INTERNATIONAL STANDARD

ISO 13625

First edition
2002-12-01

Corrected version
2003-06-15

Petroleum and natural gas industries — Drilling and production equipment — Marine drilling riser couplings

Industries du pétrole et du gaz naturel — Équipement de forage et de production — Connecteurs de tubes prolongateurs pour forages en mer

Reference number
ISO 13625:2002(E)

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Published in Switzerland

Contents

Page

Foreword

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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.

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ISO 13625 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*.

This corrected version of ISO 13625:2002 incorporates correction of the French title.

Introduction

This International Standard is based upon API[1)] Specification 16R, first edition, January 1997[1].

Users of this International Standard should be aware that further or differing requirements could be needed for individual applications. This International Standard is not intended to inhibit a vendor from offering, or the purchaser from accepting, alternative equipment or engineering solutions for the individual application. This can be particularly applicable where there is innovative or developing technology. Where an alternative is offered, the vendor will need to identify any variations from this International Standard and provide details.

1) American Petroleum Institute, 1220 L Street NW, Washington D.C. 20005, USA.

Petroleum and natural gas industries — Drilling and production equipment — Marine drilling riser couplings

1 Scope

This International Standard specifies requirements and gives recommendations for the design, rating, manufacturing and testing of marine drilling riser couplings. Coupling capacity ratings are established to enable the grouping of coupling models according to their maximum stresses developed under specific levels of loading, regardless of manufacturer or method of make-up. This International Standard relates directly to API RP 16Q, which provides guidelines for the design, selection, and operation of the marine drilling riser system as a whole.

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 148, *Steel — Charpy impact test (V-notch)*

ISO 6506-1, *Metallic materials — Brinell hardness test — Part 1: Test method*

ISO 6507-1, *Metallic materials — Vickers hardness test — Part 1: Test method*

ISO 6508-1, *Metallic materials — Rockwell hardness test — Part 1: Test method (scales A, B, C, D, E, F, G, H, K, N, T)*

ISO 6892, *Metallic materials — Tensile testing at ambient temperature*

ISO 10423:2001, *Petroleum and natural gas industries — Drilling and production equipment — Wellhead and christmas tree equipment*

ASME [2], *Boiler and Pressure Vessel Code, Section V*

ASME, *Boiler and Pressure Vessel Code, Section VIII*

ASTM [3] E 94, *Standard Guide for Radiographic Examination*

ASTM E 165, *Standard Test Method for Liquid Penetrant Examination*

ASTM E 709, *Standard Guide for Magnetic Particle Examination*

ASTM E 747, *Standard Practice for Design, Manufacture and Material Grouping Classification of Wire Image Quality Indicators (IQI) Used for Radiology*

2) American Society of Mechanical Engineers, 1950 Stemmons Freeway, Dallas, Texas 75207, USA.

3) American Society of Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103-1187, USA.

3 Terms, definitions and abbreviations

3.1 Terms and definitions

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

NOTE A comprehensive list of definitions pertaining to marine drilling riser systems is contained in API RP 16Q[2].

3.1.1
auxiliary line
external conduit (excluding choke and kill lines) arranged parallel to the riser main tube for enabling fluid flow

EXAMPLE Control system fluid line, buoyancy control line, mud boost line.

3.1.2
breech-block coupling
coupling which is engaged by partial rotation of one member into an interlock with another

3.1.3
buoyancy
devices added to the riser joints to reduce their submerged weight

3.1.4
choke and kill lines
C&K lines
external conduits, arranged parallel to the main tube, used for circulation of fluids to control well pressure

NOTE Choke and kill lines are primary pressure-containing members.

3.1.5
collet-type coupling
coupling having a slotted cylindrical element joint mating coupling members

3.1.6
dog-type coupling
coupling having dogs which act as wedges mechanically driven between the box and pin for engagement

3.1.7
flange-type coupling
coupling having two flanges joined by bolts

3.1.8
indication
visual sign of cracks, pits, or other abnormalities found during liquid penetrant and magnetic particle examination

3.1.8.1
linear indication
indication in which the length is equal to or greater than three times its width

3.1.8.2
relevant indication
any indication with a major dimension over 1,6 mm (1/16 in)

3.1.8.3
rounded indication
indication that is circular or elliptical with its length less than three times the width

3.1.9
marine riser coupling
means of quickly connecting and disconnecting riser joints

NOTE The coupling box or pin (depending on design type) provides a support for transmitting loads from the suspended riser string to the riser-handling spider while running or retrieving the riser. Additionally, the coupling can provide support for choke and kill and auxiliary lines, and load reaction for buoyancy.

3.1.10
marine drilling riser
tubular conduit serving as an extension of the well bore from the well control equipment on the wellhead at the seafloor to a floating drilling rig

3.1.11
preload
compressive bearing load developed between box and pin members at their interface; this is accomplished by elastic deformation induced during make-up of the coupling

3.1.12
rated load
nominal applied loading condition used during coupling design, analysis and testing, based on a maximum anticipated service loading

NOTE Under the rated working load, no average section stress in the riser coupling exceeds allowable limits established in this International Standard.

3.1.13
riser coupling box
female coupling member

3.1.14
riser joint
section of riser pipe having ends fitted with a box and a pin, typically including integral choke and kill and auxiliary lines

3.1.15
riser main tube
basic pipe from which riser joints are fabricated

3.1.16
riser coupling pin
male coupling member

3.1.17
stress amplification factor
SAF
K_{SAF}
factor equal to the local peak alternating stress in a component (including welds) divided by the nominal alternating stress in the pipe wall at the location of the component

NOTE This factor is used to account for the increase in the stresses caused by geometric stress amplifiers which occur in riser components.

3.1.18
threaded coupling
coupling having matching threaded members to form engagement

3.2 Abbreviations

The following abbreviations are used in this International Standard.

BOP	Blowout preventer
C&K	Choke and kill
LP	Liquid penetrant
MP	Magnetic particle
NDE	Non-destructive examination
QTC	Qualified test coupon
SAF	Stress amplification factor

4 Design

4.1 Service classifications

4.1.1 Design information

The coupling manufacturer shall provide design information for each coupling size and model which defines load capacity rating. These data are to be based on design load (see 4.5) and verified by testing (see 8.2).

4.1.2 Size

Riser couplings are categorized by riser main tube size . The riser pipe outer diameter and wall thickness (or wall thickness range) for which the coupling is designed shall be documented.

4.1.3 Rated load

The rated loads listed in here provide a means of general classification of coupling models based on stress magnitude caused by applied load. To qualify for a particular rated load, neither calculated nor measured stresses in a coupling shall exceed the allowable stress limits of the coupling material when subjected to the rated load. The allowable material stresses are established in 4.6.

The rated loads are as follows:

a) 2 220 kN (500 000 lbf);

b) 4 450 kN (1 000 000 lbf);

c) 5 560 kN (1 250 000 lbf);

d) 6 670 kN (1 500 000 lbf);

e) 8 900 kN (2 000 000 lbf);

f) 11 120 kN (2 500 000 lbf);

g) 13 350 kN (3 000 000 lbf);

h) 15 570 kN (3 500 000 lbf).

4.1.4 Stress amplification factor

The calculated SAF values for the coupling shall be documented at the pipe-to-coupling weld and at the locations of highest stress in the pin and box. SAF is a function of pipe size, and wall thickness. It is calculated as follows:

$$K_{\text{SAF}} = \frac{\sigma_{\text{LPA}}}{\sigma_{\text{NAS}}}$$

where

σ_{LPA} is local peak alternating stress;

σ_{NAS} is nominal alternating stress in pipe.

4.1.5 Rated working pressure

Riser couplings shall be designed to provide a pressure seal between joints. The manufacturer shall document the rated internal working pressure for the coupling design.

4.2 Riser loading

4.2.1 General

A drilling riser's ability to resist environmental loading depends primarily on tension. Environmental loading includes the hydrodynamic forces of current and waves and the motions induced by the floating vessel's dynamic response to waves and wind.

The determination of a riser's response to the environmental loading and determination of the mechanical loads acting upon, and developed within, the riser require specialized computer modelling and analysis. (For the general procedure used to determine riser system design loads and responses, see API RP 16Q[2].

Additional sources of applied load that are not included in the rated load may significantly affect the coupling design and shall be included in design calculations.

4.2.2 Loads induced by choke and kill and auxiliary lines

Riser couplings typically provide support for choke and kill and auxiliary lines. This support constrains the lines to approximate the curvature of the riser pipe. Loads can be induced on the coupling from pressure in the lines, imposed deflections on the lines and the weight of the lines. The manufacturer shall document those loads induced by choke and kill and auxiliary lines for which the coupling has been designed.

4.2.3 Loads induced by buoyancy

Riser couplings may provide support for buoyancy, which induces loads on the couplings. The manufacturer shall document the buoyancy thrust loads for which the coupling has been designed.

4.2.4 Loads induced during handling

Temporary loads are induced by suspending the riser from the handling tool or spider or both. The manufacturer shall document the riser handling loads for which the coupling is designed and how these loads are applied.

4.3 Determination of stresses by analysis

Design of riser couplings for static loading (see 4.6) and determination of the stress amplification factors (see 4.7) require detailed knowledge of the stress distribution in the coupling. This information is acquired by finite element analysis and subsequently validated by prototype strain gauge testing. A finite element analysis of the riser coupling shall be performed and documented. The analysis shall provide accurate or conservative peak stresses, and shall include any deleterious effects of loss of preload from wear, friction and manufacturing tolerances. Suggestions for the analysis can be found in Annex A. The following shall be documented and included in the analysis:

a) hardware and software used to perform the analysis;

b) grid size;

c) applied loads;

d) preload losses;

e) material considerations.

4.4 Stress distribution verification test

After completion of the design studies, a prototype (or multiple prototypes) of the riser coupling shall be tested to verify the stress analysis. The testing has two primary objectives: to verify any assumptions which were made about preloading, separation behaviour and friction coefficients, and to substantiate the analytical stress predictions.

Strain gauge data shall be used to measure preload stresses as they relate to make-up load or displacement. Friction coefficients shall be varied (including at least two values) in order to establish sensitivity.

The coupling design load shall be applied in order to verify any assumption made in the analysis regarding separation.

Strain gauges shall be placed as near as physically possible to at least five of the most highly stressed regions, as predicted by the finite element analyses performed in accordance with 4.3, and in five locations away from stress concentrations. Rosettes shall be used. All strain gauge readings and the associated loading conditions shall be recorded such that they may be retained as part of the coupling design documentation.

Normal design qualification tests may be performed simultaneously with this stress distribution verification testing (see 8.2).

NOTE It is often difficult to acquire sufficient strain data to totally correlate with the analytical results. High-stress areas may be inaccessible and are sometimes so small that a strain gauge gives an average rather than the peak value. The testing serves to verify the pattern of strain in regions surrounding the critical points.

4.5 Coupling design load

The coupling design load represents the maximum load-carrying capacity of the coupling. The manufacturer shall establish the design load for each coupling design, based on the methods and criteria given in this International Standard. Neither calculated nor measured stresses in a coupling shall exceed the allowable stress limits of the coupling material when subjected to the design load. The allowable material stresses are established in 4.6. The coupling's rated load (see 4.1.3) shall be less than or equal to the coupling's design load.

For simplicity, the design loading condition is taken to be axisymmetric tension. In using this simplification, riser bending moment is converted to equivalent tension, T_{EQ}. The coupling design load can be specified either as an axisymmetric tension of magnitude, T_{design}, or it may be considered to be any combination of tension (T) and bending moment (M) so that

$$T + \frac{Mc}{I} A = T + M \frac{32t(d_o - t)^2}{d_o^4 - (d_o - 2t)^4} = T + T_{EQ} = T_{design} \qquad (2)$$

