3.12](#)) determined on a non-statistical basis, typically from acquired experience or physical conditions

[SOURCE: ISO 19900:2013, 3.29]

3.97
not-to-exceed weight
NTE weight

maximum acceptable weight of the *structure* ([3.153](#)), with an associated limiting centre of gravity (CoG) envelope

[SOURCE: ISO 19901-6:2009, 3.58]

3.98
offload

transfer of a major *assembly* ([3.8](#)) or a module from a *barge* ([3.11](#)) or transport vessel to land by horizontal movement or by lifting

[SOURCE: ISO 19901-6:2009, 3.59]

3.99
offshore accommodation platform

fixed *platform* ([3.111](#)) located inside an *offshore wind farm* ([3.103](#)) used for accommodation of personnel during operational phase from which personnel embarks via helicopter, crew transfer vessel or other vessels to the *wind turbine generator* ([3.176](#)) for conducting service and maintenance

3.100
offshore installation site

area where the *locations* ([3.81](#)) of the *foundations* ([3.60](#)) for the *wind turbine generators* ([3.176](#)) and the *offshore substation* ([3.102](#)) will be installed offshore

3.101**offshore installation vessel**

offshore construction and installation vessel(s) involved in the construction of the *offshore wind farm* (3.103)

3.102**offshore substation**

structure (3.153) in an *offshore wind farm* (3.103) which connects the *array cables* (3.6) and the *export cables* (3.51) and transforms the voltage level between both

3.103**offshore wind farm****OWF**

offshore site generating electricity from wind energy with the components such as *foundations* (3.60), *transition pieces* (3.163), *piles*, *towers* (3.160), *nacelles* (3.95), *hub* (3.70), *blades* (3.14), *array cables* (3.6) as well as *export cable* (3.51) and *offshore substation* (3.102) and/or *offshore accommodation platform* (3.99) where required

3.104**offshore transmission owner****OFTO**

entity which takes responsibility of the assets which usually link offshore generation to the onshore network

Note 1 to entry: In terms of physical assets, an OFTO will normally have the ownership of (i) offshore electricity transmission infrastructure such as *offshore substations* (3.102), the *export cable* (3.51) as well as the onshore cabling, (ii) any onshore substations, and (iii) the electrical equipment relating to the operation thereof. However, the ownership of the electricity transmission can be different depending on local regulation.

Note 2 to entry: OFTO differs from *owner* (3.107).

3.105**offshore transport**

offshore transportation of the components of an *offshore wind farm* (3.103) from designated *marshalling port* (3.85) or another fabrication yard to the *offshore installation site* (3.100)

3.106**operational duration**

planned duration of a port and *marine operation* (3.82), excluding a contingency period

Note 1 to entry: See also *weather window* (3.174).

Note 2 to entry: See also Reference [56].

3.107**owner**

representative of the company or companies which own an *offshore wind farm* (3.103) project

EXAMPLE An owner can be wind farm lease and permit holder, developer, employer of contractors which manufacture and install the components of an offshore wind farm and potential operator of the offshore wind farm.

Note 1 to entry: Owner differs from OFTO (3.104).

3.108**padear**

lift point (3.76) consisting of a central member of tubular or flat plate form with horizontal *trunnion* (3.165), or consisting of a solid casting, around which a sling or *grommet* (3.62) can be passed

[SOURCE: ISO 19901-6:2009, 3.62]

3.109

padeye

lift point (3.76) consisting essentially of a plate, reinforced by cheek plates if necessary, with a hole through which a shackle can be connected

[SOURCE: ISO 19901-6:2009, 3.63]

3.110

permit to access

permit issued by the construction management of an *offshore wind farm* (3.103) during construction when required to an *offshore installation vessel* (3.101) to allow entry into the safety zone of an *offshore installation site* (3.100) in order to conduct its designated works agreed by the construction management

3.111

platform

complete *assembly* (3.8) including *structure* (3.153), *topsides* (3.158) and, where applicable, *foundations* (3.60)

[SOURCE: ISO 19901-6:2009, 3.64]

3.112

point of no return

PNR

point during an operation or a geographical point along a route that represents the final opportunity to reverse, delay or abandon the operation and return to a *safe condition* (3.126)

[SOURCE: ISO 19901-6:2009, 3.65, modified for clarity.]

3.113

pre-assembly

stages of the process for the assembly of the *wind turbine generator* (3.176) (WTG) components at the staging port including works and parts of the WTG or other required components in order to commence *loadout* (3.80) of pre-assembled WTG components

3.114

pre-piling

activities in relation to installing piles in the *seabed* (3.128) where upon a *jacket* (3.73) or a similar deep *foundation* (3.60) is going to be installed

3.115

recognized organization

RO

organisation that has been assessed by a flag state, and found to comply with Part 2 of the Code for Recognized Organizations (RO Code) MSC.349(92) and IMO resolution MEPC.237(65)

[SOURCE: MSC.349(92)^[69], modified for clarity.]

3.116

risk assessment and method statements

RAMS

documents which detail the way a work task or process is to be completed outlining the hazards involved and the required safety precautions based on detailed risk assessments

3.117

remotely-operated vehicle

ROV

underwater vehicle operated remotely from a surface vessel or installation

[SOURCE: ISO 14723:2009, 4.32]

3.118**representative value**

value assigned to a *basic variable* (3.12) for *verification* (3.169) of a *limit state* (3.77)

[SOURCE: ISO 19900:2013, 3.38]

3.119**reserve buoyancy**

contingency buoyancy expressed in percentage of the nominal total intact buoyancy of *barges* (3.11) or vessels or floating *structures* (3.153)

[SOURCE: ISO 19901-6:2009, 3.68, modified for clarity.]

3.120**resistance**

capacity of a *structure* (3.153), component or a cross-section of a component to withstand *action* (3.1) effects without exceeding a *limit state* (3.77)

[SOURCE: ISO 19904-1:2006, 3.32]

3.121**return period**

average period between occurrences of an event or of a particular value being exceeded

Note 1 to entry: The offshore industry commonly uses a return period measured in years for environmental events. The return period in years is equal to the reciprocal of the annual probability of exceedance of the event.

[SOURCE: ISO 19901-1:2005, 3.23]

3.122**rigging**

slings, shackles and other devices including *spreader bars/frames* (3.145) used to connect the *structure* (3.153) being lifted to the crane

[SOURCE: ISO 19901-6:2009, 3.71]

3.123**rigging weight**

total weight of *rigging* (3.122), i.e. between the *lift points* (3.76) and the crane hook, including slings, *grommets* (3.62), shackles, lifting tools and *spreader bars or frames* (3.145) including contingency

[SOURCE: ISO 19901-6:2009, 3.72, modified for clarity.]

3.124**rotor-nacelle assembly**

part of an offshore wind turbine carried by the *support structure* (3.155)

Note 1 to entry: See Figure 1 for information.

[SOURCE: IEC 61400-3:2010; 3.35]

3.125**safe haven**

sheltered *location* (3.81) at which a *tow* (3.159) or transport can seek refuge from inclement weather

[SOURCE: ISO 19901-6:2009, 3.73]

3.126**safe condition**

condition where the object is considered to be exposed to a normal level of risk of damage or loss

3.127

scour protection

materials placed on the *seabed* ([3.128](#)) to prevent scour from developing around the *foundation* ([3.60](#)) where the foundation penetrates into the seabed

3.128

seabed

materials below the sea in which the *structure* ([3.153](#)) is founded, whether of soils such as sand, silt or clay, cemented material or of rock

Note 1 to entry: The seabed can be considered as the half-space below the *sea floor* ([3.130](#)).

[SOURCE: ISO 19901-6:2009, 3.74]

3.129

sea fastening

temporary fastening items which keep movable items in position during transportation at sea

[SOURCE: ISO 19901-6:2009, 3.75]

3.130

sea floor

interface between the sea and the *seabed* ([3.128](#))

[SOURCE: ISO 19901-4:2003, 3.5]

3.131

search and rescue

SAR

operation to retrieve persons in distress, provide for their initial medical or other needs and deliver them to a place of safety

3.132

section of array cable

length of *array cable* ([3.6](#)) of a specific cable type between two *foundations* ([3.60](#)) or between a foundation and an *offshore substation* ([3.102](#)) or between a foundation and an onshore substation

3.133

self-propelled modular transporter

SPMT

platform ([3.111](#)) vehicle with a large array of steerable wheels, connected to a central spine beam by hydraulic suspension that can be raised or lowered

3.134

semi-submersible

floating *structure* ([3.153](#)) normally consisting of a deck structure with a number of widely spaced, large cross-section, supporting columns connected to submerged pontoons

[SOURCE: ISO 19904-1:2006, 3.36]

3.135

significant wave height

H_s

mean wave height (crest to trough) of the one-third highest waves

3.136**site chart**

updated map of the *offshore installation site* ([3.100](#)) showing important information of e.g. all planned or existing *locations* ([3.81](#)), allowable jack-up positions, jack-up footprints, as as-built/as-laid information, safety zone, positions of all other equipment temporarily anchored in the offshore installation site such as measurement equipment, cardinal buoys, to allow the bridges of all *offshore installation vessels* ([3.101](#)) and other offshore spreads working in the offshore installation site to have the same information

3.137**skew load factor****SKL**

factor by which the load on any *lift point* ([3.76](#)), or pair of lift points, is multiplied to account for sling length mismatch in a statically *indeterminate lift* ([3.71](#))

Note 1 to entry: The SKL distribution is applied for the design of the whole *structure* ([3.153](#)), the lifting points, the slings, the shackles and the *spreader bars or frames* ([3.145](#)).

[SOURCE: ISO 19901-6:2009, 3.78, modified - Note 1 to entry added.]

3.138**skidshoe**

bearing pad attached to the *structure* ([3.153](#)) that engages in the *skidway* ([3.139](#)) and carries a share of the vertical load

[SOURCE: ISO 19901-6:2009, 3.79]

3.139**skidway**

system of structural beams (concrete or steel) or rails, on the quay and on the floating unit, on which the *structure* ([3.153](#)) is loaded out via the *skidshoes* ([3.138](#))

[SOURCE: ISO 19901-6:2009, 3.80]

3.140**skirt**

structure ([3.153](#)) constructed at or below the base of a structure that extends downwards from the bottom of the *foundation* ([3.60](#)) plate, penetrating into the *seabed* ([3.128](#))

Note 1 to entry: Skirts are used to increase the capacity of the foundation to resist vertical and horizontal loads and improve erosion resistance.

[SOURCE: ISO 19901-6:2009, 3.81]

3.141**sling eye**

loop at each end of a sling, either formed by a *splice* ([3.144](#)) or by a mechanical termination

[SOURCE: ISO 19901-6:2009, 3.82]

3.142**special purpose vessel**

mechanically self-propelled vessel which, by reason of its function, might carry more than 12 special personnel

Note 1 to entry: A special purpose vessel fulfils various roles on *offshore wind farms* ([3.103](#)) including rock dumping vessel, fall pipe vessel, *unexploded ordnance* ([3.168](#)) survey, explosive ordnance disposal, and deployment and operation of bubble curtains for noise mitigation measures.

[SOURCE: Reference [\[41\]](#)]

3.143

splash zone

area of a *structure* (3.153) that is frequently wetted due to waves and tidal variations or during lift operations; also used during installation of *foundations* (3.60) when immersing the foundation components in the water

Note 1 to entry: Refers to the wave-affected zone of the water column surrounding a structure whether during installation phase or during operation.

[SOURCE: ISO 19901-6:2009, 3.83, modified – Note 1 to entry slightly reworded for clarity.]

3.144

splice

length of sling where the rope is connected back into itself by tucking the tails of the unit ropes back through the main body of the rope(s), after forming the *sling eye* (3.141)

[SOURCE: ISO 19901-6:2009, 3.84]

3.145

spreader bar

spreader frame

structure (3.153) designed to resist the bending and compression forces induced by angled slings by altering the line of action of the force on a *lift point* (3.76) into a vertical plane

Note 1 to entry: The usual purpose of a spreader bar or frame is to avoid a clash between the *rigging* (3.122) and the structure, which would result if the rigging were connected directly from the lift point to the hook.

[SOURCE: ISO 19901-6:2009, 3.85]

3.146

spud can

structure (3.153) which can be attached to the base of the jacking legs, normally a conical structure which provides stability to lateral forces on the jack-up when deployed into the sea-bed systems

3.147

squat effect

tendency of floating objects or vessels to undergo an increase in draught when underway in shallow water

[SOURCE: ISO 19901-6:2009, 3.86, modified for clarity.]

3.148

steel cable-laid sling

SCLS

assembly of several (usually six) round stranded *steel wire ropes* (3.149) (referred to as unit ropes), laid helically around a core (usually a seventh rope)

Note 1 to entry: The definition strictly applies to the type of steel wire rope construction. Cable-laid slings have hand-spliced eye end terminations by splicing the rope back on itself to form an eye termination.

Note 2 to entry: See IMCA LR 008, M 179 for guidance on the manufacture and safe use of cable-laid slings and *grommets* (3.62) amongst others for flemish eye resin filled sleeve termination (FERFS).

[SOURCE: ISO 19901-6:2009, 3.87, Note 2 to entry modified for clarity.]

3.149

steel wire rope

rope made of various types of steel wire construction

EXAMPLE A steel wire rope can be a stranded rope consisting of six or eight strands laid helically around a core (steel core, fibre core, IWRC), a spiral rope, etc.

Note 1 to entry: Each combination of material and type of construction normally results in different properties and characteristics.

[SOURCE: ISO 19901-6:2009, 3.88]

3.150
steel wire rope grommet
SWRG

endless loop-shaped sling made up from a single length of round stranded *steel wire rope* (3.149)

Note 1 to entry: As for cable-laid slings, the steel wire rope used in a *grommet* (3.62) is also referred to as a unit rope.

Note 2 to entry: During the production of grommets, a temporary rigid core is used, which is replaced at the end of spiralling by the first half loop and the last half loop of the unit rope. When removing the temporary rigid core, the ends of the unit rope are tucked into the body of the grommet to form the core, with the tuck position diametrically opposite the core butt position.

Note 3 to entry: See IMCA LR 008, M 179 for guidance on the manufacture and safe use of cable-laid slings and grommets.

[SOURCE: ISO 19901-6:2009, 3.89 modified - Note 2 and 3 to entry reworded for clarity.]

3.151
steel wire rope sling
SWRS

sling made from a single *steel wire rope* (3.149) with various possible end terminations

Note 1 to entry: Terminations include spliced eyes, flemish eye with swaged steel sleeve (also known as super loop), flemish eye resin filled sleeve (FERFS), spelter sockets, resin sockets, etc.

Note 2 to entry: See IMCA LR 008, M 179 for guidance on the manufacture and safe use of cable-laid slings and *grommets* (3.62).

[SOURCE: ISO 19901-6:2009, 3.90, modified – Note 2 to entry inserted for clarity.]

3.152
strength

mechanical property of a material indicating its ability to resist *actions* (3.1), usually given in units of stress

[SOURCE: ISO 19902:2007, 3.49]

3.153
structure

organized combination of connected parts designed to withstand *actions* (3.1) and provide adequate rigidity

[SOURCE: ISO 19900:2013, 3.49]

3.154
sub-structure

part of an offshore wind turbine *support structure* (3.155) which extends upwards from the *seabed* (3.128) and connects the *foundation* (3.60) to the *tower* (3.160)

Note 1 to entry: See Figure 1.

[SOURCE: IEC 61400-3: 2010; 3.46]

3.155
support structure

part of an offshore wind turbine consisting of the *tower* (3.160), *sub-structure* (3.154) and *foundation* (3.60)

Note 1 to entry: See Figure 1.

[SOURCE: IEC 61400-3:2010; 3.47]

3.156

termination efficiency factor

factor by which the calculated breaking strength of a rope is reduced to take account of the reduction in *strength* (3.152) caused by a *splice* (3.144) or other end termination

[SOURCE: ISO 19901-6:2009, 3.93]

3.157

third party

person or body that is recognized as being independent of the parties involved, as concerns the issue in question

3.158

topside

structure (3.153) and equipment placed on a supporting *foundation* (3.60) such as a *tower* (3.160) including *nacelle* (3.95), *hub* (3.70) and *blades* (3.14) as well as topside for *offshore substations* (3.102) or *offshore accommodation platforms* (3.99)

Note 1 to entry: For a jack-up, the hull is not part of the topsides.

Note 2 to entry: A separate fabricated deck or module support frame is part of the topsides.

[SOURCE: ISO 19900:2013, 3.52, modified - Note 1 to entry slightly reworded for clarity.]

3.159

tow

marine transportation of an object or its supporting *barge* (3.11) by being pulled or pushed by tow vessel(s)

Note 1 to entry: A tow can be defined into the following types:

- dry: marine transportation of an object with the object located clear of the water aboard a barge or other unit;
- wet: marine transportation of an object with the object floating directly in the water.

[SOURCE: ISO 19901-6:2009, 3.95]

3.160

tower

tower constituting the part of a *support structure* (3.155) for the *wind turbine generator* (3.176) between the top flange of the *transition piece* (3.163) or top flange of the *foundation* (3.60) and the bottom flange of the *nacelle* (3.95) connecting the *sub-structure* (3.154) to the *rotor-nacelle assembly* (3.124)

Note 1 to entry: See Figure 1.

[SOURCE: IEC 61400-3]

3.161

trailer

unpowered vehicle towed by a powered vehicle used for transport

3.162

transport frames

steel *structure* (3.153) to support, if required, the onshore transport of the *wind turbine generator* (3.176) components which will be joined onto the corresponding steel structure at the vessel [i.e. *bolting* (3.16) frames or twistlocks] for seafastening

3.163

transition piece

part of the *foundation* (3.60) connecting the *foundation support structure* (3.155) to the *wind turbine generator* (3.176) *tower* (3.160)

3.164**tripod**

three-legged offshore *foundation* (3.60), normally fixed by piles to the *seabed* (3.128)

3.165**trunnion**

lift point (3.76) on a *structure* (3.153) consisting of a tubular member or cast cantilever with a stopping plate at the end, around which a sling or *grommet* (3.62) can be passed

Note 1 to entry: An upending trunnion is used to rotate a structure from horizontal to vertical, or vice versa, and the trunnion forms a bearing point around which the sling, grommet or another structure rotates.

[SOURCE: ISO 19901-6:2009, 3.97]

3.166**tugger line**

line between a winch and an object to control the orientation and position to prevent or reduce the motion, or to position a lifted object during an installation operation

[SOURCE: ISO 19901-6:2009, 3.98]

3.167**upending**

process of changing the orientation of an object in the water from the horizontal to the vertical by means of ballasting, flooding, by crane assistance or a combination of these techniques, or in air only by means of crane assistance

EXAMPLE Upending in air only by means of crane assistance, *monopile* (3.93) using upending tool or bucket.

[SOURCE: ISO 19901-6:2009, 3.99]

3.168**unexploded ordnance****UXO**

explosive weapons (bombs, naval mines, etc.) that did not explode when they were deployed mostly during wars in the sea and still pose a potential risk of detonation once touched during *marine operation* (3.82) by either jack-up vessels or equipment during *cable laying* (3.20) and *cable burial* (3.19) or *deburial*

Note 1 to entry: Explosive remnants of war that has been primed, fused, armed or otherwise prepared for use or used. It may have been fired, dropped, launched or projected yet remains unexploded either through malfunction or design or for any other reason (jettison or dumping). UXOs laying on *seabed* (3.128) or buried pose a risk of blast or detonation once stimulated with sufficient energy during marine operations (geotechnical operations, cable laying with ploughing and trenching or piling operations).

3.169**verification**

examination made to confirm that an activity, product, or service is in accordance with specified requirements

[SOURCE: ISO 19901-6:2009, 3.100]

3.170**watertight**

capability of preventing the penetration of water into or through the *structure* (3.153) with a water pressure head corresponding to that for which the surrounding structure is designed

[SOURCE: ISO 19901-6:2009, 3.101]

3.171

weather-restricted operation

marine operation (3.82) that can take place safely within the limits of a favourable weather forecast

Note 1 to entry: It is not necessary that the design weather criteria reflect the statistical extremes for the area and season. A suitable factor should be applied between design weather criteria and operational weather limiting criteria.

[SOURCE: ISO 19901-6:2009, 3.102]

3.172

weathertight

capability of preventing the penetration of water into the *structure* (3.153) during temporary exposure to water

Note 1 to entry: A watertight closing appliance is also considered weathertight.

[SOURCE: ISO 19901-6:2009, 3.103]

3.173

weather-unrestricted operation

marine operation (3.82) that can take place safely in any weather condition that can be encountered during a season

Note 1 to entry: The statistical extremes for the area and seasons are considered in the design weather criteria.

[SOURCE: ISO 19901-6:2009, 3.104]

3.174

weather window

operational duration (3.106) including a contingency period determined with due allowance for the nature and criticality of the individual operations (safe to safe) and for which forecast environmental conditions remain below prescribed operational limits

3.175

50/50 weight estimate

value representing the median value in the probability distribution of weight estimates

Note 1 to entry: The actual weight is equally likely to be smaller or larger than the 50/50 weight estimate.

Note 2 to entry: The 50/50 weight estimate is used as the basis for weight budgeting.

[SOURCE: IEC 61400-3:2010, Figure 1]

3.176

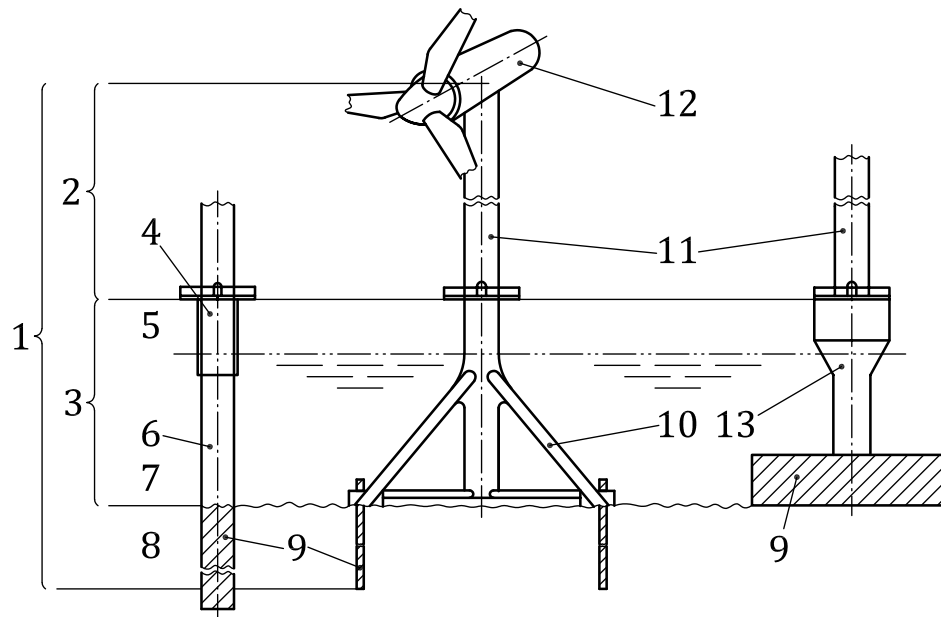
wind turbine generator

offshore wind turbine generator

WTG

turbine generator which converts the kinetic wind energy into electric energy, typically including the *tower* (3.160), the *nacelle* (3.95), the rotor, the *blades* (3.14) and the associated equipment

Note 1 to entry: See Figure 1 depicting all parts of an offshore wind turbine.



Key

1 support structure	6 pile	11 tower
2 tower	7 sea floor	12 rotor-nacelle assembly
3 sub-structure	8 seabed	13 GBS
4 transition piece with platform	9 foundation	
5 water level	10 jacket/tripod	

Figure 1 — Parts of an offshore wind turbine (SOURCE: IEC 61400-3:2009, Figure 1)

3.177

working load limit

WLL

maximum load that can safely be applied to a rope, sling, *grommet* (3.62), shackle or *lift point* (3.76) or lifting tool or *spreader bar* or *frame* (3.145)

[SOURCE: ISO 19901-6:2009, 3.106, modified for clarity.]

4 Symbols and abbreviated terms

4.1 Symbols

$A_1, A_2, A_3,$	areas under or between the wind heeling moment curve and the hydrostatic righting moment curve (see Figures 4 and 5)
B_0	total available buoyancy of the structure
B_r	reserve buoyancy, expressed in percent of B_0
d	nominal diameter of a rope, sling or leg of a grommet, expressed in millimetres
d_h	diameter of shackle pinhole, expressed in millimetres
d_p	diameter of shackle pin, expressed in millimetres
f_{fr}	calculated percentage friction force

f_{SF}	safety factor (in WSD method)
$f_{SF,FRS}$	safety factor for a fibre rope sling
$f_{SF,FRG}$	safety factor for a fibre rope grommet
$f_{SF,sh}$	safety factor for a shackle (in WSD method)
$f_{SF,Y}$	safety factor for component Y (in WSD method)
$F_{CS,FRS}$	corresponding breaking strength of a fibre rope sling
$F_{CS,FRG}$	corresponding breaking strength of a fibre rope grommet
F_{dgf}	design grommet force (for a complete grommet)
$F_{dgf,1}$	design force for one leg of a grommet
F_{dhl}	design hook load for a one-crane lift
$F_{dhl,i}$	design hook load on hook i for a two-hook lift
F_{dsf}	design sling force for a one-part sling
$F_{dsf,2\text{ parts}}$	design sling force for each part of a two-part sling
F_{hl}	“dynamic” or nominal hook load, expressed in kilonewtons
F_{rgf}	representative grommet force (for a complete grommet)
$F_{rgf,1}$	representative force for one leg of a grommet
F_{rhl}	representative hook load for a one-hook lift by a single crane
$F_{rhl,i}$	representative hook load on hook i for a two-hook lift ($i = 1, 2$)
F_{rsf}	representative sling force for a one-part sling
$F_{rsf,2\text{ parts}}$	representative sling force for each part of a two-part sling
$F_{srhl,i}$	nominal hook load, F_{hl} , statically resolved between hooks ($i = 1, 2$)
F_{BP}	continuous static bollard pull of each tug, expressed in kilonewtons
$F_{DS,FRS}$	design strength of a fibre rope sling, in force terms;
$F_{DS,FRG}$	design strength of a fibre rope grommet, in force terms;
$F_{DS,sh}$	design strength of a shackle in force terms
$F_{DS,Y}$	design strength of component Y in force terms, where Y is a sling or a grommet (in PFD method)
F_{min}	minimum value of the breaking strength of a steel wire rope, expressed in kilonewtons
f_{MR}	is the metocean reduction factor (alpha factor according to Reference [56] or as determined project-specifically);
F_{PR}	minimum towline pull required, expressed in kilonewtons
$F_{RS,sh}$	representative strength of a shackle in force terms
$F_{RS,FRS}$	representative strength of a fibre rope sling

$F_{RS,FRG}$	representative strength of a fibre rope grommet
$F_{RS,Y}$	representative strength of component Y in force terms, where Y is a sling or a grommet (see 19.6)
$F_{WLL,FRS}$	WLL of a fibre rope sling, in force terms
$F_{WLL,FRG}$	WLL of a fibre rope grommet, in force terms
$F_{WLL,sh}$	working load limit (WLL) of a shackle in force terms
$F_{WLL,Y}$	working load limit (WLL) of component Y in force terms, where Y is a sling or a grommet (in WSD method)
g	acceleration of gravity, equal to 9,81 m/s ²
H_c	height of cribbing above deck, expressed in millimetres
H_{max}	maximum anticipated wave height at the site during loadout, expressed in metres
H_s	significant wave height, expressed in metres
k_{be}	bending efficiency factor
k_{CoG}	CoG factor, the value of which reflects the uncertainty in the position of the CoG when statically distributing the lift weight between the lift points
k_{DAF}	dynamic amplification factor
k_{lf}	lateral force factor
k_{sf}	CoG shift factor, the value of which reflects the uncertainty in the position of the CoG when statically distributing the total hook load between the two hooks
k_{skl}	skew load factor, the value of which reflects unequal load sharing in an indeterminate lift between slings that differ in length as a result of manufacturing tolerances
k_{te}	termination efficiency factor
k_{tf}	tilt factor, the value of which reflects the effect of uneven heights of the crane hooks and/or uneven hoisting speeds when statically distributing the total hook load between the two hooks
k_{wcf}	weight contingency factor
k_{yaw}	yaw factor, the value of which reflects the effect of yawing during lifting with two cranes when statically distributing the lift weight between the lift points
l_{freebd}	effective freeboard, expressed in metres
L_{lim}	is the design operational limit (operational limiting criteria according to Reference [56]).
L_{WF}	is the forecasted operational limit (forecasted operation criteria according to Reference [56]);
P_{clf}	calculated lateral force on a lift point due to known misalignment between the orientation of the lift point and the sling direction (where applicable)
P_{dlf}	design lateral force on a lift point
P_{ddf}	design force on a lift point in line with the sling direction

P_{dvf}	design vertical force on a lift point
P_{rlf}	representative lateral force on a lift point
P_{rdf}	representative force on a lift point in line with the sling direction
P_{rvf}	representative vertical force on a lift point
T_C	is the estimated maximum contingency period.
T_{eff}	tug efficiency in the considered sea conditions, expressed in percent
T_{POP}	is the planned operation duration (or the duration required to stop the operation and go back to a safe condition);
T_R	is the weather window (operation reference period according to Reference [56]);
W	gross weight
W_c	cargo weight, expressed in kilo newtons (kN)
W_{cw}	calculated weight
W_{lw}	“dynamic” or nominal lift weight
$(W_{rlw})_{one\ crane}$	representative lift weight on a lift point for one-hook lifts by one crane
$(W_{rlw})_{two\ cranes}$	representative lift weight on a lift point for lifts by two cranes
W_{rw}	rigging weight
$W_{rw,i}$	rigging weight associated with crane hook i ($i = 1, 2$)
W_s	weight of the sling
W_{st}	static hook load
$W_{srlw,i}$	statically resolved lift weight for crane hook i ($i = 1, 2$)
$W_{srlw,j}$	statically resolved lift weight acting on lift point j
$W_{srlw,i,j}$	statically resolved lift weight for crane hook i acting on lift point j
W_{ww}	weighed weight
W_0	weight of the structure in air
Y	grommet types SWRG or FRG
$\gamma_{f,hl}$	partial action factor for hook load (in PFD method)
$\gamma_{f,lp}$	partial action factor for forces on a lift point when designing lift points and their attachment to the structure (in PFD method)
$\gamma_{f,mf}$	partial action factor for forces on a lift point when designing structural members directly supporting or framing into the lift points (in PFD method)
$\gamma_{f,m}$	partial action factor for forces on a lift point when designing other structural members (in PFD method)
$\gamma_{f,s}$	partial action factor for forces in slings, grommets and shackles (in PFD method)

γ_R	partial resistance factor (in PFD method)
$\gamma_{R,FRS}$	partial resistance factor for a fibre rope sling
$\gamma_{R,FRG}$	partial resistance factor for a fibre rope grommet
$\gamma_{R,sh}$	partial resistance factor for a shackle (in PFD method)
$\gamma_{R,Y}$	partial resistance factor for component Y (in PFD method) Y = SWRS; SCLS; FRS; SWRG or FRG
ϕ_{max}	maximum dynamic heeling angle due to wind and waves, expressed in degrees
θ	angle between the sling and the horizontal plane, expressed in degrees

4.2 Abbreviated terms

AAAA	Always afloat, always accessible
AIS	Automatic identification system
ALARP	As low as reasonably practicable
AMS	Anchor management system
ASD/WSD	Allowable stress design/working stress design
CAD	Computer aided design
CBRA	Cable burial risk assessment
CCTV	Closed circuit television
CGBL	Calculated grommet breaking load
CoG	Center of gravity
COLREGS	International regulations for preventing collisions at sea
COSHH	Control of substance hazardous to health
CPT	Cone penetration test
CRBL	Calculated rope breaking load
CTV	Crew transfer vessel
DAF	Dynamic amplification factor
DGPS	Differential global positioning system
DoC	Depth of cover
DoL	Depth of lowering
DP	Dynamic positioning
EPIRB	Emergency position indicating radio beacon
ERCoP	Emergency response cooperation plan

ETA	Estimated time of arrival
ETD	Estimated time of departure
FIFO	First-in-first-out
FMEA	Failure mode and effects analysis
FRG	Fibre rope grommet
FRS	Fibre rope sling
GA	General arrangement
GBS	Gravity base structure
GDB	Geo data base
GDPR	General protection regulation (EU)
GIS	Geographical information system
GM	Effective metacentric height
GNSS	Global navigation satellite system
GZ	Metacentric height
HAZID	Hazard identification study
HAZOP	Hazard and operability study
HDD	Horizontal direction drilling
HSSE	Health, safety, security and environment
ICPC	International cable protection committee
ID	Personal identification
IHO	International Hydrographic Organization
IMCA	International Marine Contractors Association
IMDG	International maritime dangerous goods
IMO	International Maritime Organization
ISM	International safety management
ISPS	International ship and port facility safety
LAN	Local area network
LAT	Lowest astronomical tide
LIFO	Last-in-last-out
LRFD	Load and resistance factor design
MBES	Multibeam echosounder

MBL	Minimum breaking load
MBR	Minimum bending radius
MBS	Minimum breaking strength
MC	Marine coordination
MRCC	Marine rescue coordination center
MSDS	Material safety data sheet
MWS	Marine warranty surveyor
NDT	Non-destructive test
NTE	Not-to-exceed
OHS	Occupational health and safety
OWF	Offshore wind farm
PFD	Partial factor design
PLGR	Pre lay grapnel run
PMS	Positioning monitoring system
PNR	Point of no return
PPE	Personal protective equipment
pUXO	Possible UXO
QRA	Quantified risk analysis
RAMS	Risk assessment and method statements
RCS	Recognized classification society
ROV	Remote operated vehicle
RPD	Rack phase difference
RPL	Route positioning list
RTK	Real time kinematic system
SAR	Search and rescue
SCLS	Steel cable-laid sling
SHL	Static hook load
SKL	Skew load factor
SOLAS	Safety of life at sea convention
SPMT	Self-propelled modular transporters
SWL	Safe working load

SWRG	Steel wire rope grommet
SWRS	Steel wire rope sling
TV	Television
ULS	Ultimate limit state
UXO	Unexploded ordnances
VIO	Vortex induced oscillations
WG84	World Geodetic System
WLL	Working load limits
WSD	Working stress design
WTG	Wind turbine generator

5 General considerations

5.1 Introduction

5.1.1 General

There are three categories of “port facility” when installing, maintaining, repairing and decommissioning offshore wind farms:

- almost all WTG components, foundations, topsides and cabling are manufactured in facilities adjacent to a loadout quay, and this constitutes the “manufacturer’s port”;
- most often the components are transported to a marshalling port, from where they are loaded out onto the installation vessel and taken to the offshore wind farm, but sometimes they are transferred directly from the manufactures to the OWF on board the installation vessel;
- during the operational phase and partially during installation, there can be maintenance issues that arise. Maintenance teams can be mobilised from a “maintenance port”.

In terms of activities at ports there are three distinct types:

- vessel operations associated with transportation which can be characterized as “project cargo logistics”;
- vessel operations associated with loadout and installation when components leave the marshalling port;
- vessel operations when components leave the maintenance port are associated with equipment that requires maintenance during marine operations.

Port operations include activities at the staging port in order to prepare the components for loadout as well as any preparations of the port areas for the construction, maintenance, repair or decommissioning. Such operations can include:

- pre-assembly of components;
- temporary storage;
- positioning components at the quayside for loadout;
- set-up of offices for construction;

- implementation of port security measures;
- offload of components from barge or vessel to shore;
- soil preparation and levelling of the marshalling port;
- seabed dredging and/or rock placement adjacent to the loadout quay.

Marine operations related to offshore wind farms include short-term marine movements and other activities where the structure(s) or the operation is at risk from the marine environment. Such operations include but are not limited to:

- loadout from shore to barge or vessel;
- launching from shore, or sheltered areas or barge to water, e.g. floating monopiles;
- float-out topsides from dry docks;
- wet or dry towage and other marine transportations;
- temporary anchoring and stationkeeping during construction;
- installation by means of launching or float-off, upending, lowering by ballasting, float-over or lifting;
- cable installation and cable repair;
- positioning, jacking and pre-loading jack-ups and leg stabilised units;
- unexploded ordnance survey;
- geophysical and geotechnical surveys;
- refuelling offshore substations and temporary generators used on WTG before full energization (if required);
- bunkering of offshore installation vessels;
- provisioning of vessels and structures in the offshore wind farm;
- paint repair works;
- scour protection;
- component exchange;
- decommissioning and total or partial removal of the structure including reinstatement of the environmental conditions prior to site development to the extent required.

General requirements and guidance on safety and emergency issues, and reference to applicable legislation, are contained in [5.1.2](#) to [5.10](#). Effective management of these issues requires full knowledge of applicable regulatory requirements.

General disclaimer to technical requirements on stability, crane and towline stated in these rules: if special purpose vessels are used, IMO rules apply in respect to these requirements.

5.1.2 Safety requirements

Personnel is the most valuable asset and protecting them should be at the forefront of any HSSE endeavour.

A system such as ISO 45001^[66], "Occupational health and safety (OHS) management system", or any other equally acceptable system should be used.

The overall objective of the safety of marine operations is to perform all operational activities at minimum risk of accidents or incidents to personnel, environment and property. This can be met if the following factors to minimize the risk are taken into consideration:

- the operation is designed taking into account the statistical weather extremes for the area and season;
- the operational weather conditions, chosen at values not exceeding the specified operational limits, are forecasted for a sufficiently long period to enable completion of the operation;
- the required equipment, vessels and other means are designed and checked for adequate performance with respect to their intended use;
- there is redundancy in the critical equipment provided to cover possible breakdown situations;
- the operations are planned, in nature and duration, such that accidental situations, breakdowns or delays have a very low probability of occurrence and are covered by detailed contingency plans;
- adequate documentation has been prepared for a safe, step-by-step execution of the operation, with clear indications of the organization and chain of command;
- the operations are conducted by competent personnel;
- safe systems of work are devised in light of a systematic risk assessment.

Special precautions shall be adhered to during jacking operations. Location specific assessment and procedures shall be provided by each of the respective offshore installation vessels for each jacking location in a vessel approach plan and, where appropriate, reviewed by the marine warranty surveyor before jacking operations take place. Marine coordination during construction works shall issue a site chart (showing the locations of the structures and cables, etc. in the offshore site) which shall be used by all offshore installation vessels in planning their vessel movements. The approval of the vessel approach plan by a marine warranty surveyor (MWS) can be a precondition for obtaining a permit to access the location in question.

Each of the respective offshore installation vessels shall take full account of the exact locations where vessels have previously jacked and the positions of proposed and/or installed subsea cables and scour protection.

In case of anchoring, the respective offshore installation vessel shall provide detailed anchor plans taking full account of project plan, subsea cables, etc. for approval by the MWS. Actual anchor positions shall be documented by the offshore installation vessel when deployed and again when recovered. Each of the respective offshore installation vessel safety zones shall take into account anchor positions.

5.2 Jurisdiction

5.2.1 Introduction

Installation of offshore wind farms and related port and marine operations are subject to approval by appropriate parties in due time before actual activities commence. Thus, national and international regulations and guidelines on personnel safety and protection of the environment are the governing requirements. It should also be noted that marine operations can involve more than one nation's area of jurisdiction and that, for barges and vessels, while the flag state jurisdiction is primary, additional requirements can be imposed by the coastal or port state.

5.2.2 Safety of life at sea

In order to respect the safety of life at sea, information with respect to conventions, codes and guidelines is required. The information is subdivided into separate provisions with respect to vessels on international voyages and vessels on domestic voyages, and is further subdivided to separately address mandatory instruments (i.e. conventions) and recommended instruments (i.e. codes and recommendations).

For vessels on international voyages, the vessel's flag state generally requires the vessel's compliance with the international conventions and mandatory codes identified in References [22] to [28], [39] and [44]. Such compliance is generally demonstrated by the issuance of the relevant certificate mandated by the convention.

Before selection of any vessel where the vessel's flag state is not party to the most recent protocols or amendments to the instruments referenced above, careful consideration should be exercised.

The international conventions identified in References [22] to [28] do not apply to domestic voyages. In such cases, national standards offering equivalent levels of safety should be applied.

References [34], [38], [40] to [42], and [45] to [48] provide recommendations that the flag state can adopt and apply as mandatory requirements, as applicable, to vessels under their jurisdiction. Where these are not adopted and applied by the flag state, national standards offering equivalent levels of safety should be applied.

5.2.3 Environment

A system such as the suit of standards ISO 14000^[64], "Environmental management", or any other equally acceptable system should be used.

The legislation for the protection of the environment is evolutionary and covers various aspects. It is embodied in a number of instruments of broad scope, from the law of the sea and general practices covering natural resources exploitation, protection of marine environment, pollution and dumping of waste, through to international conventions, regional conventions and national rules.

Applicable international conventions can be found in References [32] to [34].

5.3 HSSE plan

A health, safety, security and environment (HSSE) plan shall be established. The objectives of the plan shall be:

- to protect the health of the workforce;
- to document the HSSE standards, processes and procedures that apply to the work;
- to identify, assess and manage hazards and risks arising during the work, reducing the risks to as low as reasonably practicable (ALARP);
- to ensure that safety is inherent in planning and design of the work;
- to ensure minimal impact on the environment;
- to ensure the security of the work site, particularly the port facilities including components and access procedures.

The HSSE plan shall identify the allocation of responsibilities and interfaces during each phase of the project, together with the specific procedures, methods and work instructions to be applied, including risks from simultaneous operations at the construction site.

Selected issues to be taken up in the HSSE plan are described in 5.4 to 5.10.

5.4 Risk management

5.4.1 Introduction

For risk management, a recognized standard shall be used, such as ISO 31000^[65] or ISO 17776^[3]. In any case, the provisions of 5.4 and 5.5 apply.

It is good industry practice that no major activity is carried out on a site without an approved method statement, describing all performed activities in detail. The risk assessment process shall be part of that approval procedure. The risk assessment resulting in RAMS to be provided, shall analyse the activities performed in the method statement.

A mandatory interface shall be defined to ensure that there is extensive and adequate communication with all parties involved in the project. All relevant parties on project (internal or external) shall contribute to the RAMS assessment (including engineering and installation design). As a consequence, all design phase documents related to the installation shall be cross referenced in the method statements.

The overall responsibility for risk management shall be clearly defined when planning marine operations.

Risk management shall be applied to the project to reduce the effects of hazards and to limit the overall risk. This objective can be achieved by addressing the following functions in turn:

- identification of potential hazards;
- assessment of risk potential;
- prevention of hazards wherever possible;
- control to reduce the potential consequences of unavoidable hazards;
- measures to reduce the probabilities of occurrence of an incident, or to mitigate the consequences of an incident, should one occur.

Each port and marine operation, including each major system that is essential to the performance and safety of port and marine operations, e.g. lifting procedures, power generation and supply systems, ballast and compressed air systems, shall be subjected to a documented hazard study.

Personnel and organisations involved in port and marine operations, as well as those involved in the design and operation of the systems, shall take part in the hazard studies.

It is recommended that consequence assessment be used to rank the probabilities and consequences of various events, to form a basis for further investigation if necessary.

5.4.2 Techniques to evaluate risks

Appropriate techniques to evaluate risks include, but are not limited to:

- design and execution: HAZOP, HAZID, and scenario based risk assessments;
- execution implementation: job safety analyses, safety campaigns and drills, hazard hunts and tool box talks, which can be applied at field supervision level.

QRA techniques can be used:

- to compare levels of risk between alternative proposals or between known and novel methods;
- to enable rational choices to be made between alternatives.

5.5 Job safety analysis

Job safety analysis should be performed to detail the:

- sequence of the operation;
- equipment to be used at each stage;
- hazards to be controlled;