International Standard

ISO 19901-1

Specific requirements for offshore structures —

Part 1: Metocean design and operating considerations

Exigences spécifiques relatives aux structures en mer —

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

Third edition
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Foreword

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This document was prepared by Technical Committee ISO/TC 67, *Oil and gas industries including lower carbon energy*, Subcommittee SC 7, *Offshore structures,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 12, *Oil and gas industries including lower carbon energy,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

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This third edition cancels and replaces the second edition (ISO 19901-1:2015), which has been technically revised.

The main changes are as follows:

— clarification on the role of the metocean expert (5.2 and A.5.2);

— additional information related to the determination of associated criteria (5.3 and A.5.3);

— additional information related to the estimation of extreme or abnormal conditions (5.7 and A.5.7);

— alignment of the content related to wind with API RP 2MET (Clause 7 and Clause A.7);

— additional information related to breaking or non-breaking wave kinematic estimation (8.4.3 and A.8.4.3);

— expansion of the content related to additional environment factors to be considered (Clause 10 and Clause A.10);

— introduction of text related to the verification of weather forecast information (Clause 12 and Clause A.12);

— update to offshore Canada regional annex (Annex D);

— update to Sakhalin/Sea of Okhotsk regional annex (Annex E);

— update to Caspian Sea regional annex (Annex F);

— introduction of Mediterranean Sea regional annex (Annex H);

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— introduction of Brazil regional annex (Annex I);

— re-introduction of US Gulf of Mexico regional annex (Annex J);

— re-introduction of coast of California regional annex (Annex K);

— re-introduction of the overview annex of regions excluding Gulf of Mexico and California (Annex L).

A list of all parts in the ISO 19901 series can be found on the ISO website.

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.

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Introduction

The International Standards on offshore structures prepared by TC 67 (i.e. ISO 19900, the ISO 19901 series, ISO 19902, ISO 19903, ISO 19904-1, the ISO 19905 series, ISO 19906) constitute a common basis covering those aspects that address design requirements and assessments of all offshore structures used by the oil and gas industries including lower carbon energy 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, should be considered in relation to the overall reliability of all offshore structural systems.

The International Standards on offshore structures prepared by TC 67 are 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.

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).

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Even for areas like the Gulf of Mexico, offshore Indonesia and the North Sea, where there are over 40 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 experts, 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. In particular, due account should be taken of the uncertainties that arise from the analyses of limited datasets. It is hence important to employ experts 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.

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 19904-1, ISO 19905-1 and ISO 19906.

NOTE Specific metocean requirements for site-specific assessment of jack-ups are contained in ISO 19905-1, for arctic offshore structures in ISO 19906, for arctic offshore operations in ISO 35106 and for topside structures in ISO 19901-3.

Some background to, and guidance on, the use of this document is provided in Annex A. The clause numbering in Annex A is the same as in the main text to facilitate cross-referencing.

Regional information, where available, is provided in the Annexes B to L. This information has been developed by experts from the region or country concerned to supplement the guidance provided in this document. Each regional annex provides regional or national data on environmental conditions for the area concerned.

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Specific requirements for offshore structures —

Part 1: Metocean design and operating considerations

IMPORTANT — The electronic file of this document contains colours which are considered to be useful for the correct understanding of the document. Users should therefore consider printing this document using a colour printer.

1 Scope

This document provides two broad types of requirements for the determination and use of meteorological and oceanographic (metocean) conditions for the design, construction and operation of offshore structures:

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

— those related to the characterization and use of metocean parameters for the design, the construction activities or the operation of offshore structures.

This document covers the following environmental conditions and metocean parameters:

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— 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;

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

Metocean parameters specified in this document are applicable to:

— the determination of actions for the design of new structures;

— the determination of actions 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);

— the operation of the platform, where appropriate.

It is beyond the scope of this document to provide detailed instructions that can be followed to produce reliable estimates of extreme or abnormal conditions in all areas and in all cases.

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 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*

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ISO 19906, *Petroleum and natural gas industries — Arctic offshore structures*

3 Terms and definitions

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

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

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 1 to entry: Abnormal events are typically accidental and environmental (including seismic) events having probabilities of exceedance of the order of 10^{-3} to 10^{-4} per annum.

3.2
chart datum
local datum used to fix *water depths* (3.51) on a chart or tidal heights over an area

Note 1 to entry: Chart datum is usually an approximation to the level of the *lowest astronomical tide* (3.17).

Note 2 to entry: Chart datum can differ from one chart to another and care is required if cross referencing sites that are not on the same chart.

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3.3
conditional probability
probability of the occurrence of a variable *A*, given that other variables *B*, *C*, ... have certain assigned values

Note 1 to entry: The conditional probability of *A* given that *B*, *C*, ... occur is written as $P(A|B,C,...)$. The concept is applicable to metocean parameters, as well as to actions and action effects.

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EXAMPLE When considering wave parameters, *A* can be the individual crest elevation, *B* the *water depth* (3.51) and *C* the *significant wave height* (3.36), and so on.

3.4
design crest elevation
extreme crest elevation measured relative to *still water level* (3.44)

Note 1 to entry: The design crest elevation is used in combination with information on astronomical tide, *storm surge* (3.45), platform settlement, reservoir subsidence and *water depth* (3.51) uncertainty and is derived using *extreme value* (3.7) analysis. Where simplified models are used to estimate the kinematics of the *design wave* (3.5), 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. In reality, the wave with the greatest trough-to-crest height and the wave with the highest crest are different waves.

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

Note 1 to entry: The design wave is an engineering abstraction. 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.

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Note 2 to entry: 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 water level
combination of *design crest elevation* (3.4), astronomical tide and *storm surge* (3.45) referenced to either *LAT* (3.17) or *MSL* (3.20)

3.7
extreme value
representative value of a parameter used in ultimate limit state checks

Note 1 to entry: Extreme events have probabilities of the order of 10^{-2} per annum.

3.8
gravity wave
wave in a fluid or in the interface between two fluids for which the predominant restoring forces are gravity and buoyancy

Note 1 to entry: Wind-generated surface waves.

3.9
gust
brief rise and fall in wind speed lasting less than 1 min

Note 1 to entry: In some countries, gusts are reported in meteorological observations if the maximum wind speed exceeds approximately 8 m/s.

3.10
gust wind speed
maximum value of the wind speed of a *gust* (3.9) averaged over a short (3 s to 60 s) specified duration within a longer (1 min to 1 h) specified duration, measured at a given elevation

Note 1 to entry: For design purposes, the specified duration depends on the dimensions and natural period of (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.

3.11
highest astronomical tide
HAT
level of high tide when all harmonic components causing the tides are in phase

Note 1 to entry: The harmonic components are in phase approximately once every 19 years, but these conditions are approached several times each year.

3.12
hindcasting
method of simulating historical (metocean) data for a region through numerical modelling

3.13
infra-gravity wave
surface *gravity wave* (3.8) with a period in the range of approximately 25 s to 500 s

Note 1 to entry: In principle an infra-gravity wave is generated by different physical processes but is most commonly associated with waves generated by non-linear second-order difference frequency interactions between different *swell* (3.47) wave components.

3.14
internal wave
gravity wave (3.8) which propagates within a stratified water column

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3.15
JONSWAP
Joint North Sea Project Spectrum
version of the Pierson-Moskowitz *spectrum* (3.42) which accounts for the continued development of the spectrum through non-linear wave-wave interaction over time and space

3.16
long-term distribution
probability distribution of a variable over a long time scale

Note 1 to entry: The time scale exceeds the duration of a *sea-state* (3.32), in which the statistics are assumed constant (see *short-term distribution* (3.35)). 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* (3.36) (based on, for example, storm peaks or all sea-states);

— significant wave height in the months May to September;

— individual wave heights;

— current speeds (such as for use in assessing vortex-induced vibrations of drilling risers);

— *scatter diagrams* (3.30) with the joint distribution of significant wave height and wave period (such as for use in a fatigue analysis);

— a particular action effect;

— sea ice types and thickness;

— iceberg mass and velocity;

— storm maximum significant wave height.

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3.17
lowest astronomical tide
LAT
level of low tide when all harmonic components causing the tides are in phase

Note 1 to entry: The harmonic components are in phase approximately once every 19 years, but these conditions are approached several times each year.

3.18
marginal distribution
marginal probability
statistical distribution (probability) of the occurrence of a variable A independent of any other variable

Note 1 to entry: The marginal distribution is obtained by integrating the full distribution over all values of the other variables B, C, ... and 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* (3.22) B and all *significant wave heights* (3.36) C, occurring at a particular site.

3.19
marine growth
living organisms attached to an offshore structure

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3.20
mean sea level
MSL
arithmetic mean of all sea levels measured over a long period, a minimum of 1 year

Note 1 to entry: Seasonal changes in mean level can be expected in some regions and over many years the mean sea level can change.

3.21
mean wind speed
time-averaged wind speed, averaged over a specified time interval and at a specified elevation

Note 1 to entry: The mean wind speed varies with elevation above *mean sea level* (3.20) and the averaging time interval; a standard reference elevation is 10 m and with an averaging time of 10 min. See also *gust wind speed* (3.10) and *sustained wind speed* (3.46).

3.22
mean zero-crossing period
average period between (up or down) zero-crossing waves in a *sea-state* (3.32)

Note 1 to entry: In practice the mean zero-crossing period is often estimated from the zeroth and second moments of the *wave spectrum* (3.52) as $T_z = T_2 = \sqrt{m_0(f)/m_2(f)} = 2\pi\sqrt{m_0(\omega)/m_2(\omega)}$.

3.23
monsoon
seasonally reversing wind pattern, with associated pattern of rainfall

Note 1 to entry: The term was first applied to the winds over the Arabian Sea which blow for six months from northeast and for six months from southwest, but it has been extended to similar winds in other parts of the world.

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3.24
most probable maximum
value of the maximum of a variable with the highest probability of occurring

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Note 1 to entry: 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.

3.25
operating conditions
most severe combination of environmental conditions under which a given operation is permitted to proceed

Note 1 to entry: 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 or safety.

3.26
polar low
depression that forms in polar air, often near a boundary between ice and sea

3.27
residual current
part of the total current that is not constituted from harmonic tidal components (i.e. the tidal stream)

Note 1 to entry: 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.

3.28
residual water level
part of the total water level that is not constituted from harmonic tidal components (i.e. the tidal height)

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3.29
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. For a rare event, the return period in years is equal to the reciprocal of the annual probability of exceedance of the event.

3.30
scatter diagram
joint probability of two or more (metocean) parameters

Note 1 to entry: A scatter diagram is especially used with wave parameters in the metocean context (for example in fatigue assessments). The wave scatter diagram is commonly understood to be the probability of the joint occurrence of the *significant wave height* (3.36) (H_s) and a representative period (T_z or T_p).

3.31
sea floor
interface between the sea and the *seabed* (3.33) and referring to the upper surface of all unconsolidated material

3.32
sea-state
condition of the sea during a period in which its statistics remain approximately stationary and egodic

Note 1 to entry: In a statistical sense the sea-state does not change markedly within the period. The period during which this condition exists depends on the particular weather condition at any given time, however it is often assumed to be 3 h in extra-tropical conditions, however it can be as short as 1 h in tropical cyclonic conditions.

3.33
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

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3.34
seiche
oscillation of a body of water at its natural period

3.35
short-term distribution
probability distribution of a variable within a short interval of time during which conditions are assumed to be statistically stationary

Note 1 to entry: The interval chosen is most often the duration of a *sea-state* (3.32).

3.36
significant wave height
statistical measure of the height of waves in a *sea-state* (3.32)

Note 1 to entry: 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* (3.40)) 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.

3.37
site-averaging
averaging *extreme values* (3.7) from a number of individual sites

Note 1 to entry: It is used to take account of the localised extent of phenomena such as *tropical cyclones* (3.49) or meso-scale eddies e.g. warm core rings in the Gulf of Mexico.

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3.38
site-pooling
concatenating datasets from several sites into a single dataset for extremal analysis, with the length of the dataset equating to the sum of the individual datasets.

Note 1 to entry: It is used to take account of the localised extent of phenomena such as *tropical cyclones* (3.49) or meso-scale eddies e.g. warm core rings in the Gulf of Mexico.

3.39
soliton
solitary wave or wave packet travelling on an internal density discontinuity which, as a result of the cancellation of non-linear and dispersive effects, maintains its shape and speed over extended distances

EXAMPLE Internal tides which form on the density gradient within the water column can interact with the continental slope and form internal solitary wave packets.

3.40
spectral moment
integral over frequency of the *spectral density function* (3.42) multiplied by the *n*th power of the frequency, either expressed in hertz (cycles per second) as $m_n\left(f\right)=\int_0^\infty f^n S\left(f\right)df$ or expressed in circular frequency (radians/second) as $m_n(\omega)=\int_0^\infty \omega^n S(\omega)\mathrm{d}\omega$

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

Note 2 to entry: 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. Care should be taken when utilizing moments of order higher than 2, as for standard spectral models, the 4th moment will not converge; the value is in effect determined by the choice of truncation.

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3.41
spectral peak period
period of the maximum (peak) energy density in the *spectrum* (3.42)

Note 1 to entry: In practice there is often more than one peak in a spectrum.

3.42
spectral density function
measure of the variance associated with a time-varying variable per unit frequency band and per unit directional sector

Note 1 to entry: Energy density function is used synonymously with spectral density function.

Note 2 to entry: Spectrum is a shorter expression for the full and formal name of spectral density function or energy density function.

Note 3 to entry: 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.

3.43
squall
strong wind event characterized by a sudden onset, a duration of the order of minutes and often, a sudden decrease in speed

Note 1 to entry: A squall is often accompanied by a change in wind direction, a drop in barometric pressure, a drop in air temperature and heavy precipitation.

Note 2 to entry: The WMO classification of a squall requires the wind speed to increase by at least 8 m/s and attain a top speed of at least 11 m/s, lasting at least 1 min in duration.

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