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Petroleum and natural gas industries — Specific requirements for offshore structures —

Part 1: **Metocean design and operating considerations**

Industries du pétrole et du gaz naturel — Exigences spécifiques relatives aux structures en mer —

Partie 1: Dispositions océano-météorologiques pour la conception et l'exploitation

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 19901-1 was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*, Subcommittee SC 7, *Offshore structures*.

ISO 19901 consists of the following parts, under the general title *Petroleum and natural gas industries — Specific requirements for offshore structures*:

— *Part 1: Metocean design and operating considerations*

— *Part 2: Seismic design procedures and criteria*

— *Part 4: Geotechnical and foundation design considerations*

— *Part 5: Weight control during engineering and construction*

— *Part 7: Stationkeeping systems for floating offshore structures and mobile offshore units*

The following parts are under preparation:

— *Part 3: Topsides structure*

— *Part 6: Marine operations*

ISO 19901 is one of a series of standards for offshore structures. The full series consists of the following International Standards.

— ISO 19900, *Petroleum and natural gas industries — General requirements for offshore structures*

— ISO 19901 (all parts), *Petroleum and natural gas industries — Specific requirements for offshore structures*

— ISO 19902, *Petroleum and natural gas industries — Fixed steel offshore structures*[1)]

— ISO 19903, *Petroleum and natural gas industries — Fixed concrete offshore structures*[1)]

1) To be published.

— ISO 19904-1, *Petroleum and natural gas industries — Floating offshore structures — Part 1: Monohulls, semi-submersibles and spars*[2)]

— ISO 19904-2, *Petroleum and natural gas industries — Floating offshore structures — Part 2: Tension leg platforms*[3)]

— ISO 19905-1, *Petroleum and natural gas industries — Site-specific assessment of mobile offshore units — Part 1: Jack-ups*[3)]

— ISO/TR 19905-2, *Petroleum and natural gas industries — Site-specific assessment of mobile offshore units — Part 2: Jack-ups commentary*[3)]

— ISO 19906, *Petroleum and natural gas industries — Arctic offshore structures*[3)]

2) To be published.

3) Under preparation.

Introduction

The series of International Standards applicable to types of offshore structure, ISO 19900 to ISO 19906, constitutes a common basis covering those aspects that address design requirements and assessments of all offshore structures used by the petroleum and natural gas industries worldwide. Through their application the intention is to achieve reliability levels appropriate for manned and unmanned offshore structures, whatever the type of structure and the nature or combination of the materials used.

It is important to recognize that structural integrity is an overall concept comprising models for describing actions, structural analyses, 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. The implications involved in modifications, therefore, need to be considered in relation to the overall reliability of all offshore structural systems.

The series of International Standards applicable to types of offshore structure is intended to provide a wide latitude in the choice of structural configurations, materials and techniques without hindering innovation. Sound engineering judgement is therefore necessary in the use of these International Standards.

The overall concept of structural integrity is described above. Some additional considerations apply for metocean design and operating conditions. The term “metocean” is short for “meteorological and oceanographic” and refers to the discipline concerned with the establishment of relevant environmental conditions for the design and operation of offshore structures. A major consideration in the design and operation of such a structure is the determination of actions on, and the behaviour of, the structure as a result of winds, waves and currents.

Environmental conditions vary widely around the world. For the majority of offshore locations there are little numerical data from historic conditions; comprehensive data often only start being collected when there is a specific need, for example, when exploration for hydrocarbons is being considered. Despite the usually short duration for which data are available, designers of offshore structures need estimates of extreme and abnormal environmental conditions (with an individual or joint probability of the order of 1×10^{-2} / year and 1×10^{-3} to 1×10^{-4} / year, respectively).

Even for areas like the Gulf of Mexico, offshore Indonesia and the North Sea, where there are up to 30 years of fairly reliable measurements available, the data are insufficient for rigorous statistical determination of appropriate extreme and abnormal environmental conditions. The determination of relevant design parameters has therefore to rely on the interpretation of the available data by specialists, together with an assessment of any other information, such as prevailing weather systems, ocean wave creation and regional and local bathymetry, coupled with consideration of data from comparable locations. It is hence important to employ specialists from both the metocean and structural communities in the determination of design parameters for offshore structures, particularly since setting of appropriate environmental conditions depends on the chosen option for the offshore structure.

This part of ISO 19901 provides procedures and guidance for the determination of environmental conditions and their relevant parameters. Requirements for the determination of the actions on, and the behaviour of, a structure in these environmental conditions are given in ISO 19901-3, ISO 19901-6, ISO 19901-7, ISO 19902, ISO 19903, ISO 19904, ISO 19905 and ISO 19906.

Some background to, and guidance on, the use of this part of ISO 19901 is provided in informative Annex A. The clause numbering in Annex A is the same as in the normative text to facilitate cross-referencing.

A discussion on wave spectra is provided in informative Annex B.

Regional information, where available, is provided in informative Annex C.

Petroleum and natural gas industries — Specific requirements for offshore structures —

Part 1: Metocean design and operating considerations

1 Scope

This part of ISO 19901 gives general requirements for the determination and use of meteorological and oceanographic (metocean) conditions for the design, construction and operation of offshore structures of all types used in the petroleum and natural gas industries.

The requirements are divided into two broad types:

a) those that relate to the determination of environmental conditions in general, together with the metocean parameters that are required to adequately describe them;

b) those that relate to the characterization and use of metocean parameters for the design, the construction activities or the operation of offshore structures.

The environmental conditions and metocean parameters discussed comprise

— extreme and abnormal values of metocean parameters that recur with given return periods that are considerably longer than the design service life of the structure,

— long-term distributions of metocean parameters, in the form of cumulative, conditional, marginal or joint statistics of metocean parameters, and

— normal environmental conditions that are expected to occur frequently during the design service life of the structure.

Metocean parameters are applicable to

— the determination of actions and action effects for the design of new structures,

— the determination of actions and action effects for the assessment of existing structures,

— the site-specific assessment of mobile offshore units,

— the determination of limiting environmental conditions, weather windows, actions and action effects for pre-service and post-service situations (i.e. fabrication, transportation and installation or decommissioning and removal of a structure), and

— the operation of the platform, where appropriate.

NOTE Specific metocean requirements for tension leg platforms are to be contained in ISO 19904-2[1], for site-specific assessment of jack-ups in ISO 19905-1[2], for arctic structures in ISO 19906[3] and for topsides structures in ISO 19901-3[4].

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 19900, *Petroleum and natural gas industries — General requirements for offshore structures*

ISO 19902, *Petroleum and natural gas industries — Fixed steel offshore structures* [4)]

ISO 19903, *Petroleum and natural gas industries — Fixed concrete offshore structures*

ISO 19904-1, *Petroleum and natural gas industries — Floating offshore structures — Part 1: Monohulls, semi-submersibles and spars*

3 Terms and definitions

For the purpose of this document, the terms and definitions given in ISO 19900 and the following apply.

3.1
abnormal value
design value of a parameter of abnormal severity used in accidental limit state checks in which a structure is intended not to suffer complete loss of integrity

NOTE Abnormal events have probabilities of the order of 10^{-3} to 10^{-4} per annum. In the limit state checks, some or all of the partial factors are set to 1,0.

3.2
chart datum
local datum used to fix water depths on a chart or tidal heights over an area

NOTE Chart datum is usually an approximation to the level of the lowest astronomical tide.

3.3
conditional distribution
conditional probability
statistical distribution (probability) of the occurrence of a variable A, given that other variables B, C, … have certain assigned values

NOTE The conditional probability of A given that B, C, … occur is written as $P(A|B,C,\ldots)$. The concept is applicable to metocean parameters, as well as to actions and action effects.

EXAMPLE When considering wave parameters, A can be the individual crest elevation, B the water depth and C the significant wave height, and so on.

3.4
design crest elevation
extreme crest elevation measured relative to still water level

NOTE The design crest elevation is used in combination with information on astronomical tide, storm surge, platform settlement, reservoir subsidence and water depth uncertainty and is derived from an extreme value analysis. Because of the simplified nature of the models used to estimate the kinematics of the design wave, the design crest elevation can be different from, usually somewhat greater than, the crest elevation of the design wave used to calculate actions on the structure.

4) To be published.

3.5
design wave
deterministic wave used for the design of an offshore structure

NOTE 1 The design wave is an engineering abstract. Most often it is a periodic wave with suitable characteristics (e.g. height H, period T, steepness, crest elevation). The choice of a design wave depends on

— the design purpose(s) considered,

— the wave environment,

— the geometry of the structure,

— the type of action(s) or action effect(s) pursued.

NOTE 2 Normally, a design wave is only compatible with design situations in which the action effect(s) are quasi-statically related to the associated wave actions on the structure.

3.6
extreme value
design value of a parameter used in ultimate limit state checks, in which a structure's global behaviour is intended to stay in the elastic range

NOTE Extreme events have probabilities of the order of 10^{-2} per annum.

3.7
gust
brief rise and fall in wind speed lasting less than 1 min

NOTE In some countries, gusts are reported in meteorological observations if the maximum wind speed exceeds approximately 8 m/s.

3.8
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

NOTE 1 For design purposes, the specified duration depends on the dimensions and natural period of the (part of the) structure 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 In practice, for design purposes, the gust wind speeds for different durations (e.g. 3 s, 5 s, 15 s, 60 s) are derived from the wind spectrum.

3.9
highest astronomical tide
HAT
level of high tide when all harmonic components causing the tides are in phase

NOTE The harmonic components are in phase approximately once every 19 years, but these conditions are approached several times each year.

3.10
hindcasting
method of simulating historical (metocean) data for a region through numerical modelling

3.11
long-term distribution
probability distribution of a variable over a long time scale

NOTE The time scale exceeds the duration of a sea state, in which the statistics are assumed constant (see short-term distribution in 3.29). The time scale is hence comparable to a season or to the design service life of a structure.

EXAMPLE Long-term distributions of

— significant wave height,
— significant wave height in the months May to September,
— individual wave heights,
— current speeds (such as for the vortex induced vibrations of drilling risers),
— scatter diagrams with the joint distribution of significant wave height and wave period (such as for a fatigue analysis), or
— a particular action effect.

3.12
lowest astronomical tide
LAT
level of low tide when all harmonic components causing the tides are in phase

NOTE The harmonic components are in phase approximately once every 19 years, but these conditions are approached several times each year.

3.13
marginal distribution
marginal probability
statistical distribution (probability) of the occurrence of a variable A that is obtained by integrating over all values of the other variables B, C, …

NOTE The marginal probability of A for all values of B, C, … is written as $P(A)$. The concept is applicable to metocean parameters, as well as to actions and action effects.

EXAMPLE When considering wave conditions, A can be the individual crest elevation for all mean zero-crossing periods B and all significant wave heights C, occurring at a particular site.

3.14
marine growth
living organisms attached to an offshore structure

3.15
mean sea level
MSL
arithmetic mean of all sea levels measured at hourly intervals over a long period, ideally 19 years

NOTE Seasonal changes in mean level can be expected in some regions and over many years the mean sea level can change.

3.16
mean wind speed
time-averaged wind speed, averaged over a specified time interval

NOTE The mean wind speed varies with elevation above mean sea level and the averaging time interval; a standard reference elevation is 10 m and a standard time interval is 1 h. See also sustained wind speed (3.37) and gust wind speed (3.8).

3.17
mean zero-crossing period
average period of the (up or down) zero-crossing waves in a sea state

NOTE In practice the mean zero-crossing period is often estimated from the zeroth and second moments of the wave spectrum as $T_z = T_2 = \sqrt{m_0(f)/m_2(f)} = 2\pi\sqrt{m_0(\omega)/m_2(\omega)}$.

3.18
monsoon
wind which blows for several months approximately from one direction

NOTE The term was first applied to the winds over the Arabian Sea which blow for six months from north-east and for six months from south-west, but it has been extended to similar winds in other parts of the world.

3.19
most probable maximum
value of the maximum of a variable with the highest probability of occurring

NOTE The most probable maximum is the value for which the probability density function of the maxima of the variable has its peak. It is also called the mode or modus of the statistical distribution.

3.20
operating conditions
most severe combination of environmental conditions under which a given operation will be permitted to proceed

NOTE Operating conditions are determined for operations that exert a significant action on the structure. Operating conditions are usually a compromise: they are sufficiently severe that the operation can generally be performed without excessive downtime, but they are not so severe that they have an undue impact on design.

3.21
polar low
depression that forms in polar air, often near a boundary between ice and sea

3.22
residual current
part of the total current that is not constituted from harmonic tidal components (i.e. the tidal stream)

NOTE Residual currents are caused by a variety of physical mechanisms and comprise a large range of natural frequencies and magnitudes in different parts of the world.

3.23
return period
average period between occurrences of an event or of a particular value being exceeded

NOTE 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.

3.24
scatter diagram
joint probability of two or more (metocean) parameters

NOTE A scatter diagram is especially used with wave parameters in the metocean context, see A.5.8. The wave scatter diagram is commonly understood to be the probability of the joint occurrence of the significant wave height (H_S) and a representative period (T_z or T_p).

3.25
sea floor
interface between the sea and the seabed

[ISO 19901-4:2003]

3.26
sea state
condition of the sea during a period in which its statistics remain approximately constant

NOTE In a statistical sense the sea state does not change markedly within the period. The period during which this condition exists is usually assumed to be three hours, although it depends on the particular weather situation at any given time.

3.27
seabed
materials below the sea in which a structure is founded, whether of soils such as sand, silt or clay, cemented material or of rock

NOTE The seabed can be considered as the half-space below the sea floor.

[ISO 19901-4:2003]

3.28
seiche
oscillation of a body of water at its natural period

3.29
short-term distribution
probability distribution of a variable within a short interval of time during which conditions are assumed to be statistically constant

NOTE The interval chosen is most often the duration of a sea state.

3.30
significant wave height
statistical measure of the height of waves in a sea state

NOTE The significant wave height was originally defined as the mean height of the highest one-third of the zero up-crossing waves in a sea state. In most offshore data acquisition systems the significant wave height is currently taken as $4\sqrt{m_0}$ (where m_0 is the zeroth spectral moment, see 3.31) or 4σ, where σ is the standard deviation of the time series of water surface elevation over the duration of the measurement, typically a period of approximately 30 min.

3.31
spectral moment
n^th spectral moment
integral over frequency of the spectral density function multiplied by the nth power of the frequency, either expressed in hertz (cycles per second) as $m_n(f) = \int_0^\infty f^n S(f)df$ or expressed in circular frequency (radians/second) as $m_n(\omega) = \int_0^\infty \omega^n S(\omega)d\omega$

NOTE 1 As $\omega = 2\pi f$, the relationship between the two moment expressions is: $m_n(\omega) = (2\pi)^n m_n(f)$.

NOTE 2 The integration extends over the entire frequency range from zero to infinity. In practice the integration is often truncated at a frequency beyond which the contribution to the integral is negligible and/or the sensor no longer responds accurately.

3.32
spectral peak period
period of the maximum (peak) energy density in the spectrum

NOTE In practice there is often more than one peak in a spectrum.

3.33
spectral density function
energy density function
spectrum
measure of the variance associated with a time-varying variable per unit frequency band and per unit directional sector

NOTE 1 Spectrum is a shorthand expression for the full and formal name of spectral density function or energy density function.

NOTE 2 The spectral density function is the variance (the mean square) of the time-varying variable concerned in each frequency band and directional sector. Therefore the spectrum is in general written with two arguments: one for the frequency variable and one for a direction variable.

NOTE 3 Within this document the concept of a spectrum applies to waves, wind turbulence and action effects (responses) that are caused by waves or wind turbulence. For waves, the spectrum is a measure of the energy traversing a given space.

3.34
squall
strong wind event characterized by a sudden onset, a duration of the order of minutes and a rather sudden decrease in speed

NOTE 1 A squall is often accompanied by a change in wind direction, a drop in air temperature and by heavy precipitation.

NOTE 2 To be classed as a squall the wind speed would typically be greater than about 8 m/s and last for longer than 2 min (thereby distinguishing it from a gust).

3.35
still water level
abstract water level typically used for the calculation of wave kinematics for global actions and wave crest elevation for minimum deck elevations

NOTE Still water level is an engineering abstract calculated by adding the effects of tides and storm surge to the water depth but excluding variations due to waves (see Figure 1). It can be above or below mean sea level.

3.36
storm surge
change in sea level (either positive or negative) that is due to meteorological (rather than tidal) forcing

3.37
sustained wind speed
time-averaged wind speed with an averaging duration of 10 min or longer

3.38
swell
sea state in which waves generated by winds remote from the site have travelled to the site, rather than being locally generated

3.39
tropical cyclone
closed atmospheric or oceanic circulation around a zone of low pressure that originates over the tropical oceans

NOTE 1 The circulation is counter-clockwise in the northern hemisphere and clockwise in the southern hemisphere.

NOTE 2 At maturity, the tropical cyclone can be one of the most intense storms in the world, with wind speeds exceeding 90 m/s and accompanied by torrential rain.