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**Erdöl- und Erdgasindustrie –
Bohr- und Förderanlagen –
Teil 1: Auslegung und Betrieb von Bohrförderanlagen auf See
(ISO 13624-1:2009);
Englische Fassung EN ISO 13624-1:2009**

Petroleum and natural gas industries –
Drilling and production equipment –
Part 1: Design and operation of marine drilling riser equipment (ISO 13624-1:2009);
English version EN ISO 13624-1:2009

Industries du pétrole et du gaz naturel –
Équipement de forage et de production –
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Nationales Vorwort

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Für Deutschland hat hieran der Arbeitskreis NA 109-00-01-04 AK „Bohr- und Fördereinrichtungen“ im Normenausschuss Erdöl- und Erdgasgewinnung (NÖG) mitgearbeitet.

Diese Europäische Norm enthält unter Berücksichtigung des DIN-Präsidialbeschlusses 1/2004 nur die englische Originalfassung der ISO Norm.

Für die in diesem Dokument zitierte Internationale Norm wird im Folgenden auf die entsprechende Deutsche Norm hingewiesen:

ISO 13625 siehe DIN EN ISO 13625

Nationaler Anhang NA (informativ)

Begriffe und Abkürzungen

Folgende Begriffe und Abkürzungen werden in der Norm verwendet:

3.1 Begriffe

Für die Anwendung dieses Dokuments gelten die folgenden Begriffe.

3.1.1

Speicher

Sammelbehälter

⟨für BOP⟩ ein mit Gas (Stickstoff) über Flüssigkeit gefüllter Druckbehälter, der zur Speicherung von Hydraulikflüssigkeit für den Betrieb von Bohrlochsicherungen (Blowout-Preventern) benutzt wird

3.1.2

Speicher

Sammelbehälter

⟨für Riserspanner⟩ ein mit Gas (im Allgemeinen Stickstoff) über Flüssigkeit gefüllter Druckbehälter, der gasseitig von den Gashochdruckflaschen des Spanners mit Druck beaufschlagt wird und Hochdruck-Hydraulikflüssigkeit zur Aktivierung der Zylinder des Riserspanners zuführt

3.1.3

Verstellorgan

Mechanismus für den Fern- oder automatischen Betrieb eines Ventils oder einer Drosseleinrichtung

3.1.4

Luftkammerauftrieb

die an einen Riserstrang durch den Nettoauftrieb einer Luftkammer angelegte Zugspannung, erzeugt durch einen oben geschlossenen und unten offenen Zylinder, der an der Außenseite des Riserstrangs einen mit Luft gefüllten Ringraum bildet

3.1.5

Ringraum

Raum zwischen zwei Rohren, wenn sich ein Rohr im Innern des anderen Rohres befindet

3.1.6

Scheingewicht

effektives Gewicht

Unterwassergewicht (Eintauchgewicht)

Gewicht abzüglich Auftrieb

ANMERKUNG Das Scheingewicht wird gewöhnlich als Gewicht in Wasser, Feuchtgewicht, Unterwassergewicht oder effektives Gewicht bezeichnet.

3.1.7

Riser-Hilfsleitung

außen am Riser-Hauptrohr angebrachte Rohrleitung (ausgenommen Drossel- und Totpumpleitung)

BEISPIEL Hydraulikleitung, Auftrieb-Steuerleitung, Schlamm-Boostleitung.

3.1.8

Rückdruck

sich aus der Drosselung der Flüssigkeitsströmung stromab ergebender Druck

3.1.9

Kugelgelenk

Kugelgelenkaufbau mit einer zentralen Durchflussöffnung, die gleich oder größer ist als der Innendurchmesser des Risers, und die in dem Riserstrang eingebaut werden kann, um die lokalen Biegespannungen zu verringern

3.1.10

Bohrlochausbruch

unkontrollierter Ausbruch von Bohrlochflüssigkeit aus dem Bohrloch

3.1.11

Bohrlochsicherung

Blowout-Preventer

BOP

unmittelbar über dem Futterrohr angebrachte Vorrichtung, die geschlossen werden kann, um das Bohrloch zu verschließen

3.1.12

Blowout-Preventer

〈Ringpreventer〉 fernbetätigte Vorrichtung, die eine Abdichtung im Ringraum um irgendein Objekt des Bohrlochs oder im Bohrloch selbst ausbilden kann

ANMERKUNG Die Abdichtung wird durch das Zusammendrücken eines mit Füllstoff verstärkten Elastomers mit Hydraulikdruck bewerkstelligt.

3.1.13

BOP-Garnitur

Montageeinheit einer Bohrlochsteuereinrichtung, einschließlich BOPs, Rollen, Ventilen, Hydraulikanschlüssen und Rohrstützen, die an das Unterwasserbohrloch angeschlossen ist

ANMERKUNG Bei der üblichen Verwendung dieses Begriffs wird manchmal das untere Riserpaket (LMRP) mit einbezogen.

3.1.14

Bohrlochaufbau

BHA

Aufbau, bestehend aus dem Bohrmeißel, Stabilisatoren, Räumer, Schwerstangen, verschiedene Typen von Ersätzen usw., der mit dem unteren Ende des Strangs vom Bohrgestänge verbunden ist

3.1.15

Muffe

Aufnahmeelement einer Riserkupplung, Einführhilfe einer Drossel- und Totpumpleitung oder Riser-Hilfsleitung

3.1.16

Verschlusskupplung

Kupplung, die durch Drehung eines Elements in einer Verriegelung bei einem Drehwinkel von 90° oder weniger mit einem anderen Element einrastet

3.1.17

Auftriebssteuerleitung

für die Steuerung des Auftriebs, zum Aufpumpen der Kammern und Ablassen der Luft aus den Kammern des Auftriebskörpers vorgesehene Hilfsleitung

3.1.18**Auftriebseinheit**

zusätzlich an den Risersegmenten zur Verringerung ihres effektiven Gewichts angebrachte Einrichtungen, wodurch sich die Anforderungen an die Riservorspannung verringern

ANMERKUNG Die üblicherweise für Riser verwendeten Einrichtungen bestehen aus Modulen syntaktischer Schaumstoffe oder aus Luftkammern mit offenem Boden

3.1.19**Drossel- und Totpumpleitung****Choke- und Kill-Leitung****Totpumpleitung**

außen, längsseits des Riserstrangs angebrachte Rohrleitung, die zur Druckreglung der Ölquelle für die Umwälzung von Flüssigkeiten in das Bohrloch hinein und aus dem Bohrloch heraus benutzt wird

3.1.20**Steuereinheit**

Anordnung von Unterwasserventilen und -reglern, die durch besondere Anschlüsse Hydraulikflüssigkeit zum Bedienen der Bohrlochsicherung zuführen, sobald diese von der Wasseroberfläche aus betätigt werden

3.1.21**Kupplung**

mechanisches Mittel zum Zusammenfügen von zwei Risersegmenten in einer Stoßverbindungskupplung

3.1.22**Umlenkstück****Steuerventil**

Vorrichtung, die am Bohrlochkopf oder am Marineriser (Seesteigleitung) angebracht ist, um den vertikalen Strömungsweg zu schließen und den Fluss des Erdöls aus der Produktionsbohrung von der Bohrplattform und vom Bohrturm wegzuleiten

3.1.23**Klauenkupplung**

Kupplung mit Keilstücken (Greifhaken), die für den Eingriff zwischen Zapfen- und Muffenteil mechanisch bewegt werden

3.1.24**Hydraulikschlauch**

flexible Leitung, die das Anschlusselement einer Drossel-, Totpump- oder Hilfsleitung am Teleskopausgleichsstück mit der entsprechenden Rohrleitung an der Bohrturmstruktur verbindet

ANMERKUNG Ein U-förmige Biegung oder "Drapierung" in dieser Leitung lässt die Relativbewegung zwischen dem Innenzylinder und dem Außenzylinder des Teleskopausgleichsstücks zu, so wie sich das Schiff bewegt.

3.1.25**Abtrieb**

unbeabsichtigte seitliche Bewegung eines dynamisch positionierten Schiffes von seiner vorgesehenen Position in Bezug auf den Bohrlochkopf

3.1.26**Bohrspülung****Bohrschlamm**

im Umlauf durch das Bohrgestängerohr zum Bohrloch und zurück zum Bohrturm geführte Flüssigkeit auf Wasser- oder Öl-Basis zwecks Eindämmung des Lagerstättendrucks, Abtransport des Bohrkleins (Cuttings), Schmierung und Kühlung des Bohrmeißels, Behandlung der Wand der Förderbohrung und als Quelle zur Erlangung von die Ölbohrung betreffenden Informationen

3.1.27

Wegfahren

unbeabsichtigte Bewegung eines dynamisch positionierten Schiffes vom Abnahmeort durch den Hauptantrieb des Schiffes oder Lageerhaltungsstrahlruder

3.1.28

dynamische Positionierung

automatische Lageerhaltung

computergestütztes System zur Aufrechterhaltung der Schiffsposition durch selektiv antreibende Strahlruder

3.1.29

Grenzwert der dynamischen Spannung

maximal zulässiger Druck multipliziert mit der effektiven Hydraulikfläche, dividiert durch die Anzahl der Leitungsstücke

3.1.30

effektive Hydraulikzylinderfläche

Nettofläche (Nutzfläche) sich bewogender Teile, die dem Spanner-Hydraulikdruck ausgesetzt sind

3.1.31

effektive Zugspannung

Spannung, die die Standfestigkeit des Risers reguliert

Siehe 5.4.4

3.1.32

Werksabnahmeprüfung

Prüfung durch den Hersteller eines bestimmten Produkts zur Validierung der Konformität des Produkts mit den Leistungsanforderungen und Bemessungsdaten

3.1.33

ausfallsicher

Begriff, der auf Ausrüstungen oder eine Anlage angewendet wird, die konstruktiv so ausgeführt sind/ist, dass im Falle eines Ausfalls oder einer Störung irgendeines Teils der Anlage automatisch Geräte zum Stabilisieren des Betriebs oder zur Sicherstellung der Betriebssicherheit aktiviert werden

3.1.34

Auffüllleitung

Leitung, durch die dem Ringraum des Risers Flüssigkeit zugefügt wird

3.1.35

Flanschkupplung

Kupplung mit zwei durch Schrauben miteinander verbundenen Flanschen

3.1.36

Ablenkwinkel

Winkel zwischen der vertikalen Achse und einer Riserspannerleitung an der Stelle, wo die Leitung am Teleskopausgleichsstück befestigt ist

Siehe Bild 1.

3.1.37

Biegegelenk

Baueinheit aus Stahl und Elastomer mit einer zentralen Durchführung, deren Durchmesser gleich oder größer ist als die Riserbohrung, und die am Riserstrang zur Verringerung der lokalen Biegespannungen angebracht werden kann

3.1.38**Krümmmer****Schwanenhals**

Art eines Anschlussstückes mit einem halbkreisförmig gebogenen Rohrabschnitt, damit sich eine nominelle Änderung der Fließrichtung von 180° erreichen lässt

3.1.39**kabelloses Wiedereinführen**

Einrichtung einer druckführenden Verbindung zwischen der BOP-Garnitur und dem Unterwasser-Bohrlochkopf oder zwischen dem LMRP und der BOP-Garnitur mithilfe eines Fernsehbildes und/oder von akustischen Signalen anstelle von Führungs- oder Leitsystemen zur Nachführung bei Orientierung und Ausrichtung

3.1.40**Handhabungswerkzeug****Einbauwerkzeug**

Maschinenzange, die sich mit dem oberen Ende eines einzelnen Risersegments verbindet, um das Anheben und Absenken der Einzelrohre und des zusammengefügt Riserstrangs mit den Hebegegeräten im Bohrturm zu ermöglichen

3.1.41**Hub**

Schiffsbewegung in vertikaler Richtung

3.1.42**Hot-Spot-Spannung****lokale Spitzenspannung**

höchste Spannung im in Betracht gezogenen Bereich oder am in Betracht gezogenen Bauteil

ANMERKUNG Die Grundeigenschaft einer lokalen Spitzenspannung besteht darin, dass sie keine wesentliche Verformung verursacht und hauptsächlich als möglicher Ausgangsort für einen Ermüdungsrisss störend ist. Diese Spannungen sind örtlich streng begrenzt und treten an geometrischen Diskontinuitäten auf.

3.1.43**hydraulisches Anschlussstück**

mechanisches, hydraulisch aktiviertes Bindeglied, das die Verbindung der BOP-Garnitur zum Bohrlochkopf oder dem LMRP zur BOP-Garnitur herstellt

3.1.44**hydraulische Versorgungsleitung**

Hilfsleitung vom Schiff zur Unterwasser-BOP-Garnitur, über die Betriebsflüssigkeiten des Steuer- und Regelsystems für das LMRP und die BOP-Garnitur zugeführt werden

3.1.45**instrumentiertes Risersegment****IRJ**

mit Messfühlern ausgestattetes Risersegment zur Überwachung von Parametern, wie mechanische Spannung in der Riserwandung, Winkelversatz des Risers, Temperatur und Druck des Fluids im Ringraum usw.

3.1.46**Hochdruckschlauch**

flexibler Hochdruckschlauch von Drossel-, Totpump- oder Hilfsleitungen, der für einen ständigen Durchfluss rund um ein Biege-/Kugelgelenk sorgt, während die Winkelbewegung am Biege-/Kugelgelenk aufgenommen wird

3.1.47

Ovalausformung des Bohrlochs in Längsrichtung

Bildung eines länglichen Schlitzes in der Komponente eines Risersystems in Hauptrichtung der Bohrung, die durch Reibungsverschleiß des sich drehenden Bohrstrangs an der Riserkomponente hervorgerufen wird

3.1.48

Anlegesegment

Risersegment, das zeitweilig zum Anlegen der BOP-Garnitur am Bohrlochkopf über dem Teleskopausgleichsstück angeschlossen wird, wenn das Teleskopausgleichsstück kollabiert und festgesteckt ist

3.1.49

Setzschulter

Absatzschulter

Schulter oder Vorsprung auf der Außenfläche einer Riserkupplung oder eines anderen Riserbauteils zur Abstützung des Risers und der BOP-Garnitur beim Absenken und Zurückziehen

3.1.50

unteres Riserpaket

LMRP

oberer Abschnitt einer aus zwei Segmenten bestehenden Unterwasser-BOP-Garnitur, bestehend aus einem hydraulischen Anschlussstück, Ringpreventer, Biegegelenk, Riser-Adapter, flexiblen Hochdruckschlauch für die Drossel-, Totpump- und Hilfsleitungen und Unterwassersteuereinheiten

ANMERKUNG Das untere Riserpaket koppelt an die Unterwasser-BOP-Garnitur an.

3.1.51

Fertigungslänge

tatsächliche Länge eines Riserbauteils, die zum Zusammenbau eines Riserstrangs beigetragen hat (Gesamtlänge des Bauteils minus Muffenverbindung)

3.1.52

Rüstzeit

Einrichtezeit

Zeitraum, der mit dem Zusammenstecken von Zapfen und Muffe beginnt und endet, sobald die Muffenverbindung vorgespannt ist

3.1.53

Vorspannwerkzeug

Gerät, das zum Ineinandergreifen und/oder Vorspannen der Verbindungselemente benutzt wird

3.1.54

Bohrstrang

Rohrleitung, die als Verlängerung des Bohrstrangs von der Einrichtung am Bohrlochkopf am Meeresboden zu einem schwimmenden Bohrturm dient

3.1.55

maximaler Einstellwert des Spanners

maximale Einstellung, die bei Ergänzung mit dynamischen Variationen geringer ist als der Grenzwert der dynamischen Spannung (3.1.29)

3.1.56

Schlamm-Boostleitung

Hilfsleitung, die von der Oberfläche ergänzende Bohrflüssigkeit zuführt und diese am Oberteil des unteren Riserpakets (LMRP) einspeist, um gegebenenfalls die Umwälzung von Bohrklein nach oben über den Riser zu unterstützen

3.1.57**verflanschen**

Aneinanderfügen eines Systems vom Bauteilen für den Transport von Fluiden

3.1.58**Nennbelastung**

Belastung, die mit Hilfe der Nennmaße der Rohrwanddicke des Risers an der betreffenden Stelle berechnet wird

3.1.59**Zapfen**

Einführelement der Steckverbindung eines Risers oder einer Drossel-, Totpump- oder Hilfsleitung

3.1.60**Vorspannung**

Druckbelastung, die sich zwischen den Elementen von Muffe und Zapfen an deren Berührungsfläche entwickelt

ANMERKUNG Die Vorspannung wird bei der Herstellung der Verbindung mit einer elastischen Verformung erreicht.

3.1.61**Schutzeinrichtung, Muffe****Schutzeinrichtung, Zapfen**

Kappe oder Deckel, die/der benutzt wird, um Muffe oder Zapfen bei Lagerung und Transport/Handhabung vor Beschädigungen zu schützen

3.1.62**Passesegment****Passgestänge**

(wesentlich) kürzer als die Normallänge eines Risersegments

3.1.63**Nennlast**

normaler Belastungszustand, der bei Riserentwurf, -analyse und -prüfung unter Zugrundelegung der maximal anzunehmenden Betriebsbelastung eingesetzt wird

Siehe API Spec 16F

3.1.64**Übertragungsfunktion****RAO**

(regelmäßige Wellen) Verhältnis der Schiffsbewegung zur Wellenamplitude, die diese Bewegung verursacht und über eine Reihe von Wellenperioden dargestellt

3.1.65**Riser-Adapter**

Übergangsstück zwischen Riser(segment) und Biege-/Kugelgelenk

3.1.66**Riserringraum**

Raum um ein in einem Riser aufgehängtes Rohr (Bohrgestänge, Futterrohr, Produktionsrohr)

ANMERKUNG Dessen Außengrenze ist die Innenfläche des Riserrohres.

3.1.67**Riser-Anschlussstück****LMRP-Anschlussstück**

hydraulisch betriebener Anschluss, der das LMRP mit dem oberen Ende der BOP-Garnitur verbindet

3.1.68

Risertrennung

Arbeitsvorgang beim Entsperren der Riserkupplung zum Trennen des Risers und LMRP von der BOP-Garnitur

3.1.69

Riser-Aufhängungssystem

Hilfseinrichtung zum Abstützen (zum Tragen) eines während eines Sturms vom Bohrschiff abgetrennten Risers einer Tiefwasser-Förderanlage, ohne übermäßige Belastung auf den Riser auszuüben

3.1.70

Riser-Aufhängevorrichtung

Werkzeug, das zum Einrasten in das Innenprofil des Risers und dessen Anschluss an den Bewegungskompensator verwendet wird

3.1.71

Risersegment

Abschnitt eines Riser-Hauptrohres, dessen Enden mit einem Zapfen und einer Muffe versehen sind, einschließlich Drossel-, Totpump- und (wahlweise) Hilfsleitungen und deren Haltebügel

3.1.72

Riser-Hauptrohr

Riserrohr

nahtloses oder elektrisch geschweißtes Rohr, das den Hauptkörper der Struktur des Risersegments bildet

ANMERKUNG Das Riser-Hauptrohr ist die Rohrleitung für die Führung des Bohrstrangs und Aufnahme des Rücklauf-Fluidstroms vom Bohrloch.

3.1.73

Riser-Rückstoßsystem

Hilfseinrichtung zur Begrenzung der Aufwärtsbeschleunigung des Risers, wenn eine Abkopplung am Riseranschluss vorgenommen wird

3.1.74

Riserhaltekreuz

Vorrichtung mit einziehbaren Klemmbacken oder Klauen, die zum Abstützen des Riserstrangs am obersten Ansatz der Kupplungsaufgabe beim Absenken und Zurückziehen des Risers benutzt wird

3.1.75

Riserstrang

abgesenkter Zusammenbau von Risersegmenten

3.1.76

Riserspanner

Vorrichtung zur Verschaffung und Aufrechterhaltung der Zugspannung am abgesenkten Riserstrang, um Knicken/Wölben zu verhindern

3.1.77

Riserspannring

strukturelle Anschlussstelle des Teleskopsegments vom Außenzylinder und den Riserspannern

3.1.78

Drehdurchführung

Spülbuchse

RKB

Buchse, die oben auf dem Drehtisch (des Bohrturms) angeordnet ist

ANMERKUNG Sie überträgt die Drehkraft vom Drehtisch zur Spülstange und wird üblicherweise als Bezugsbasis für Vertikalmessungen von der Arbeitsbühne aus benutzt.

3.1.79**Schraubverbindung**

Rohrverbindung (Riser) mit Gewindezapfen und Gewindemuffe (Zapfenende und Steckende), die für ein druckdichtes Eingreifen der beiden Rohrsegmente sorgt

ANMERKUNG Gewöhnlich wird ein externer Mechanismus benutzt, um Zapfen und Muffe im eingerasteten Zustand zu halten.

BEISPIEL Drossel- und Totpumpleitungen eines Risersegments werden durch den konstruktiven Aufbau des Riseranschlusses im eingerasteten Zustand gehalten.

3.1.80**Riser-Normsegment**

Segment mit einer für die Lagerregale, Größe der Zugangsöffnung (V-Tür), Belastbarkeit der Riser-Handhabungseinrichtungen eines bestimmten Bohrschiffs üblichen Länge oder einer(n) typischen Länge für eine besondere Riserabnahme

3.1.81**Abkopplung bei Sturm**

Abkopplung des Risers zur Vermeidung übermäßiger Beanspruchung durch Schiffsbewegungen, die durch Schlechtwetterbedingungen verstärkt werden

3.1.82**Strakes**

außen am Riser zur Unterdrückung Wirbel induzierter Schwingungen angebrachte, wendelförmig gewundene Ansätze

3.1.83**Verstärkungsfaktor der Beanspruchung****SAF**

F_{SA}

Wert gleich dem lokalen Maximum abwechselnder Beanspruchung in einem Bauteil (einschließlich Schweißnähten), dividiert durch die abwechselnde Beanspruchung in der Rohrwand am Einbauort des Bauteils

ANMERKUNG Dieser Faktor wird für die Messung des Belastungsanstiegs, verursacht durch die geometrische Bealastungsverstärkung, die in Riser Bauteilen auftritt, benötigt.

3.1.84**Druckring**

Einrichtung für die Übertragung der Auftriebskraft eines Auftriebsmoduls auf das Risersegment

3.1.85**Unterwasser-Füllventil**

besonderes Risersegment mit einem Ventil, mit dem es möglich ist, den Ringraum des Risers zur See hin zu öffnen

ANMERKUNG Um zu verhindern, dass der Riser (die Seesteigleitung) zusammenbricht, kann das Ventil durch eine automatische Betätigungsvorrichtung geöffnet werden, die von einem Differenzdruck-Messfühler gesteuert wird.

3.1.86**Haltebügel**

in Abständen entlang eines Risersegments angebrachte Bügel, die eine radiale und seitliche Abstützung von der Hauptleitung des Risers zu den Drossel- und Totpumpleitungen (Choke- und Kill-Leitungen) bieten

3.1.87**Längsschwingung (Welle)**

Schiffsbewegung entlang der Kippachse (Schiffslängsachse)

3.1.88

Driftschwingung

Schiffsbewegung entlang der Steuerbord-Backbord-Schwenkachse (Nickachse)

3.1.89

syntaktischer Schaum

üblicherweise ein Verbundmaterial von (Mikro-)Hohlkugeln in einer Polymermatrix oder in einem Bindemittel

3.1.90

Teleskopausgleichsstück

Teleskopsegment

Risersegment mit einem Innen- und einem Außenzylinder und einem dazwischen befindlichen Dichtungsmittel

ANMERKUNG Die Innen- und Außenzylinder eines Teleskopausgleichsstückes bewegen sich relativ zueinander, um die notwendige Längenänderung des Riserstrangs auszugleichen, da das Schiff Drift- und Längsschwingungen sowie Hub ausgesetzt ist.

3.1.91

Packermanschette des Teleskopausgleichsstücks

Mittel zum Abdichten des Ringraums zwischen dem Innen- und Außenzylinder des Teleskopausgleichsstücks

3.1.92

Anschlusselement

Verbindung zwischen einer Drossel- und Totpumpleitung an einem Teleskopausgleichsstück und dessen Hydraulikschlauch, die in Fließrichtung eine Wende von 180° bewirkt

3.1.93

Kupplung mit Überwurfmutter

Kupplung mit paarigen Gewindeelementen am Zapfen- und Muffenteil zur Herbeiführung des Eingriffs

ANMERKUNG Das Gewinde auf der einen Seite der Kupplung ist in Bezug auf den Riser frei drehbar; deshalb ist es nicht notwendig, das Anschlussstück zu drehen, um die Verbindung der Kupplung herzustellen. Das Gewinde bildet nicht die Dichtung.

3.1.94

Spannring

Stützring um das obere Ende des Anschlussstücks, wo die Spannerleitungen angebracht sind

3.1.95

Baumusterzertifizierung

Prüfung eines repräsentativen Musters (oder Prototyps) durch einen Hersteller eines Produkts, das die konstruktive Ausführung genau bestimmt und demzufolge die Integrität der übrigen Produkte gleicher Auslegung, Werkstoffe und Fertigung bestätigt

3.1.96

Wirbel induzierte Schwingung

längs und quer verlaufende Oszillation eines Risers in einer Strömung, die durch periodische Wirbelbildung hervorgerufen wird

3.1.97

Bohrlochkopfanschluss

Anschluss der Blowout-Preventer-Garnitur

hydraulisch betätigter Anschluss, der die BOP-Garnitur mit dem Unterwasserbohrloch verbindet

3.2 Abkürzungen

BOP	Bohrlochsicherung; Blowout-Preventer; Bohrlochabsperrvorrichtung
DP	Dynamische Positionierung
DTL	Grenzwert der dynamischen Spannung
ID	Innendurchmesser
LFJ	Unteres Biegegelenk
LMRP	Unteres Riserpaket
OD	Außendurchmesser
RAO	Übertragungsfunktion
RKB	Drehdurchführung; Spülbuchse
ROV	Ferngesteuerte (Unterwasser-)Fahrzeuge
SAF	Verstärkungsfaktor der Beanspruchung
UFJ	Oberes Biegegelenk

Nationaler Anhang NB
(informativ)

Literaturhinweise

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English Version

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Foreword

This document (EN ISO 13624-1:2009) has been prepared by Technical Committee ISO/TC 67 "Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries" in collaboration with Technical Committee CEN/TC 12 "Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries" the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2010, and conflicting national standards shall be withdrawn at the latest by May 2010.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

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Introduction

Since the first edition of API RP 16Q was first issued in November, 1993, hydrocarbon exploration in deep-water environments has increased significantly. As a consequence of this, the need has been identified to update that code of practice to address the issues of deep-water drilling risers in sufficient detail to supplement API RP 16Q for drilling in water depths up to 3 048 m (10 000 ft).

Under the auspices of the DeepStar programme, substantial work was commissioned during 1999 and 2000 by the DeepStar Drilling Committee 4502 and lead to the development by several contractors of *Deep-water Drilling Riser Methodologies, Operations, and Integrity Guidelines* in February 2001. These guidelines were intended to supplement the existing text of API RP 16Q (1993). In a subsequent Joint Industry Project funded by DeepStar 5500 and in collaboration with API, these guidelines were supplemented with other identified revisions to produce a draft update second edition of API RP 16Q and an associated API Technical Report 16TR1, designed to be read in conjunction with the revised API RP 16Q and to supplement its contents, by providing additional guidance on recommended riser analysis methodologies through detailed explanations, step-by-step procedures and worked examples.

API publications can be used by anyone desiring to do so. Every effort has been made to assure the accuracy and reliability of the data contained in them. It is the responsibility of the users of this part of ISO 13624 to ensure that its use does not result in any loss or damage or in the violation of any federal, state, or municipal regulation.

Annex A through Annex E are informative.

1 Scope

This part of ISO 13624 pertains to the design, selection, operation and maintenance of marine riser systems for floating drilling operations. Its purpose is to serve as a reference for designers, for those who select system components, and for those who use and maintain this equipment. It relies on basic engineering principles and the accumulated experience of offshore operators, contractors, and manufacturers.

NOTE Technology is advancing in this field and improved methods and equipment are continually evolving. Each owner and operator is encouraged to observe the recommendations outlined herein and to supplement them with other proven technology that can result in more cost effective, safer, and/or more reliable performance.

The marine drilling riser is best viewed as a system. It is necessary that designers, contractors, and operators realize that the individual components are recommended and selected in a manner suited to the overall performance of that system. For the purposes of this part of ISO 13624, a marine drilling riser system includes the tensioner system and all equipment between the top connection of the upper flex/ball joint and the bottom of wellhead conductor outer casing. It specifically excludes the diverter. Also, the applicability of this part of ISO 13624 is limited to operations with a subsea BOP stack deployed at the seafloor.

Clauses 1 through 7 of this part of ISO 13624 are directly applicable to most floating drilling operations. Special situations are addressed in 8.1 and 8.4 dealing with deep-water drilling and collapse. The special considerations required for guidelineless drilling are addressed in 8.2. In addition, 8.3 and 8.5 address operations in cold-weather conditions and H₂S considerations.

It is important that all riser primary-load-path components addressed in this part of ISO 13624 be consistent with the load classifications specified in ISO 13625.

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 13625, *Petroleum and natural gas industries — Drilling and production equipment — Marine drilling riser couplings*

BS 7910, *Guide to methods for assessing the acceptability of flaws in metallic structures*

3 Terms, definitions, and abbreviations

3.1 Terms and definitions

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

3.1.1 accumulator

⟨BOP⟩ pressure vessel charged with gas (nitrogen) over liquid and used to store hydraulic fluid under pressure for operation of blowout preventers

3.1.2 accumulator

⟨riser tensioner⟩ pressure vessel charged with gas (generally nitrogen) over liquid that is pressurized on the gas side from the tensioner high-pressure gas supply bottles and supplies high-pressure hydraulic fluid to energize the riser tensioner cylinder

3.1.3

actuator

mechanism for the remote or automatic operation of a valve or choke

3.1.4

air-can buoyancy

tension applied to the riser string by the net buoyancy of an air chamber created by a closed top, open-bottom cylinder forming an air-filled annulus around the outside of the riser pipe

3.1.5

annulus

space between two pipes when one pipe is inside the other

3.1.6

apparent weight

effective weight

submerged weight

weight minus buoyancy

NOTE Apparent weight is commonly referred to as weight in water, wet weight, submerged weight, or effective weight.

3.1.7

auxiliary line

conduit (excluding choke-and-kill lines) attached to the outside of the riser main tube

EXAMPLE Hydraulic supply line, buoyancy-control line, mud-boost line.

3.1.8

back pressure

pressure resulting from restriction of fluid flow downstream

3.1.9

ball joint

ball-and-socket assembly that has a central through-passage equal to or greater than the riser internal diameter and that may be positioned in the riser string to reduce local bending stresses

3.1.10

blowout

uncontrolled flow of well fluids from the wellbore

3.1.11

blowout preventer

BOP

device attached immediately above the casing, which can be closed to shut in the well

3.1.12

blowout preventer

(annular type) remotely controlled device which can form a seal in the annular space around any object in the wellbore or upon itself

NOTE Compression of a reinforced elastomer packing element by hydraulic pressure effects the seal.

3.1.13

BOP stack

assembly of well-control equipment, including BOPs, spools, valves, hydraulic connectors and nipples, that connects to the subsea wellhead

NOTE Common usage of this term sometimes includes the lower marine riser package (LMRP).

3.1.14

bottom-hole assembly

BHA

assembly composed of the bit, stabilizers, reamers, drill collars, various types of subs, etc., that is connected to the bottom of a string of drillpipe

3.1.15

box

female member of a riser coupling, C&K line stab assembly or auxiliary line stab assembly

3.1.16

breech-block coupling

coupling that is engaged by rotation of one member into an interlock with another member by an angle of rotation of 90 ° or less

3.1.17

buoyancy-control line

auxiliary line dedicated to controlling, charging or discharging air-can buoyancy chambers

3.1.18

buoyancy equipment

devices added to riser joints to reduce their apparent weight, thereby reducing riser top tension requirements

NOTE The devices normally used for risers take the form of syntactic foam modules or open-bottom air chambers.

3.1.19

choke-and-kill line

C&K line

kill line

external conduit arranged laterally along the riser pipe and used for circulation of fluids into and out of the wellbore to control well pressure

3.1.20

control pod

assembly of subsea valves and regulators that, when activated from the surface, directs hydraulic fluid through special porting to operate BOP equipment

3.1.21

coupling

mechanical means for joining two sections of riser pipe in an end-to-end engagement

3.1.22

diverter

device attached to the wellhead or marine riser to close the vertical flow path and direct well flow away from the drill-floor and rig

3.1.23

dog-type coupling

coupling having wedges (dogs) that are mechanically driven between the box and pin for engagement

3.1.24

drape hose

flexible line connecting a choke, kill or auxiliary line terminal fitting on the telescopic joint to the appropriate piping on the rig structure

NOTE A U-shaped bend or "drape" in this line allows for relative movement between the inner barrel of the telescopic joint and the outer barrel of the telescopic joint as the vessel moves.

3.1.25

drift-off

unintended lateral move of a dynamically positioned vessel off of its intended location relative to the wellhead, generally caused by loss of stationkeeping control or propulsion

3.1.26

**drilling fluid
mud**

water- or oil-based fluid circulated down the drillpipe into the well and back up to the rig for purposes including containment of formation pressure, the removal of cuttings, bit lubrication and cooling, treating the wall of the well and providing a source for well data

3.1.27

drive-off

unintended move of a dynamically positioned vessel off location driven by the vessel's main propulsion or stationkeeping thrusters

3.1.28

**dynamic positioning
automatic stationkeeping**

computerized means of maintaining a vessel on location by selectively driving thrusters

3.1.29

dynamic tension limit

maximum allowable pressure multiplied by the effective hydraulic area, divided by the number of line parts

3.1.30

effective hydraulic cylinder area

net area of moving parts exposed to tensioner hydraulic pressure

3.1.31

effective tension

tension that controls the stability of risers

See 5.4.4.

3.1.32

factory acceptance testing

testing by a manufacturer of a particular product to validate its conformance to performance specifications and ratings

3.1.33

fail safe

term applied to equipment or a system so designed that, in the event of failure or malfunction of any part of the system, devices are automatically activated to stabilize or secure the safety of the operation

3.1.34

fillup line

line through which fluid is added to the riser annulus

3.1.35

flange-type coupling

coupling having two flanges joined by bolts

3.1.36

fleet angle

angle between the vertical axis and a riser tensioner line at the point where the line connects to the telescopic joint

See Figure 1.

3.1.37

flex joint

steel and elastomer assembly that has a central through-passage equal to or greater in diameter than the riser bore and that may be positioned in the riser string to reduce local bending stresses

3.1.38

gooseneck

type of terminal fitting using a pipe section with a semicircular bend to achieve a nominal 180° change in flow direction

3.1.39

guidelineless re-entry

establishment of pressure-containing connection between the BOP stack and the subsea wellhead or between the LMRP and the BOP stack using a TV image and/or acoustic signals instead of guidelines to guide the orientation and alignment

3.1.40

handling tool

running tool

device that joins to the upper end of a riser joint to permit lifting and lowering of the joint and the assembled riser string in the derrick by the elevators

3.1.41

heave

vessel motion in the vertical direction

3.1.42

hot spot stress

local peak stress

highest stress in the region or component under consideration

NOTE The basic characteristic of a peak stress is that it causes no significant distortion and is principally objectionable as a possible initiation site for a fatigue crack. These stresses are highly localized and occur at geometric discontinuities.

3.1.43

hydraulic connector

mechanical connector that is activated hydraulically and connects the BOP stack to the wellhead or the LMRP to the BOP stack

3.1.44

hydraulic supply line

auxiliary line from the vessel to the subsea BOP stack that supplies control system operating fluid to the LMRP and BOP stack

3.1.45

instrumented riser joint

IRJ

riser joint equipped with sensors for monitoring parameters, such as tension in the riser pipe wall, riser angular offset, annulus fluid temperature and pressure, etc.

3.1.46

jumper hose

flexible section of choke, kill or auxiliary line that provides a continuous flow around a flex/ball joint while accommodating the angular motion at the flex/ball joint

3.1.47

key-seating

formation of a longitudinal slot in the bore of a riser system component caused by frictional wear of the rotating drillstring on the riser component

3.1.48

landing joint

riser joint temporarily attached above the telescopic joint used to land the BOP stack on the wellhead when the telescopic joint is collapsed and pinned

3.1.49

landing shoulder

riser support shoulder

shoulder or projection on the external surface of a riser coupling or other riser component for supporting the riser and BOP stack during deployment and retrieval

3.1.50

lower marine riser package

LMRP

upper section of a two-section subsea BOP stack consisting of a hydraulic connector, annular BOP, flex joint, riser adapter, jumper hoses for the choke, kill and auxiliary lines, and subsea control pods

NOTE This interfaces with the lower subsea BOP stack.

3.1.51

made-up length

actual length contributed to a riser string by a made-up riser component (overall component length minus box/pin engagement)

3.1.52

make-up time

riser coupling

time period beginning when the box and pin are stabbed and ending when the coupling is fully preloaded

3.1.53

make-up tool

preload tool

device used to engage and/or preload coupling members

3.1.54

marine drilling riser

tubular conduit serving as an extension of the wellbore from the equipment on the wellhead at the seafloor to a floating drilling rig

3.1.55

maximum tensioner setting

maximum setting that, when added with dynamic variations, is less than the **dynamic tension limit** (3.1.29)

3.1.56

mud-boost line

auxiliary line that provides supplementary drilling fluid from the surface and injects it into the riser at the top of the LMRP to assist in the circulation of drill cuttings up the marine riser, when required

3.1.57

nipple up

assemble a system of fluid handling components

3.1.58

nominal stress

stress calculated using the nominal pipe wall dimensions of the riser at the location of concern

3.1.59

pin

male member of a riser coupling or a choke, kill or auxiliary line stab assembly

3.1.60

preload

compressive bearing load developed between box and pin members at their interface

NOTE This is accomplished by elastic deformation during make-up of the coupling.

3.1.61

protector, box

protector, pin

cap or cover used to protect the box or pin from damage during storage and handling

3.1.62

pup joint

shorter than standard length riser joint

3.1.63

rated load

nominal applied loading condition used during riser design, analysis and testing based on maximum anticipated service loading

See API Spec 16F.

3.1.64

response amplitude operator

RAO

⟨regular waves⟩ ratio of a vessel's motion to the wave amplitude causing that motion and presented over a range of wave periods

3.1.65

riser adapter

crossover between riser and flex/ball joint

3.1.66

riser annulus

space around a pipe (drillpipe, casing or tubing) suspended in a riser

NOTE Its outer boundary is the internal surface of the riser pipe.

3.1.67

riser connector

LMRP connector

hydraulically operated connector that joins the LMRP to the top of the BOP stack

3.1.68

riser disconnect

operation of unlatching of the riser connector to separate the riser and LMRP from the BOP stack

3.1.69

riser hang-off system

means for supporting a disconnected deep-water riser from the drilling vessel during a storm without inducing excessive stresses in the riser

3.1.70

riser hang-off tool

tool used to latch onto an interior profile in the riser and connect it to the motion compensator

3.1.71

riser joint

section of riser main tube having the ends fitted with a box and pin and including choke, kill and (optional) auxiliary lines and their support brackets

3.1.72

riser main tube

riser pipe

seamless or electric-welded pipe that forms the principal conduit of the riser joint

NOTE The riser main tube is the conduit for guiding the drillstring and containing the return fluid flow from the well.

3.1.73

riser recoil system

means of limiting the upward acceleration of the riser when a disconnect is made at the riser connector

3.1.74

riser spider

device having retractable jaws or dogs used to support the riser string on the uppermost coupling support shoulder during deployment and retrieval of the riser

3.1.75

riser string

deployed assembly of riser joints

3.1.76

riser tensioner

means for providing and maintaining top tension on the deployed riser string to prevent buckling

3.1.77

riser tensioner ring

structural interface of the telescopic joint outer barrel and the riser tensioners

3.1.78

rotary kelly bushing

RKB

bushing that sits on top of the rotary table

NOTE It transmits torque from the rotary table to the kelly and is commonly used as a reference for vertical measurements from the drill-floor.

3.1.79

stab

mating box and pin assembly that provides a pressure-tight engagement of two pipe joints

NOTE An external mechanism is usually used to keep the box and pin engaged.

EXAMPLE Riser joint choke and kill stabs are retained in the stab mode by the make-up of the riser coupling.

3.1.80

standard riser joint

joint of typical length for a particular drilling vessel's riser storage racks, the derrick V-door size, riser-handling equipment capacity or a particular riser purchase

3.1.81

storm disconnect

riser disconnect to avoid excessive loading from vessel motions amplified by inclement weather conditions

3.1.82

strakes

helically wound appendages attached to the outside of the riser to suppress vortex induced vibrations

3.1.83

stress amplification factor

SAF

F_{SA}

value 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 that occur in riser components.

3.1.84

thrust collar

device for transmitting the buoyant force of a buoyancy module to the riser joint

3.1.85

subsea fill-up valve

special riser joint having a valve means to allow the riser annulus to be opened to the sea

NOTE To prevent riser pipe collapse, the valve can be opened by an automatic actuator controlled by a differential-pressure sensor.

3.1.86

support bracket

bracket positioned at intervals along a riser joint that provides intermediate radial and lateral support from the riser main tube to the choke, kill and auxiliary lines

3.1.87

surge

vessel motion along the fore/aft axis

3.1.88

sway

vessel motion along the port/starboard axis

3.1.89

syntactic foam

typically, a composite material of spherical fillers in a matrix or binder

3.1.90

telescopic joint

slip joint

riser joint having an inner barrel and an outer barrel with a means of sealing between them

NOTE The inner and outer barrels of the telescopic joint move relative to each other to compensate for the required change in the length of the riser string as the vessel experiences surge, sway, and heave.

3.1.91

telescopic joint packer

means of sealing the annular space between the inner and outer barrels of the telescopic joint

3.1.92

terminal fitting

connection between a rigid choke, kill or auxiliary line on a telescopic joint and its drape hose, effecting a nominal 180° turn in flow direction

3.1.93

threaded-union coupling

coupling having mating threaded members on the pin and box to form the engagement

NOTE The threads on one side of the coupling are free to rotate relative to the riser pipe, so it is not necessary that that the joint rotate to make up the coupling. The threads do not form the seal.

3.1.94

tension ring

support ring around the top of the joint where tensioner lines are attached

3.1.95

type certification testing

testing by a manufacturer of a representative specimen (or prototype) of a product that qualifies the design and, therefore, validates the integrity of other products of the same design, materials and manufacture

3.1.96

vortex induced vibration

in-line and transverse oscillation of a riser in a current induced by the periodic shedding of vortices

3.1.97

wellhead connector

stack connector

hydraulically operated connector that joins the BOP stack to the subsea wellhead

3.2 Abbreviations

BOP	blowout preventer
DP	dynamic positioning
DTL	dynamic tension limit
ID	internal diameter
LFJ	lower flex joint
LMRP	lower marine riser package
OD	outside diameter
RAO	response amplitude operator
RKB	rotary kelly bushing
ROV	remotely operated vehicle
SAF	stress amplification factor
UFJ	upper flex joint

4 Component function and selection

4.1 Introduction

General requirements common to all components are outlined in 4.2 and, where appropriate, individual components are addressed in the rest of Clause 4. The following general format is used:

- a) function: the basic function of the component is described;
- b) typical designs: examples of typical designs are presented;
- c) selection criteria: general performance requirements are outlined.

4.2 Component selection criteria

Design of a riser system begins with an assessment of expected operating conditions and an engineering analysis to establish parameters, such as tensile, bending and combined stresses (maximum and mean), buoyancy requirements, top tension requirements, vessel response amplitude operators (RAOs), etc. Other factors influencing riser system design include riser length (water depth), dimensional requirements (bore, wall thickness, etc.), internal pressure rating, choke/kill, and auxiliary-line specifications, make-up method, storage and handling conditions, operating economy, etc. Once established, these riser-system design criteria should permit the selection of riser components that suit the application.

All riser primary-load-path components addressed in this part of ISO 13624 shall be consistent with the load classifications specified in ISO 13625.

4.3 Marine drilling riser system

The marine riser system forms an extension of the wellbore from the blowout preventer (BOP) stack to the drilling vessel; see Figure 1.

The primary functions of the marine riser system are to

- a) provide for fluid communication between the well and the drilling vessel
 - 1) in the riser annulus under normal drilling conditions,
 - 2) through the choke-and-kill lines when the BOP stack is being used to control the well;
- b) support the choke, kill and auxiliary lines;
- c) guide tools into the well;
- d) serve as a running and retrieving string for the BOP stack.



- Figure 1 — Marine riser system and associated equipment**

4.4 Tensioner system

4.4.1 Function

Tensioner units are used to apply vertical force to the top of the marine drilling riser to control its stresses and displacements. The units are normally located on the drilling vessel near the periphery of the drill-floor. They provide a nearly constant axial tension to the riser while the floating drilling vessel moves vertically and laterally in response to the wind, waves and current.

4.4.2 Typical design

A typical tensioner unit uses a hydraulic ram with large-volume, air-filled auxiliary pressure vessels (APV) to maintain a nearly constant pressure/tension on a line (wire rope). One end of the line is attached at the vessel and the other is attached to the outer barrel of the telescopic joint. Typically, a four-part line-reeving system is used so that the piston stroke is equal to one-quarter of the vessel heave. The number and rating of tensioner units used determines the total capacity of the tensioner system. The tension applied by each unit can be varied up to its design capacity by increasing or decreasing the applied air pressure. The tensioner system should be capable of providing sufficient tension based upon the maximum rated water depth, maximum expected mud weight, and other loadings determined from riser analyses.

Direct-acting hydraulic rod-cylinder tensioners are also used on deep-water drilling vessels.

Designs for tensioner systems are described in ISO/TR 13624-2:—, Clause 4.

4.4.3 Selection criteria

Some important considerations for designing an effective tensioner system are as follows.

- a) Fleet angle: The idler sheaves should be placed so as to minimize the fleet angle. This maximizes the vertical component of tension, minimizes the horizontal component and increases wireline life.

Because of the fleet angle, the vertical tension applied to the outer barrel of the telescopic joint is less than the tension supplied by the tensioner system. A reduction factor (see 5.3.2) should be used to reconcile these parameters.

- b) Wireline life: Wireline life is a function of many parameters, including wire-rope construction, sheave diameter, applied tension, operating circumstances relating to travel, etc. See API RP 9B.
- c) Accumulators and air-pressure vessels: Each tensioner unit should have an accumulator that is large enough to store a volume of hydraulic fluid greater than the cylinder volume. Large air-pressure vessels reduce pressure changes caused by the compression and expansion of the stored air as the tensioner strokes in and out.
- d) Fluid and air flow requirements: Properly sized lines reduce tension variations caused by piping-system pressure losses.

A list of hydraulic fluids compatible with the tensioner units should be specified by the tensioner manufacturer.

- e) Friction and inertia losses: Seal friction, sheave friction and inertia of sheaves, wire rope, tensioner rods, and pistons all contribute to variations in the wireline tension.
- f) Dynamic tension limit (DTL): Tensioner ratings are defined differently by various manufacturers. This part of ISO 13624 defines a dynamic tension limit, F_{DTL} , as given in Equation (1); see also 3.1.29:

$$F_{DTL} = P_A \times A_{CYL} / N_{LP} \quad (1)$$

where

P_A is the maximum allowable system operating pressure;

A_{CYL} is the effective hydraulic area;

N_{LP} is the number of line parts.

- All components in a riser-system installation, including piping, should be designed for the maximum allowable working pressure. See ASME UG 125-136 for relief-valve-setting criteria.
 - The tensioner system should be designed to permit one unit to be out of service for maintenance or repair without jeopardizing the ability of the remaining tensioner units to provide the required tension to the marine drilling riser. A unit may be either a single tensioner or a pair of tensioners, depending on specific design.
- g) Maximum tension setting: The maximum tension setting should not exceed 90 % of the F_{DTL} so that the maximum tension, including dynamic variations, is less than the F_{DTL} .
- h) Velocity-limiting device: Some type of flow-control device is normally located in the line between the fluid port on each tensioner and its respective air/liquid interface bottle. This device should offer minimal resistance to fluid flow during all anticipated heave velocities. However, if a tensioner wireline should break or other failure occur that allows the tensioner to stroke out at an uncontrolled rate, this flow-control valve should sense the abnormally high fluid flow rate and immediately stop or greatly reduce the fluid flow into the tensioner.

4.5 Diverter system (surface)

4.5.1 Function

When drilling a top hole through the structural casing, the riser may be employed enabling the use of weighted mud to provide overbalance, if needed. Blowout preventers (BOPs) are not in place at this stage (see 4.14.1) because the structural casing normally lacks sufficient pressure integrity to allow shut-in. Therefore, if the well flows, the riser directs that flow to the diverter system aboard the rig. Typically, the diverter system includes an annular sealing device, means to both open the vent line and close the mud flowline, and a control system.

4.5.2 Location

Surface diverter systems on floating rigs are usually installed directly below the rotary table. The diverter unit is latched into a built-in housing. The upper flex/ball joint, which is the uppermost component in a marine drilling riser system, is usually mounted to the bottom of the diverter unit.

A subsea diverter stack may be installed on the wellhead to divert subsea.

4.5.3 Operation

API RP 64 provides recommended practices for diverter systems equipment and operations.

4.6 Telescopic joint (slip joint)

4.6.1 Function

The basic function of the telescopic joint is to compensate for the relative translational movement between the vessel and the riser. The outer barrel provides structural support for riser tensioner loads.

4.6.2 Typical design

4.6.2.1 General

A telescopic joint has an outer barrel that is connected to the drilling riser, an inner barrel that is connected to an upper flex joint, and a tensioner ring that transmits loads from the tensioner system to the outer barrel of the riser.

4.6.2.2 Riser tensioner attachment

The riser tensioner lines typically attach to the tensioner ring near the top of the telescopic joint outer barrel. This attachment provides the structural interface between the marine riser and the tensioner system. Padeyes on the tensioner ring accommodate pinned connections at the ends of the tensioner lines. The tensile load to support the riser is transmitted through the riser tensioner ring to the pipe wall of the outer barrel and, subsequently, through the couplings and pipe walls of the riser joints.

4.6.2.3 Optional features of the tensioner ring

The following lists optional features of the tensioner ring.

- a) For turret-moored and dynamically positioned vessels, a low-friction bearing on the tensioner ring allows the vessel to rotate. Resulting torsional loads on the riser and wellhead should be considered.
- b) For guidelineless re-entry, an hydraulic motor drive may be provided on the tensioner ring to orient the LMRP with the BOP stack.
- c) For operational convenience, the riser tensioner ring may be detached from the outer barrel and fitted for latching to the bottom of the diverter housing for storage. This arrangement eliminates the time-consuming operations of connecting/disconnecting tensioner lines when deploying/retrieving the riser. Integral stab connectors may also be provided to permit ready connections of the drape hose terminal fittings.

4.6.3 Selection criteria

The selection of a telescopic joint should include consideration and evaluation of the following basic items.

- a) Strength: In both its retracted and extended positions, the telescopic joint should support the weight of the riser and BOP stack. The dynamic loads on the telescopic joint should be considered.
- b) Stroke length: The maximum stroke length required for the telescopic joint should accommodate the combined expected heave, vessel offset, tidal change and maximum anticipated vessel excursion in the event of a stationkeeping failure.
- c) Tensioner ring: Angular orientation on the padeyes on the tensioner ring should accommodate the positions of the tensioner line sheaves. The tensioner ring should be rated for the maximum load capacity of the telescopic joint.
- d) Auxiliary lines: The designer of the attachments for auxiliary lines, choke-and-kill lines, and the telescopic joint packing pressure line should consider the layout of the rig and the ease of making and breaking the connections during running and retrieving operations.
- e) Packing elements: The packing element that is used to seal between the outside of the inner barrel and the inside of the outer barrel is available as either single-element or double-element units. The advantage of the double-element unit is that when one of the packing elements fails, the second element can be energized, thus maintaining the seal between the drilling fluid and the environment, without having to shut down the drilling operation.
- f) Handling and storage: The telescopic joint is typically longer and heavier than the standard riser joint and, therefore, it has special handling and storage requirements.

4.7 Riser joints

4.7.1 Function

A riser joint is a large-diameter, high-strength pipe (riser main tube), either seamless or electric welded, with couplings welded to each end. When the riser system is being deployed, the riser joints are coupled together on the drill-floor and lowered into the water. The string of riser joints represents the principal component of the riser system and is used to perform the riser-system functions listed in 4.3. The box or pin coupling at the upper end of the riser joint usually has a landing shoulder. This landing shoulder, or riser-support shoulder, supports the loads (static and dynamic) of the marine riser and BOP stack when it is suspended from the riser spider (see 4.11.2.2). The coupling may also provide support for choke, kill and auxiliary lines, and load reaction for buoyancy devices.

4.7.2 Typical designs

4.7.2.1 Main tube

Riser main tube and the associated couplings are generally sized to be compatible with a specific BOP stack size. Compatible BOP bore and riser outer diameter combinations are shown in Table 1.

Table 1 — Compatible BOP bore and riser outer diameter combinations

BOP bore mm (in)	Riser outer diameter mm (in)
346,1 (13-5/8)	406,4 (16) riser
425,5 (16-3/4)	473,1 (18-5/8) riser
476,3 (18-3/4)	508 (20) riser, or 533,4 (21) riser, or 558,8 (22) riser with thick wall

4.7.2.2 Riser couplings

The four basic riser coupling designs are

- a) dog type;
- b) flanged;
- c) threaded union;
- d) breech-block.

Each riser manufacturer usually offers couplings with different strength ratings.

4.7.2.3 Choke/kill and auxiliary lines

Typically, riser joints have choke/kill and auxiliary lines attached to the exterior of the main riser tube by support brackets. On most risers, these lines pass through the riser support shoulder. These riser-mounted choke/kill and auxiliary lines are described in 4.12.

4.7.3 Selection criteria

The following items should be considered when selecting, designing or specifying riser joints.

- a) Riser main tube: The riser main tube should have adequate strength to withstand combined loads from waves, current, applied tension, motion of the rig and drilling fluid weight in accordance with Table 2. Collapse pressure and handling loads should also be considered. The strength characteristics of the main tube are dictated by its diameter, wall thickness and grade of steel. Steel grades commonly used in risers are X-52, X-65, and X-80, where the numbers refer to the minimum yield strength, expressed in kilopounds-force per square inch, of each grade.
 - The inside diameter shall provide sufficient annular space to accommodate the desired casing programme.
 - Typically, riser-joint lengths range from 15,2 m to 27,4 m (50 ft to 75 ft). The storage and handling characteristics on the rig shall be considered in the selection of the length.
- b) Pup joints: Pup joints are riser joints that are shorter than full-length riser joints. Pup joints of various lengths should be available to accommodate riser spaceout. See 6.4.2.
- c) Riser couplings: Coupling selection should be based on
 - strength;
 - load rating of support ring;
 - stress amplification factor (fatigue resistance);
 - reliability;
 - speed of make-up;
 - preload for make-up;
 - maintenance requirements;
 - main tube dimensions;
 - strength-to-weight ratio.

4.8 Lower marine riser package (LMRP)

4.8.1 Function

The lower marine riser package (LMRP) typically includes an assemblage of a riser adapter; a flex/ball joint; one, two, or no annular BOPs; subsea control pods; and an hydraulic connector mating the riser system to the BOP stack. The LMRP provides a releasable interface between the riser and the BOP stack. In addition, it provides hydraulic control of BOP stack functions through the control pods. Jumper hoses provide a flow path around the flex/ball joint for the choke and kill lines.

4.8.2 Typical design

The LMRP can be designed to a variety of configurations depending upon the type, size, ratings and operational water depth of its components. Some design considerations are

- a) standard guidepost radius (see API RP 53);
- b) minimum bore size and compatible pressure ratings;
- c) bending strength;

- d) clearance for retrievable control pods;
- e) accommodation for subsea accumulators;
- f) loads and clearances during an emergency disconnect;
- g) available space for storage and handling aboard drilling vessel;
- h) emergency recovery system for deep-water BOPs;
- i) guidance system for re-entry of guidelineless BOPs;
- j) sequenced, retractable control pod stabs and choke/kill stabs on guidelineless systems;
- k) flexible lines (see 4.10);
- l) guidance structure for BOP handling.

4.8.3 Selection criteria

The selection of LMRP components should be based on the following factors:

- a) well-control considerations;
- b) BOP pressure rating and bore;
- c) guideline or guidelineless operations;
- d) overall height and weight limitations;
- e) operating environment and design loads;
- f) method of BOP control and operational fail-safe design features;
- g) operational water depth;
- h) method for running/retrieving control pods;
- i) methods for re-entry on guidelineless systems;
- j) methods for emergency recovery.

4.9 Flex and ball joints

4.9.1 Function

Flex and ball joints are used to allow angular misalignment between the riser and the BOP stack, thereby reducing the bending moment on the riser. They are also used at the top of the riser to allow for the motion of the rig. In some instances, they may also be installed at some intermediate level in the riser string below the telescopic joint to reduce stresses in the riser. The rotational stiffness of flex joints makes them more effective than ball joints in controlling riser angles. Typically, the rotational stiffness of a flex joint is a non-linear function of angle and ranges from 13 600 N·m (10 000 ft-lbf) per degree of rotation to 108 800 N·m (80 000 ft-lbf) per degree of rotation. Rotational stiffness can also vary with temperature.

4.9.2 Typical design

4.9.2.1 Flex joints

The flexure members of a flex joint are typically bonded laminations of elastomer between stacks of spherically shaped steel rings. The elastomer provides flexure and pressure sealing. Some designs provide a

landing shoulder for a readily removable wear bushing. Still others provide a wear ring that can be replaced during periodic overhaul of the flex joint. Because of the design of flex joints, repair of major key-seat damage can prove uneconomical. The user should request that the supplier provide a list of facilities with the capabilities to repair key-seat damage.

4.9.2.2 Ball joints

A ball joint is a forged steel ball and socket containing a cylindrical neck extension with a riser adapter attached at the end of the neck. The ball and socket employs a seal that contains the drilling fluids. In most designs, replaceable wear rings or wear bushings are used. Some ball joints require pressure balancing.

4.9.3 Selection criteria

The following items should be considered when selecting, specifying or designing flex joints and ball joints:

- a) flex/ball joint function and location in the riser system;
- b) maximum angular rotation and maximum rotational stiffness required, which can be determined by a preliminary riser analysis;
- c) pressure rating; the flex/ball joint should maintain pressure integrity throughout exposure to wellbore fluids, maximum anticipated temperatures, maximum design mud weight, and maximum design water depth;
- d) maximum tensile load being applied;
- e) maximum torque being applied.

4.10 Flexible choke-and-kill lines

4.10.1 Function

Flexible choke-and-kill lines allow relative movement at the telescopic joint (drape hose) and at flex/ball joints (jumper hose) in the riser system.

4.10.2 Typical design

Three basic designs are commonly used:

- flexible pipe;
- steel reinforced hoses;
- flow loops with threaded, clamped, or flanged end fittings.

If threaded end fittings are used, they shall contain a means of sealing other than the threads.

4.10.3 Selection criteria

Flexible lines should be compatible with the rest of the choke-and-kill piping system and with the BOP stack, riser and choke-and-kill manifold. Selection of flexible lines should take into account the following considerations:

- a) length requirement and tolerance;
- b) end fitting compatibility;

- c) pressure rating (gas and liquid);
- d) collapse rating;
- e) temperature rating (maximum, minimum, and ambient conditions);
- f) minimum bend radius;
- g) fluid compatibility;
- h) resistance to wear by abrasive fluids;
- i) corrosion resistance;
- j) fatigue resistance to bend and pressure cycling.

4.11 Riser running equipment

4.11.1 Function

Riser and diverter handling tools are used for hoisting and lowering the riser and BOP stack. The riser spider is used to support the riser and BOP stack while they are being run or retrieved. When used, guidelines direct the riser and associated subsea equipment to the wellhead.

4.11.2 Typical design

4.11.2.1 Handling tools

Riser handling tools make up to the top of the riser during deployment and retrieval. The top connection is a short length of pipe that is supported by the hoisting equipment.

Another tool of importance is the diverter-handling tool, which may be used to carry the entire riser system load prior to landing the stack on the wellhead. If the diverter-handling tool is used to support the entire riser and BOP stack, it should meet the same standards as the riser-handling tool.

4.11.2.2 Riser spiders

A riser spider provides support for the riser and BOP stack at the drill-floor. Shock-absorbing spiders are designed to reduce impact loads on riser-support shoulders. Gimbaling spiders reduce bending moments on the shoulders.

4.11.2.3 Guidelines

Guidelines may be used to direct the riser and associated subsea equipment to their mating connections near the seafloor. Generally, four wire rope guidelines, forming the corners of a square, extend up from the temporary guidebase to the floating drilling vessel where each is tensioned by a guideline tensioner (similar to a riser tensioner). Typically, the guideline attachment points are 2 m (6 ft) from the centre of the wellbore forming a square measuring approximately 2,6 m (8,5 ft) per side.

4.11.3 Selection criteria

The selection, rating and testing of riser running equipment should be based on the following:

- a) maximum static loading capacity;
- b) dynamic loads induced by vessel motions, waves and currents;
- c) bending loads during riser running operations;
- d) impact loads.