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

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

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

Partie 7: Systèmes de maintien en position des structures en mer flottantes et des unités mobiles en mer

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Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
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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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The committee responsible for this document is ISO/XXX

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This second/third/... edition cancels and replaces the first/second/... edition (), [clause(s) / subclause(s) / table(s) / figure(s) / annex(es)] of which [has / have] been technically revised.

ISO XXXX consists of the following parts. [Add information as necessary.]

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ISO 19901-7 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*.

This third edition cancels and replaces the second edition (ISO 19901-7:2013), which has been technically revised.

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This third edition of ISO 19901-7 includes several changes. The largest changes are the deletion of informative sections related to geotechnical design of anchors to incorporate the same in 19901-4 and the inclusion of OPB fatigue guidance.

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 3: Topsides structure*

— *Part 4: Geotechnical and foundation design considerations*

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

— *Part 6: Marine operations*

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

— *Part 8: Marine soil investigations*

Part 9: Structural integrity management (under preparation).

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

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— 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*

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— ISO 19902, *Petroleum and natural gas industries — Fixed steel offshore structures*

— 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*

— ISO 19905 (all parts), *Petroleum and natural gas industries — Site-specific assessment of mobile offshore units*

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

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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, petrochemical and natural gas industries worldwide. Through their application, the intention is to achieve reliability levels appropriate for manned and unmanned offshore structures, whatever type of structure and nature or combination of 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 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.

This part of ISO 19901 was developed in response to the worldwide offshore industry's demand for a coherent and consistent definition of methodologies to analyse, design and evaluate stationkeeping systems used for floating production and/or storage platforms of various types (e.g. semi-submersibles, spar platforms, ship-shaped structures) and to assess site-specific applications of mobile offshore units (such as mobile offshore drilling units and flotels) and construction units (such as heavy lift vessels and pipelay units).

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Stationkeeping is a generic term covering systems for keeping a floating structure, which is under the constant influence of external actions, at a pre-defined location and/or heading with limited excursions. Stationkeeping systems resist external actions by means of any of the following:

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— mooring systems (e.g. spread moorings or single point moorings);

— dynamic positioning systems (generally consisting of thrusters);

— a combination of mooring system and thrusters (thruster assisted)

The external actions generally consist of wind, wave, current and ice actions on the floating structure, mooring and/or risers.

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.

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

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

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

1 Scope

This part of ISO 19901 specifies methodologies for

a) the design, analysis and evaluation of stationkeeping systems for floating structures used by the oil and gas industries to support any combination of:

   1) production,

   2) storage,

   3) offloading,

   4) drilling and well intervention.

b) the assessment of stationkeeping systems for site-specific applications of mobile offshore units and construction units.

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Most stationkeeping systems used with the class of floating structures covered by a) are termed “permanent mooring systems”, for which this part of ISO 19901 is applicable to all aspects of the life cycle and includes requirements relating to the manufacture of mooring components, as well as considerations for in-service inspections. Most stationkeeping systems used with mobile offshore units, the class covered by b), are termed “mobile mooring systems”. Throughout this part of ISO 19901, the term “floating structure”, sometimes shortened to “structure”, is used as a generic term to indicate any member of the two classes, a) and b).

This part of ISO 19901 is applicable to the following types of stationkeeping systems, which are either covered directly in this part of ISO 19901 or through reference to other guidelines:

— spread moorings (catenary, taut-line and semi-taut-line moorings);

— single point moorings, anchored by spread mooring arrangements;

— dynamic positioning systems;

— thruster-assisted moorings.

Descriptions of the characteristics and of typical components of these systems are given in Annex A.

The requirements of this part of ISO 19901 mainly address spread mooring systems and single point mooring systems with mooring lines composed of steel chain and wire rope. This part of ISO 19901 also provides guidance on the application of the methodology to synthetic fibre rope mooring systems, and includes additional requirements related to the unique properties of synthetic fibre ropes.

This part of ISO 19901 is applicable to single anchor leg moorings (SALMs) and other single point mooring systems (e.g. tower soft yoke systems) only to the extent to which the requirements are relevant.

This part of ISO 19901 is not applicable to the vertical moorings of tension leg platforms (TLPs).

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The methodology described in this part of ISO 19901 identifies a set of coherent analysis tools that, combined with an understanding of the site-specific metocean conditions, the characteristics of the floating structure under consideration, and other factors, can be used to determine the adequacy of the stationkeeping system to meet the functional requirements of this part of ISO 19901.

NOTE For moorings deployed in ice-prone environments, additional requirements are given in ISO 19906.<< Sec 13.7 of 19906>>

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

ISO 19901-4, *Petroleum and natural gas industries — Specific requirements for offshore structures — Part 4: Geotechnical and foundation design considerations*

ISO 19901-6, *Petroleum and natural gas industries — Specific requirements for offshore structures — Part 6: Marine operations*

ISO 19901-8, *Petroleum and natural gas industries — Specific requirements for offshore structures — Part 8: Marine soil investigations.*ISO 19904-1, *Petroleum and natural gas industries — Floating offshore structures — Part 1: Monohulls, semi-submersibles and spars*

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ISO 19905-3, Petroleum and natural gas industries — Site-specific assessment of mobile offshore units — Part 3: Floating units1)

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ISO 19906, Petroleum and natural gas industries – Arctic Offshore Structures

3 Terms and definitions

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

3.1
action
external load applied to the structure (direct action) or an imposed deformation or acceleration (indirect action)

EXAMPLE An imposed deformation can be caused by fabrication tolerances, settlement, temperature change or moisture variation.

NOTE An earthquake typically generates imposed accelerations.

[ISO 19900:2013]

3.2
action effect
effect of actions on structural components

[ISO 19900:2013]

1) Under preparation.

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

3.3
catenary mooring
mooring system where the restoring action is provided by the distributed weight of mooring lines

[ISO 19900:2013]

3.4
characteristic value
value assigned to a basic variable, an action or a resistance from which the design value can be found by the application of a partial factor

NOTE 1 The value usually has a prescribed probability of not being violated which, in the case of an action, will normally relate to a reference period.

NOTE 2 Adapted from ISO 19900:2013, definition 2.7.

3.5
common mode/common cause failure:
failure of similar components on different mooring legs resulting from the same direct cause, occurring within a relatively short time, where these failures are not consequences of another

3.6
damage event
event-driven damage to mooring components including physical damage, overload, excessive bending, etc., often experienced during the installation phase.

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3.7
degradation mechanisms
time-based physical or chemical mechanisms or processes by which mooring components degrade. Examples are corrosion, wear, fatigue, etc.

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3.8
design criteria
quantitative formulations that describe the conditions to be fulfilled for each limit state

[ISO 19900:2013]

3.9
design service life
assumed period for which a structure or a structural component is to be used for its intended purpose with anticipated maintenance, but without substantial repair being necessary

NOTE Adapted from ISO 19900:2013, definition 2.12.

3.10
design situation
set of physical conditions during a certain reference period for which the design will demonstrate that relevant limit states are not exceeded

NOTE Adapted from ISO 19900:2013, definition 2.13.

3.11
disconnectable floating structure
floating structure capable of discontinuing production and rapidly disconnecting from its ancillary components such as risers, moorings, and/or well systems in response to the occurrence or to the detection of a threshold event.

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3.12
dynamic action
action that induces acceleration of a structure or a structural component of a magnitude sufficient to require specific consideration

3.13
dynamic positioning
DP
stationkeeping technique consisting primarily of a system of automatically controlled on-board thrusters, which generate appropriate thrust vectors to counter the mean and slowly varying induced actions

3.14
expected value
first-order statistical moment of the probability density function for the considered variable that, in the case of a time-dependent parameter, can be associated with a specific reference period

3.15
failure causes
includes the initiators, defects, processes and mechanisms generating damage or degradation which are the basic reasons for failure, and may be introduced into the mooring system across all phases of the mooring system lifecycle from design to operation.

3.16
failure mode
the manifestation of loss of functionality of a mooring component and it is the manner by which failure is observed

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3.17
fit-for-purpose
fitness-for-purpose
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meeting the intent of an International Standard although not meeting specific provisions of that International Standard in local areas, such that failure in these areas will not cause unacceptable risk to life-safety or the environment

[ISO 19900:2013]

3.18
floating structure
structure where the full weight is supported by buoyancy

[ISO 19900:2013]

NOTE The full weight includes lightship weight, mooring system pre-tension, riser pre-tension, operating weight, etc.

3.19
limit state
state beyond which the structure no longer fulfils the relevant design criteria

[ISO 19900:2013]

3.20
maintenance
set of activities performed during the operating life of a structure to ensure it is fit-for-purpose

3.21
minimum breaking strength
MBS
RCS certified strength of a chain, wire rope, fibre rope or accessories

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3.22
mobile mooring system
mooring system, generally retrievable, intended for deployment at a specific location for a short-term operation, such as those for mobile offshore units (MOUs)

NOTE Some components of a mobile mooring system might not be retrievable and should be designed following the requirements of permanent mooring system.

3.23
mobile offshore drilling unit
MODU
structure capable of engaging in drilling and well intervention operations for exploration or exploitation of subsea petroleum resources

3.24
mobile offshore unit
MOU
structure intended to be frequently relocated to perform a particular function

[ISO 19900:2002]

EXAMPLE Pipelaying vessel or barge, offshore construction structure, accommodation structure (floatel), service structure, or mobile offshore drilling units.

3.25
mooring component
general class of component used in the mooring of floating structures

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EXAMPLE Chain, steel wire rope, synthetic fibre rope, clump weight, buoy, winch/windlass, fairlead or anchor.

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3.26
owner
representative of the company or companies which own a development, who can be the operator on behalf of co-licensees

3.27
permanent mooring system
mooring system normally used to moor floating structures deployed for long-term operations, such as those for a floating production system (FPS)

3.28
proximity
closeness in distance

NOTE 1 Mooring systems are considered to be in proximity to a surface installation (or facility) if any part of the other installation lies within a contour described by the set of offsets coinciding with each line reaching 100 % MBS in the intact or redundancy check condition, whichever is larger.

NOTE 2 Mooring systems are considered to be in proximity to a sea floor installation (or facility) if any part of the other installation lies within a polygon formed by the anchor locations.

3.29
RCS
recognized classification society
member of the international association of classification societies (IACS), with recognized and relevant competence and experience in floating structures, and with established rules and procedures for classification/certification of installations used in petroleum-related activities

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3.30
resistance
capacity of a structure, a component or a cross-section of a component to withstand action effects without exceeding a limit state

NOTE This definition is at variance with that specified in ISO 19900:2002.

3.31
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 is equal to the reciprocal of the annual probability of exceedance of the event.

[ISO 19901-1:2005]

3.32
riser
piping connecting the process facilities or drilling equipment on the floating structure with the subsea facilities or pipelines, or reservoir

NOTE 1 Possible functions include drilling and well intervention, production, injection, subsea systems control and export of produced fluids.

NOTE 2 Adapted from ISO 19900:2002, definition 2.29.

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3.33
semi-submersible
floating structure normally consisting of a deck structure with a number of widely spaced, large cross-section, supporting columns connected to submerged pontoons

NOTE Pontoon/column geometry is usually chosen to minimize global motions in a broad range of wave frequencies.

3.34
serviceability
ability of a structure or structural component to perform adequately for normal functional use

3.35
significant value
statistical measure of a zero-mean random variable equal to twice the standard deviation of the variable

3.36
single point mooring
mooring system that allows the floating structure to which it is connected to vary its heading (weathervane)

EXAMPLE One example of a single point mooring is a turret mooring system where a number of mooring lines are attached to a turret, which includes bearings to allow the structure to rotate.

3.37
ship-shaped structure
monohull floating structure having a geometry similar to that of ocean-going ships

3.38
spar platform
deep-draught, small water-plane area floating structure

3.39
splash zone
part of a structure that is intermittently exposed to air and immersed in the sea

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NOTE Herein the relevant structural parts are mooring lines, fairleads and thrusters.

[ISO 19900:2013]

3.40
spread mooring
mooring system consisting of multiple mooring lines terminated at different locations on a floating structure, and extending outwards, providing an almost constant structure heading

3.41
stationkeeping system
system capable of limiting the excursions of a floating structure within prescribed limits

3.42
structural component
physically distinguishable part of a structure

[ISO 19900:2002]

3.43
structure
organized combination of connected components designed to withstand actions and provide adequate rigidity

[ISO 19900:2002]

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3.44
taut-line mooring
mooring system where the restoring action is provided by elastic deformation of mooring lines

[ISO 19900:2002]

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3.45
thruster-assisted mooring
stationkeeping system consisting of mooring lines and thrusters

3.46
touchdown point
location on a mooring line where the line transitions from contacting the seabed to being in the water column

NOTE The touchdown point can change as the draught and horizontal offset of the floating structure change.

3.47
touchdown zone
set of all touchdown points within defined operating conditions

EXAMPLE The extent of the touchdown zone could be specified based on 100 year return period environmental conditions along with minimum and maximum floating structure draughts

3.48
verification
examination made to confirm that an activity, product, or service is in accordance with specified requirements

3.49
weathervaning
process by which a floating structure passively varies its heading in response to time-varying environmental actions

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4 Symbols and abbreviated terms

4.1 Symbols

C coefficient (non-dimensional unless otherwise specified)

D annual fatigue damage, in years^{-1}

d diameter of the mooring line or component, in metres (m)

F direct action, in newtons (N), or a direct action per unit length, in newtons per metre, (N/m)

f frequency, in hertz (Hz)

K fatigue constant (non-dimensional unless otherwise specified)

k axial stiffness, in newtons per metre (N/m)

L design service life, in years

l length, in metres (m)

M mass, in kilograms (kg)

m inverse slope of T-N or S-N fatigue curves

N total number of (permissible) cycles

n number of cycles per annum, in year^{-1}

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P probability of occurrence

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S offset or motion, in metres (m)

S_R stress range, in megapascals (MPa)

s standard deviation

T tension force, in newtons (N); or non-dimensional tension ratio

t time, period or duration, in seconds (s)

v velocity, in metres per second (m/s)

W submerged weight, in newtons (N), or weight per unit length, in newtons per metre (N/m)

Γ gamma function

γ design safety factor

δ bandwidth parameter for the wave frequency

ε annual creep elongation, percent per year

σ ratio of the standard deviation of the tension variations around the mean tension to a reference breaking strength

ρ density, in kilograms per cubic metre (kg/m^3)

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