TECHNICAL REPORT

ISO/TR 19905-2

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Petroleum and natural gas industries — Site-specific assessment of mobile offshore units —

Part 2: Jack-ups commentary and detailed sample calculation

Industries du pétrole et du gaz naturel — Évaluation liée au site des unités marines mobiles —

Partie 2: Compléments sur les plates-formes auto-élévatrices

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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.

In exceptional circumstances, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example), it may decide by a simple majority vote of its participating members to publish a Technical Report. A Technical Report is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.

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/TR 19905-2 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 19905 consists of the following parts, under the general title *Petroleum and natural gas industries — Site-specific assessment of mobile offshore units*:

— *Part 1: Jack-ups*

— *Part 2: Jack-ups commentary and detailed sample calculation* [Technical Report]

The following part is under preparation:

— *Part 3: Floating units*

ISO/TR 19905-2:2012 was prepared in 2012 and is referenced as ISO/TR 19905-2:2012. Users are advised, however, that it was published, and only became available, in 2013.

ISO 19905 is one of a series of International 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 19901-1, *Petroleum and natural gas industries — Specific requirements for offshore structures — Part 1: Metocean design and operating considerations*

— ISO 19901-2, *Petroleum and natural gas industries — Specific requirements for offshore structures — Part 2: Seismic design procedures and criteria*

— ISO 19901-3, *Petroleum and natural gas industries — Specific requirements for offshore structures — Part 3: Topsides structure*

- ISO 19901-4, *Petroleum and natural gas industries — Specific requirements for offshore structures — Part 4: Geotechnical and foundation design considerations*
- ISO 19901-5, *Petroleum and natural gas industries — Specific requirements for offshore structures — Part 5: Weight control during engineering and construction*
- ISO 19901-6, *Petroleum and natural gas industries — Specific requirements for offshore structures — Part 6: Marine operations*
- 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 19901-8[1)], *Petroleum and natural gas industries — Specific requirements for offshore structures — Part 8: Marine soil investigations*
- 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 19905-1, *Petroleum and natural gas industries — Site-specific assessment of mobile offshore units — Part 1: Jack-ups*
- ISO/TR 19905-2, *Petroleum and natural gas industries — Site-specific assessment of mobile offshore units — Part 2: Jack-ups commentary and detailed sample calculation*
- ISO/TR 19905-3[1)], *Petroleum and natural gas industries — Site-specific assessment of mobile offshore units — Part 3: Floating units*
- ISO 19906, *Petroleum and natural gas industries — Arctic offshore structures*

1) Under preparation.

Introduction

The series of International Standards applicable to types of offshore structures, ISO 19900 to ISO 19906, addresses design requirements and assessments for 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 or assessment rules, safety elements, workmanship, quality control procedures and national requirements, all of which are mutually dependent. The modification of one aspect of the design or assessment 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 offshore structural systems.

The series of International Standards applicable to the various 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.

ISO 19905-1 was developed from SNAME T&R Bulletin 5-5A[5], but has been considerably altered from that original document. Some of the alterations have involved a restructuring and modification of terminology, but there have been additional changes of greater technical consequence. New material has been added based on studies undertaken since the original development of SNAME T&R 5-5A; new calculation techniques have been addressed because of improved computational capabilities allowing more complex assessments; gaps that existed in the original SNAME T&R 5-5A have been filled, thereby ensuring a more thorough assessment; and changes have been made to align ISO 19905-1 with other standards within the 19900 series. A description of the more important changes, along with the reasoning for the changes, can be found in a series of papers published in 2012 by Offshore Technology Conference. These papers can be of considerable value in helping the analyst, particularly those who are familiar with SNAME T&R 5-5A, in understanding ISO 19905-1. The papers, part of the Technical Session *ISO 19905-1: A Site-Specific Assessment of Mobile Jack-Up Units* are listed in the Bibliography:

— Reference [6], *Background to the ISO 19905-Series and an Overview of the New ISO 19905-1 for the Site-Specific Assessment of Mobile Jack-Up Units*

— Reference [7], *Environmental Actions in the New ISO for the Site-Specific Assessment of Mobile Jack-Up Units*

— Reference [8], *Structural Modeling and Response Analysis in the New ISO Standard for the Site-Specific Assessment of Mobile Jack-Up Units*

— Reference [9], *Foundation Modeling and Assessment in the New ISO Standard 19905-1*

— Reference [10], *Long-Term Applications in the ISO Standard for Site Specific Assessment of Mobile Jack-Up Units and the Use of Skirted Spudcans*

— Reference [11], *Structural Acceptance Criteria in the New ISO for the Site-Specific Assessment of Mobile Jack-Up Units*

— Reference [12], *The Benchmarking of the New ISO for the Site-Specific Assessment of Mobile Jack-Up Units*

This part of ISO 19905, which has been developed from SNAME T&R Bulletin 5-5A, provides a commentary to some clauses of ISO 19905-1 including background information, supporting documentation, and additional or alternative calculation methods as applicable and also provides a detailed sample "go-by" calculation in Annex A. The reader is advised that the information presented herein is intended for use in conjunction with ISO 19905-1 and that the cautions and limitations discussed in ISO 19905-1 apply.

Petroleum and natural gas industries — Site-specific assessment of mobile offshore units —

Part 2: Jack-ups commentary and detailed sample calculation

1 Scope

This part of ISO 19905 provides a commentary to some clauses of ISO 19905-1 including background information, supporting documentation, and additional or alternative calculation methods as applicable and also provides a detailed sample 'go-by' calculation. ISO 19905-1 specifies requirements and guidance for the site-specific assessment of independent leg jack-up units for use in the petroleum and natural gas industries.

2 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 19905-1:2012, *Petroleum and natural gas industries — Site-specific assessment of mobile offshore units — Part 1: Jack-ups*

3 Terms and definitions

For the purposes of this document the terms and definitions given in ISO 19905-1 apply.

4 Symbols

4.1 Symbols for Clause 6

C_D drag coefficient

$C_{De}D_e$ equivalent drag coefficient times effective diameter

d water depth

D_2 depth attenuation

$D(\theta)$ directional spreading function from ISO 19901-1

$F(\alpha)$ directional spreading function from SNAME

f frequency (Hz)

g acceleration due to gravity

H wave height

H_{det} reduced wave height which may be used in deterministic/regular wave force calculations

H_{max} maximum wave height for a given return period; used for airgap calculations

H_{mpm} wave height associated with H_{srp}, equivalent to the height between the extreme crest and the following trough

H_{mo} estimate of H_s significant wave height (metres)

H_s scaled significant wave height to be used in irregular seas simulation (metres)

H_{srp} significant wave height for assessment return period

k wave number

m power constant in the $\left[\cos(\alpha)\right]^{2m}$ spreading function

$S_{nn}(f)$ power density of wave surface elevation as a function of wave frequency

T wave period (seconds)

T wind averaging time (seconds)

T_0 standard reference time averaging interval for wind speed of 1 h = 3 600 s

T_p peak period in wave spectrum (seconds)

T_z zero-upcrossing period of wave spectrum (seconds)

U wind speed

$U_{w,T}(10)$ is the sustained wind speed at 10 m height above mean sea level

U_{w0} is the 1 h sustained wind speed at the reference elevation 10 m above mean sea level

u the computed velocity for long crested waves

u_{red} the reduced horizontal velocity

V current velocity

α equilibrium range parameter

α_3 skewness

α_4 kurtosis

γ peak enhancement factor

γ_d scaling of drag forces

κ kinematics reduction factor

η crest elevation by Airy theory

η_s	crest elevation by Stokes
ϕ	directional spreading factor defined in ISO 19901-1
σ	spectral peakwidth parameter

4.2 Symbols for Clause 7

A	cross-sectional area of member
A_e	equivalent area of leg per unit height
A_i	equivalent area of element
A_s	sum of projected areas for all members in the considered plane
A_t	total projected envelope area of the considered plane
C_A	added mass coefficient
C_D	drag coefficient
C_{Do}	drag coefficient for chord at direction $\theta = 0°$
C_{D1}	drag coefficient for flow normal to the rack, $\theta = 90°$
C_{De}	equivalent drag coefficient
C_{Dei}	equivalent drag coefficient of member i
C_{Di}	drag coefficient of an individual member, related to D_i
$C_{Dpr}(\theta)$	drag coefficient to the projected diameter
C_{Drough}	drag coefficient for a rough member
$C_{Dsmooth}$	drag coefficient for a smooth member
C_M	inertia coefficient
C_{Me}	equivalent inertia coefficient
C_{Mei}	equivalent inertia coefficient of member i
C_{Mi}	inertia coefficient of a member, related to D_i
d	mean, undisturbed water depth (positive)
D	member diameter
D_e	equivalent diameter of leg bay
D_F	face width of leg, outside dimensions
D_i	reference dimension of individual leg members
$D_{pr}(\theta)$	projected diameter of the chord
f_i	fundamental vibration frequencies of the member
H_s	significant wave height

k	roughness height
k/D	relative roughness
KC	Keulegan-Carpenter number
l_i	length of member "i" node to node
m_a	added mass contribution (per unit length) for the member
N	constant in wind velocity power law
$\dot{r}_n$	velocity of the considered member, normal to the member axis and in the direction of the combined particle velocity
$\ddot{r}_n$	acceleration of the considered member, normal to the member axis and in the direction of the combined particle velocity
Re	Reynolds number
s	length of one bay, or part of bay considered
S	Strouhal number
S	average wave steepness
S	outer diameter of an array of tubulars
T	wave period
T_n	first natural period of sway motion
T_z	zero-upcrossing period
u	particle velocity
u_n	particle velocity normal to the member
$\dot{u}_n$	particle acceleration normal to the member
u_x, $\dot{u}_x$	horizontal water particle velocity and acceleration
U	flow velocity at the depth of the considered element
U_C	current particle velocity
U_m	maximum orbital particle velocity
U_{red}	reduced particle velocity for regular waves
U_W	representative wave particle velocity
v_n	total flow velocity normal to the member
V_C	reduced current velocity for use in the hydrodynamic model; V_C should not be taken as less than $0{,}7V_f$
V_{Cn}	current velocity normal to member used in the hydrodynamic model
V_f	far field (undisturbed) current

W dimension from backplate to pitch point of triangular chord or dimension from root of one rack to tip of other rack of split tubular chord

W width of the structure

z coordinate measured vertically upward from the mean water surface

z' modified coordinate to be used in particle velocity formulation

α indicator for relative velocity, 0 or 1

α_i angle defining flow direction relative to member

β ratio of Re/KC, a parameter to describe the test environment

β_i angle defining the member inclination

ΔF_{drag} drag force per unit length

$\Delta F_{inertia}$ inertia force per unit length

$\Delta F_{inertiaH}$ horizontal inertia force per unit length

λ wave length

ν kinematic viscosity

θ angle in degrees for waves relative to the chord orientation

θ_o angle where half the backplate is hidden behind the rackplate

ρ mass density of water or air

ζ instantaneous water surface elevation (same axis system as z)

ζ_o wave crest elevation (same axis system as z)

4.3 Symbols for Clause 8

K_o lateral stiffness without axial load

K_1 lateral stiffness with axial load

K_E sum of individual leg stiffnesses

L distance from the spudcan point of rotation to the hull centre of gravity

P axial load in one leg

P_G total gravity load only

P_g effective hull gravity load; includes hull weight and weight of the legs above the hull

y_0 deflection without axial load P

y_1 additional lateral deflection due to axial load P

y_{max} total lateral deflection

4.4 Symbols for Clause 9

a depth interpolation parameter

B_S soil buoyancy of spudcan below bearing area, i.e. the submerged weight of soil displaced by the spudcan below D, the greatest depth of maximum cross-sectional spudcan bearing area below the sea floor

F_H horizontal force applied to the spudcan due to the assessment load case

F_V gross vertical force acting on the soil beneath the spudcan due to the assessment load case

Q_V gross ultimate vertical foundation capacity

V_{Lo} maximum vertical reaction under the spudcan considered required to support the in-water weight of the jack-up during the entire preloading operation (this is not the soil capacity)

W_{BF} submerged weight of the backfill

$\gamma_{R,PRE}$ preload resistance factor

4.5 Symbols for Clause 10

A axial area of one leg (equals sum of effective chord areas, including a contribution from rack teeth; see ISO 19905-1:2012, A.8.3.3, Note)

A_s effective shear area of one leg

d distance between upper and lower guides

D_{hyst} hysteretic damping

E Young's modulus

F shear transmitted from the hull

F_g geometric factor; = 1,125 (three-leg jack-up), 1,0 (four-leg jack-up)

F_h factor to account for horizontal soil stiffness, K_{hs}, and horizontal leg-hull connection stiffness, K_{hh}

F_h modification factor to be applied to the leg lateral deformation stiffness

F_n factor to account for the number of chords; = 0,5 (three-chord leg), 1,0 (four-chord leg)

F_r modification factor to be applied to the leg-hull connection stiffness

F_v factor to account for vertical soil stiffness, K_{vs}, and vertical leg-hull connection stiffness, K_{vh}

g acceleration due to gravity

h distance between chord centres (opposed pinion chords) or pinion pitch points (single rack chords)

I second moment of area of leg

I_H representative second moment of area of the hull girder joining two legs about a horizontal axis normal to the line of environmental action

K_A effective horizontal stiffness due to axial deformation

K_B effective bending stiffness

K_e effective stiffness associated with one leg

k_f combined vertical stiffness of all fixation system components on one chord

K_{hh} horizontal leg-hull connection stiffness

K_{hull} hull rotational stiffness

k_j combined vertical stiffness of all jacking system components on one chord

K_{rh} leg-hull connection rotational stiffness

K_{rs} leg-soil connection rotational stiffness

k_u total lateral stiffness of upper guides with respect to lower guides

K_{vh} effective stiffness due to the series combination of all vertical pinion or fixation system stiffnesses, allowing for combined action with shock-pads, where fitted

L length of leg considered

M_e effective mass associated with one leg

M_h moment on leg-hull spring

M_{hull} full mass of hull including maximum variable load

M_{la} mass of leg above lower guide (in the absence of a clamping mechanism) or above the centre of the clamping mechanism

M_{lb} mass of leg below the point described for M_{la}, including added mass for the submerged part of the leg ignoring spudcan

M_s moment on leg-soil spring

N number of legs

P axial load in leg

P mean force due to vertical fixed load and variable load acting on one leg

P_E Euler buckling strength of one leg

T_n highest (or first mode) natural period

x_h hull deflection

Y distance between centre of one leg and line joining centres of the other two legs (three-leg jack-up), or distance between windward and leeward leg rows for direction under consideration (four-leg jack-up)

ν Poisson's ratio

δ_{axial} axial deflection

Δ_{horz} horizontal hull deflection

θ_{hull} hull rotation