INTERNATIONAL STANDARD

ISO 3421

First edition
2022-06

Petroleum and natural gas industries — Drilling and production equipment — Offshore conductor design, setting depth and installation

Industries du pétrole et du gaz naturel — Équipements de forage et de production — Conception des tubes conducteurs en mer, profondeur de mise en place et installation

Reference number
ISO 3421:2022(E)

Contents

Page

Foreword

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This document was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*, Subcommittee SC 4, *Drilling and production equipment,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 12, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

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

Introduction

This document provides requirements and guidance on the design, setting depth, and installation of offshore conductors used by the petroleum and natural gas industries worldwide. Sound engineering judgment is necessary in the use of this document.

Conductor design addresses actions and action combinations, strength and stability checks, and fatigue checks. Setting depth provides calculation methodologies for different installation methods. Installation identifies relevant methods and their applicability together with corresponding procedures as well as documentation and quality control requirements.

Some background to and guidelines on the use of this document is provided in Annex A.

Petroleum and natural gas industries — Drilling and production equipment — Offshore conductor design, setting depth and installation

1 Scope

This document specifies the requirements and recommendations for the design, setting depth and installation of conductors for the offshore petroleum and natural gas industries. This document specifically addresses:

— design of the conductor, i.e. determination of the diameter, wall thickness, and steel grade;

— determination of the setting depth for three installation methods, namely, driving, drilling and cementing, and jetting;

— requirements for the three installation methods, including applicability, procedures, and documentation and quality control.

This document is applicable to:

— platform conductors: installed through a guide hole in the platform drill floor and then through guides attached to the jacket at intervals through the water column to support the conductor, withstand actions, and prevent excessive displacements;

— jack-up supported conductors: a temporary conductor used only during drilling operations, which is installed by a jack-up drilling rig. In some cases, the conductor is tensioned by tensioners attached to the drilling rig;

— free-standing conductors: a self-supporting conductor in cantilever mode installed in shallow water, typically water depths of about 10 m to 20 m. It provides sole support for the well and sometimes supports a small access deck and boat landing;

— subsea wellhead conductors: a fully submerged conductor extending only a few metres above the sea floor to which a BOP and drilling riser are attached. The drilling riser is connected to a floating drilling rig. The BOP, riser and rig are subject to wave and current actions while the riser can also be subject to VIV.

This document is not applicable to the design of drilling risers.

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*

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

ISO 19901-8, *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 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.

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
axial capacity
ability of conductor to resist vertical actions without soil failure

Note 1 to entry: The axial capacity of a conductor can change with time due to the soil disturbance and recovery.

3.2
conductor
tubular pipe set into the *seabed* (3.11) to provide the initial stable structural foundation for setting the *surface casing* (3.13) and protecting the internal well string from metocean actions

3.3
conductor shoe
short conductor joint whose upper end is connected to a whole conductor while its lower end has an internal chamfer to assist penetration

3.4
design situation
set of actions and combination of actions representing real conditions during a certain time interval, for which the design demonstrates that relevant limit states are not exceeded

3.5
drilling and cementing
method for installing a *conductor* (3.2) where a borehole is drilled, the conductor is lowered into the borehole and cement slurry placed in the annulus

3.6
driving
method for installing a *conductor* (3.2) where a vessel or rig is used to hammer the conductor into place

3.7
effective weight
weight in sea water or drilling fluid

3.8
jetting
method for installing a *conductor* (3.2) where the bottom hole assembly and conductor are combined, the borehole is washed by hydraulic force and the conductor simultaneously lowered into the hole

3.9
metocean action
effect of wind, wave and current on a *conductor* (3.2)

Note 1 to entry: The determination of these effects can include the influence of tide, surge, vortex induced vibrations and related processes.

3.10
sea floor
interface between the sea and the *seabed* (3.11) referring to the upper surface of all unconsolidated material

[SOURCE: ISO 19901-1:2015, 3.30]

3.11
seabed
materials below the sea in which the structure is founded, whether of soils such as sand, silt or clay, cemented material or of rock

Note 1 to entry: The seabed can be considered as the half-space below the *sea floor* (3.10).

[SOURCE: ISO 29400:2020, 3.128]

3.12
setting depth
distance between the depth reference point, usually the *sea floor* (3.10) or sea level, and the *conductor shoe* (3.3)

Note 1 to entry: A minimum setting depth is required to provide adequate axial capacity and formation integrity at the conductor shoe during surface casing drilling and cementing.

3.13
surface casing
casing that is run inside the *conductor* (3.2) to contain pressure in conjunction with the wellhead and blow-out preventer and to protect weak formations

3.14
undrained shear strength
maximum shear stress at yielding or at a specified maximum strain in an undrained condition

4 Symbols and abbreviated terms

4.1 Symbols

4.1.1 Symbols for conductor design

A	accidental actions
A_{cs}	cross-sectional area
C_m	moment reduction factor
D	deformation actions
D_{od}	outer diameter
D_R	Palmgren-Miner's sum or damage ratio during a certain time interval
E	Young’s modulus of elasticity
E_e	extreme quasi-static metocean actions due to wind, wave and current
E_o	metocean actions due to owner-specified operating wind, wave and current parameters
F_d	design value of action
f_b	representative bending strength
f_c	representative axial compressive strength
f_e	Euler buckling strength
f_v	representative shear strength

f_y	representative yield strength
G	permanent actions
I	moment of inertia of conductor cross-section
K	effective length factor
K_{LE}	local experience factor
L	unbraced length
L_f	calculated fatigue life
M_E	maximum bending moment on cross-section due to environmental actions and deformation actions
M_I	maximum bending moment on cross-section due to eccentricities of inner strings not being centralized
N_i	number of cycles to failure under constant amplitude stress range
n_i	number of cycles of stress range
Q	variable actions
r	conductor radius of gyration
T	time period over which Palmgren-Miner's sum is determined
t	wall thickness
U_m	utilization of conductor
V	shear due to factored actions
Z_e	elastic section modulus
Z_p	plastic section modulus
$\gamma_{f,E}$	partial action factor for extreme metocean action
γ_{f,E_O} , γ_{f,E_e}	partial action factors applied to the total quasi-static metocean actions plus equivalent quasi-static action representing dynamic response for operating and extreme metocean conditions, respectively, and for which different values can be applicable for different design situations
γ_{FD}	fatigue damage design factor
γ_G , γ_Q , γ_D , γ_A	partial action factors for the various permanent, variable, deformation and accidental actions
$\gamma_{R,b}$	partial resistance factor for bending strength
$\gamma_{R,c}$	partial resistance factor for axial compressive strength
$\gamma_{R,v}$	partial resistance factor for shear strength
λ	column slenderness parameter
σ_b	bending stress due to forces from factored actions

σ_{ce}	axial compressive stress due to forces from factored external axial actions of wellhead, BOP, christmas tree, emergency equipment and Workover equipment
σ_{ci}	axial compressive stress due to forces from factored internal axial actions of inner casings and tubing
τ_b	maximum shear stress due to forces from factored actions

4.1.2 Symbols for setting depth

A_s	side surface area
D_{od}	outer diameter
ρ_{fluid}	fluid density
F_{s1}, F_{s2}	partial safety factors
F_{xBOP}	axial force applied to the conductor during the BOP installation stage
F_{xcap}	axial force applied to the conductor in the extreme design situation
F_{xial}	axial force in conductor
F_{xsc}	axial force applied to the conductor during the subsequent casings installation stage
F_{xsur}	axial force applied to the conductor during the surface casing installation stage
F_{xXt}	axial force applied to the conductor during the christmas tree and tubing installation stage
$f(z)$	unit skin friction
g	acceleration due to gravity
H	jetted conductor setting depth in the seabed
h_{min}	minimum setting depth of the conductor
K_{con}	axial stiffness of the conductor
K_0	coefficient of lateral earth pressure
K_{cs}	axial stiffness of the coupled foundation composed of the surface casing and the conductor
K_{sys}	axial stiffness of the wellbore coupled system composed of all casings and the conductor
L_a	length of conductor above the sea floor
N_{load}	axial force in conductor
P_f	soil fracture pressure
P_{fluid}	fluid circulation pressures
P_l	annular pressure loss of fluid
Q_0	conductor axial capacity immediately after jetting
Q_f	skin friction resistance of conductor
Q_r	axial capacity of conductor

Q_{setup}	set-up axial capacity of jetted conductor
Q_t	axial capacity of jetted conductor
R	design safety factor of conductor capacity
S	WOB utilization
s_u	soil undrained shear strength
$s_{u,ave}$	mean soil undrained shear strength within the setting depth range
t	time after the completing of jetting
u	pore water pressure
W_{BHA}	effective weight of jetting BHA
W_{BOP}	effective weight of BOP
W_{cap}	effective weight of capping equipment
W_{con}	effective weight of conductor
W_{cs}	weight of cementing string in air
W_{fc}	weight of the fluid inside the cementing string
W_{fdc}	weight of the fluid displaced by the casing assembly
W_{fs}	weight of the fluid inside the surface casing
W_{land}	effective weight of surface casing during cementing
W_{RT}	effective weight of drill-ahead running tool
W_{sc}	weight of surface casing in air
W_{squ}	effective weight of subsequent casings after cementing
W_{sur}	maximum action applied to the conductor from the time the surface casing is landed until the cement is set
W_{tub}	effective weight of production tubing
W_{WH}	effective weight of wellhead housing
$W_{WOB.last}$	last WOB recoded during jetting
W_{XT}	effective weight of christmas tree
α_1	distribution coefficient for the effective weight of the BOP
α_2	distribution coefficient for the effective weight of the subsequent casings
$\Delta\alpha_t$	soil set-up factor
σ_3	minimum principal stress at the calculated depth
$\sigma_h^{'}$	effective horizontal stress

σ_v' effective vertical stress, or overburden pressure

α, β empirical coefficients of soil fracture pressure

4.2 Abbreviated terms

APB annular pressure build-up

BHA bottom hole assembly

BOP blow-out preventer

HFT hydraulic fracture test

LWD logging while drilling

OEM original equipment manufacturer

ROV remote operated vehicle

SCF stress concentration factors

VIV vortex induced vibrations

WOB weight on bit

5 General requirements

5.1 General

A conductor has the following main functions:

a) to stabilize and to protect the near-surface sediments from collapse and fracturing under fluid pressures during surface casing drilling and cementing;

b) to resist the effective weight of the first casing string (surface casing), which is landed shortly after installation of the conductor, or the first two casing strings if a liner is landed before the surface casing;

c) as a composite system with the surface casing, to provide lateral stability for the well system and the BOP against cyclic and tensile loading from direct metocean actions, vessel motions and riser motions including VIV.

The exposure level of the well that a conductor supports shall be specified prior to the start of the design or assessment in accordance with ISO 19900.

5.2 Limit states for conductor design

Conductor design shall determine conductor outer diameter, wall thickness, steel grade and choice of connectors to satisfy design situations through all phases of the conductor's design service life, including the installation method.

The limit state approach shall be used for conductor design and assessment. ISO 19900 outlines the limit state verification requirements. The pertinent limit states are:

a) ultimate limit states (ULS);

b) abnormal/accidental limit states (ALS);

