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Entwurf

**Erdöl- und Erdgasindustrie –
Modulare Bohranlagen auf offshore verankerten Plattformen
(ISO 18647:2017);
Englische Fassung prEN ISO 18647:2019, nur auf CD-ROM**

Petroleum and natural gas industries –
Modular drilling rigs for offshore fixed platforms (ISO 18647:2017);
English version prEN ISO 18647:2019, only on CD-ROM

Industries du pétrole et du gaz naturel –
Spécifications pour une foreuse modulaire à bord de plateformes fixes offshore
(ISO 18647:2017);
Version anglaise prEN ISO 18647:2019, seulement en CD-ROM

Anwendungswarnvermerk

Dieser Norm-Entwurf mit Erscheinungsdatum 2019-06-21 wird der Öffentlichkeit zur Prüfung und Stellungnahme vorgelegt.

Weil die beabsichtigte Norm von der vorliegenden Fassung abweichen kann, ist die Anwendung dieses Entwurfs besonders zu vereinbaren.

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- oder in Papierform an den DIN-Normenausschuss Erdöl- und Erdgasgewinnung (NÖG), 10772 Berlin, Saatwinkler Damm 42/43, 13627 Berlin.

Die Empfänger dieses Norm-Entwurfs werden gebeten, mit ihren Kommentaren jegliche relevanten Patentrechte, die sie kennen, mitzuteilen und unterstützende Dokumentationen zur Verfügung zu stellen.

Gesamtumfang 127 Seiten

DIN-Normenausschuss Erdöl- und Erdgasgewinnung (NÖG)

Nationales Vorwort

Der Text von ISO 18647:2017 wurde vom Technischen Komitee ISO/TC 67 „Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries“ der Internationalen Organisation für Normung (ISO) erarbeitet und als prEN ISO 18647:2019 durch das Technische Komitee CEN/TC 12 „Materialien, Ausrüstungen und Offshore-Bauwerke für die Erdöl-, petrochemische und Erdgasindustrie“ übernommen, dessen Sekretariat von NEN (Niederlande) gehalten wird.

Für Deutschland hat hieran der Arbeitskreis NA 109-00-01-04 AK „Bohr- und Fördereinrichtungen — Spiegelausschuss zu ISO/TC 67/SC 4“ im DIN-Normenausschuss Erdöl- und Erdgasgewinnung (NÖG) mitgearbeitet.

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

Diese Norm enthält neben den gesetzlichen Einheiten auch die Einheit „hp“ und „in (inch)“ die in Deutschland nicht zugelassen sind. Es wird ausdrücklich darauf hingewiesen, dass die Anwendung dieser Einheiten im nationalen amtlichen und geschäftlichen Verkehr aufgrund des Gesetzes über Einheiten im Messwesen nicht zulässig ist. Die Angabe dieser Einheiten dient lediglich als Hilfe im amtlichen und geschäftlichen Verkehr (z. B. bei Einfuhr und Ausfuhr) mit solchen Staaten, die diese Einheiten anwenden.

Umrechnung:

Nicht-SI-Einheit	SI-Einheit	Umrechnung	
hp	kW	1 hp	= 0,74 kW
in (inch)	mm	1 inch	= 25,4 mm

Für die in diesem Dokument zitierten internationalen Dokumente wird im Folgenden auf die entsprechenden deutschen Dokumente hingewiesen:

ISO 6807	siehe	DIN EN ISO 6807
ISO 8503-1	siehe	DIN EN ISO 8503-1
ISO 9001	siehe	DIN EN ISO 9001
ISO 10418	siehe	DIN EN ISO 10418
ISO 12944-4	siehe	DIN EN ISO 12944-4
ISO 13501	siehe	DIN EN ISO 13501
ISO 13535	siehe	DIN EN ISO 13535
ISO 13626	siehe	DIN EN ISO 13626
ISO 13702	siehe	DIN EN ISO 13702
ISO 13703	siehe	DIN EN ISO 13703
ISO 14693	siehe	DIN EN ISO 14693
ISO 15138	siehe	DIN EN ISO 15138
ISO 19900	siehe	DIN EN ISO 19900
ISO 19901-3	siehe	DIN EN ISO 19901-3
ISO 19901-5	siehe	DIN EN ISO 19901-5
ISO 19901-6	siehe	DIN EN ISO 19901-6
ISO 19902	siehe	DIN EN ISO 19902

Nationaler Anhang NA (informativ)

Begriffe und Abkürzungen

Die Benummerung der folgenden Begriffe und Abkürzungen ist identisch mit der Benummerung in der englischen Fassung.

3. Begriffe

Für die Anwendung dieses Dokuments gelten die folgenden Begriffe.

ISO und IEC stellen terminologische Datenbanken für die Verwendung in der Normung unter den folgenden Adressen bereit:

— ISO Online Browsing Platform: verfügbar unter <http://www.iso.org/obp>

— IEC Electropedia: verfügbar unter <http://www.electropedia.org/>

3.1

Zementier-Modul

modulare Anlage, die Betonpumpe, Mischvorrichtung und Verteilersystem umfasst und dazu verwendet wird, Zementierleistungen zu erbringen

3.2

Bohrausrüstungssatz

Ausrüstungssatz, der Bohrkran/-mast, Unterbau, Hebewerke, Turmrollenlager, Kloben, Haken, Kraftdrehkopfsystem, Drehtisch, BOP, Steuerstand, Arbeitsbühnenausrüstung, Choke-und-Kill-Leitungen umfasst; er kann auch Schüttelsiebe, Degasser, Desander, Desilter, Zentrifuge, Bohrkleintrockner, Rohrtransportanlage und BOP-Transportanlage usw. umfassen, die dazu verwendet werden, während Bohrvorgängen Hebe- und Rotationsfunktionen auszuführen

Anmerkung 1 zum Begriff: Der Bohrausrüstungssatz ist üblicherweise mithilfe von Verschubschlitten so verschiebbar, dass der Mittelpunkt über einer von mehreren Bohrlochöffnungen angeordnet werden kann.

3.3

Abstand zur Bohrplattform

lichter Abstand zwischen der Unterseite des Stützbalkens eines Bohrtisches und dem BOP-Deck der Plattform

3.4

Bohrgerüst-Modul

Konstruktion, die Dieselaggregat, Treibstofftank, Luftverdichter und Lagertank, Sack Storage und Bohrschlammmischer, Elektroantrieb und zugehöriges Steuerungssystem, Spülungstank, Spülpumpe und Zusatzausrüstung, Rohrdeckbereich, Rohrleitungen und Kabelträger umfassen kann, die dazu verwendet werden, um für die Bohranlage die Stromversorgung bereitzustellen und Umlauf- und andere Funktionen auszuführen

3.5

Schnittstelle

Beziehungen zwischen einer modularen Bohranlage und verschiedenen Systemen (z. B. Sicherheit, Öl, Gas, Wasser, Elektrizität, Geräte, Kommunikation, Strukturen usw.) auf der Plattform

3.6

modulare Bohranlage

modulare Anlage zum Bohren von einer offshore verankerten Plattform aus, die aus Bohrausrüstung, Bohrerüst, Pulvertank, Zementiervorrichtung, Bohrlochuntersuchungsraum und anderer Ausrüstung besteht

3.7

Aushängebühne

Affenbühne

Plattform, die als Gestängebühne bezeichnet wird und sich in einem gewissen Abstand oberhalb der Bohrerüst befindet, um das obere Ende der Untertagerohre/des Bohrstrangs seitlich abzustützen und die auch über eine Fläche für den Bohrturmführer verfügt, damit dieser die Rohre/den Bohrstrang während des Einbringens/Herausziehens handhaben kann, während der Bohrvorgang stattfindet

3.8

Mousehole

Mauseloch

Öffnung in der Bohranlagenetage in der Nähe des Bohrtisches, in dem Bohrgestängeverbindungsstücke vorübergehend für den späteren Anschluss an den Bohrstrang untergebracht werden

Anmerkung 1 zum Begriff: Das Mousehole wird üblicherweise unterhalb angebracht, hat eine Unterseite und weist eine Länge auf, die der eines Futterrohrs entspricht.

3.9

Modul für die Gasanalyse der Spülung

modulare Anlage, die einen Raum für die Gasanalyse der Spülung, ein Datenerfassungssystem und ein Datenterminal umfasst, die dazu verwendet werden, Dienstleistungen hinsichtlich der Gasanalyse der Spülung zu erbringen

3.10

Pulvertank-Modul

modulare Anlage, die Bentonit-, Baryt- und Zementtank, Wiegeeinrichtung, Steuereinrichtung und Verteilersystem umfasst, die dazu verwendet wird, pulverförmige Materialien für die Herstellung von Bohrspülung und Zementschlamm zu lagern

3.11

anerkannte Klassifikationsgesellschaft

Mitglied der Internationalen Vereinigung der Klassifikationsgesellschaften (IACS), das über anerkannte und einschlägige Qualifikationen und Erfahrungen im Bereich Tätigkeiten in der Erdöl- und Erdgasindustrie verfügt, und für das Bestimmungen und Verfahrensweisen zur Klassifizierung/Zertifizierung derartiger Anlagen für Tätigkeiten in der Erdöl- und Erdgasindustrie festgelegt sind

3.12

Gleitschiene

Stahlkonstruktion, die glatte, ebene Oberflächen für den Bohrausrüstungssatz aufweist, um den Zugang über alle Bohrlochöffnungen in der X-Y-Ebene zu ermöglichen

Anmerkung 1 zum Begriff: Die obere Verschubschiene ist die Gleit-Verschubschiene der oberen Unterkonstruktion der Bohranlage; die untere Verschubschiene ist die Gleit-Verschubschiene der unteren Unterkonstruktion.

3.13

Verschubsystem

Ausrüstung, die Verschubschienen, Verschubschuh, vordere und hintere Verschubklauen, Verschubzylinder, Verriegelungsklauen, Verschub-Hydraulikaggregat, Verriegelungs- und Steuereinheit umfassen kann, die dazu verwendet wird, den Bohrausrüstungssatz horizontal zu bewegen und den Bereich der Bohrlochöffnung abzudecken

Anmerkung 1 zum Begriff: Alternative Systeme zum Verschieben der Bohranlage können ebenfalls angewendet werden.

3.14

Bohrlochuntersuchungs-Modul

modulare Anlage, die Bohrlochwinde, Bohrlochuntersuchungsraum, Schmiervorrichtung für Bohrlochkopf und Kabel umfasst und dazu verwendet wird, Bohrlochuntersuchungen durchzuführen

3.15

Bohrlochöffnung

für einzelne Bohrlöcher zur Verfügung gestellte Öffnung, die einen Zugang von der Unterseite der Bohrausrüstung zum Meeresboden ermöglicht

Anmerkung 1 zum Begriff: Im Allgemeinen werden unterhalb jedes Bohrlochkopfes seitliche Abstützungen von der Plattform durch die Oberseiten und durch die Wassersäule bereitgestellt, um den Bohrlochkopf mithilfe einer rohrförmigen Struktur zu stützen, um umgebungsbezogenen Kräften zu widerstehen und übermäßige Beanspruchungen und Verschiebungen zu verhindern.

4. Abkürzungen

AC	Wechselstrom (en: alternating current)
APF	aktiver Leistungsfilter (en: active power filter)
BOP	Bohrlochsicherung, Blowout-Preventer (en: blow out preventer)
CCTV	Videoüberwachung (en: closed circuit television)
DC	Gleichstrom (en: direct current)
DES	Bohrausrüstungssatz (en: drilling equipment set)
DSM	Bohrgerüst-Modul (en: drilling support module)
EEBA	Selbstretter, Atemschutzgerät für Selbstrettung (en: emergency escape breathing apparatus)
EER	Flucht, Evakuierung und Rettung (en: escape, evacuation and rescue)
ESD	Notabschaltung (en: emergency shut down)
FES	Strategie für Feuer und Explosion (en: fire and explosion strategy)
GA	Generalalarm (en: general alarm)
HAZID	Identifizierung von Gefährdungen (en: hazard identification)
HAZOP	Gefahren und Betriebsfähigkeit (en: hazard and operability)
HPU	Hydraulikaggregat (en: hydraulic power unit)
HVAC	Heizungs-, Lüftungs- und Klimaanlage/raumluftechnische Anlage (en: heating, ventilation and air conditioning)
IBOP	interne Bohrlochsicherung, interner Blowout-Preventer (en: internal blow out preventer)
LAN	lokales Netzwerk (en: local area network)
LRFD	Bemessung mit Teilsicherheitsbeiwerten (en: load and resistance factor design)
LPG	Flüssiggas (en: liquefied petroleum gas)
MC	mechanische Fertigstellung (en: mechanical completion)
MCR	Aufzeichnungen zur mechanischen Fertigstellung (en: mechanical completion records)
MCT	Kabine mit Mehrfachleitung (en: multi-cable cabin transit)
RCS	anerkannte Klassifikationsgesellschaft (en: recognized classification society)
MDR	modulare Bohranlage (en: modular drilling rig)

MT	Magnetpulverprüfung (en: magnetic particle testing)
NDT	zerstörungsfreie Prüfung (en: non-destructive testing)
P-tank	Pulvertank (en: powder tank)
PA	Lautsprechanlage (en: public address)
P&ID	R&I-Fließschema (en: piping and instrumentation diagram)
PLC	speicherprogrammierbare Steuerung (en: programmable logic controller)
PPE	persönliche Schutzausrüstung (en: personal protective equipment)
PT	Eindringprüfung (en: penetrant flaw testing)
RT	Durchstrahlungsprüfung (en: radiographic testing)
SCBA	umluftunabhängiges Atemschutzgerät (en: self-contained breathing apparatus)
SWL	sichere Arbeitslast (en: safe working load)
TDS	Kraftdrehkopfsystem (en: top drive system)
UPS	unterbrechungsfreie Stromversorgung (en: uninterruptable power supply)
UT	Ultraschallprüfung (en: ultrasonic testing)
VSD	drehzahl geregelter Antrieb (en: variable speed drive)
WPS	Schweißanweisung (en: welding procedure specification)
WPQR	Bericht über die Qualifizierung des Schweißverfahrens (en: welder performance qualification record)
WSD	Auslegung für Arbeitsbelastung (en: working stress design)

Nationaler Anhang NB (informativ)

Literaturhinweise

DIN EN ISO 6807, *Gummischläuche und -schlauchleitungen für die Anwendung beim Rotary-Bohren und bei Vibrationen — Spezifikation*

DIN EN ISO 8503-1, *Vorbereitung von Stahloberflächen vor dem Auftragen von Beschichtungsstoffen — Rauheitskenngrößen von gestrahlten Stahloberflächen — Teil 1: Anforderungen und Begriffe für ISO-Rauheitsvergleichsmuster zur Beurteilung gestrahlter Oberflächen*

DIN EN ISO 9001, *Qualitätsmanagementsysteme — Anforderungen*

DIN EN ISO 10418, *Erdöl- und Erdgasindustrie — Offshore-Produktionsanlagen — Sicherheitssysteme für Prozesse*

DIN EN ISO 12944-4, *Beschichtungsstoffe — Korrosionsschutz von Stahlbauten durch Beschichtungssysteme — Teil 4: Arten von Oberflächen und Oberflächenvorbereitung*

DIN EN ISO 13501, *Erdöl- und Erdgasindustrie — Bohrflüssigkeiten — Beurteilung von Verarbeitungssystemen*

DIN EN ISO 13535, *Erdöl- und Erdgasindustrie — Bohr- und Fördereinrichtungen — Hebegerät*

DIN EN ISO 13626, *Erdöl- und Erdgasindustrie — Bohr- und Förderanlagen — Bohrungen und Bohrloch-Aufbauten*

DIN EN ISO 13702, *Erdöl- und Erdgasindustrie — Überwachung und Eindämmung von Feuer und Explosionen auf Offshore-Produktionsplattformen — Anforderungen und Leitlinien*

DIN EN ISO 13703, *Erdöl- und Erdgasindustrie — Auslegung und Verlegung von Rohrleitungssystemen auf Offshore-Förderplattformen*

DIN EN ISO 14693, *Erdöl- und Erdgasindustrie — Ausrüstungen für Bohr- und Bohrlocharbeiten*

DIN EN ISO 15138, *Erdöl- und Erdgasindustrie — Offshore-Produktionsanlagen — Heizung, Lüftung und Klimatisierung*

DIN EN ISO 19900, *Erdöl- und Erdgasindustrie — Allgemeine Anforderungen an Offshore-Bauwerke*

DIN EN ISO 19901-3, *Erdöl- und Erdgasindustrie — Besondere Anforderungen an Offshore-Bauwerke — Teil 3: Topsides structure*

DIN EN ISO 19901-5, *Erdöl- und Erdgasindustrie — Spezielle Anforderungen für Offshore-Anlagen — Teil 5: Gewichtskontrolle während der Auslegung und Konstruktion*

DIN EN ISO 19901-6, *Erdöl- und Erdgasindustrie — Spezielle Anforderungen für Offshore-Anlagen — Teil 6: Mariner Betrieb*

DIN EN ISO 19902, *Erdöl- und Erdgasindustrie — Gegründete Stahlplattformen*

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see the following URL: www.iso.org/iso/foreword.html.

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*.

Introduction

This document is applicable to modular drilling rigs on offshore fixed platform. It is intended to provide wide latitude in the design, construction, installation and commissioning of offshore modular drilling rigs on fixed platforms, without hindering innovation. Sound engineering judgment is therefore necessary in the use of this document.

The design of a modular drilling rig includes choices of drilling equipment, layout of modules, system interface, modular structures and so on. The construction of modular drilling rigs includes the assembly of structures, welding and inspection of structures, prefabrication and installation of the piping and cables, outfitting, corrosion control and onshore installation of equipment.

Annex A provides background to, and guidance on, the use of this document, and is intended to be read in conjunction with the main body of this document. The clause numbering in Annex A follows the same structure as that in the body of the normative text in order to facilitate cross-referencing.

Annex B provides a guidance of load and resistance factor design/working stress design method.

Annex C provides a list of typical fabrication design documents of modular drilling rigs.

Annex D provides a typical loadout and seafastening design document.

Annex E provides a typical acceptance report for modular drilling rigs on offshore fixed platform.

Annex F provides a typical completion acceptance document and record for modular drilling rigs on offshore fixed platform.

Annex G provides a typical in-service inspection plan for modular drilling rigs.

– *Entwurf* –

Petroleum and natural gas industries — Modular drilling rigs for offshore fixed platforms

1 Scope

This document gives requirements for the design, fabrication, installation, commissioning and integrity management of modular drilling rigs on offshore fixed platforms.

The modular drilling rig includes some or all of the equipment as follows:

- drilling equipment including a derrick/mast and its controls that can be moved by skidding a drilling support structure;
- drilling support equipment which includes support facilities such as power supply/distribution system;
- mud and cement storage, mixing, monitoring and control equipment.

This document is applicable to the modular drilling equipment on offshore structures for the petroleum and natural gas industries, as follows:

- new equipment arranged in a modularized form;
- the equipment contained in several modules, each of which can be lifted and installed on to the platform, however, the equipment may be arranged within the modules as is convenient;
- the modules assembled together offshore for hook up and commissioning;
- intended for long term use on a new fixed offshore structure;
- Intended for temporary use on a number of different offshore platforms.

This document is not applicable to drilling equipment

- installed on mobile offshore units, and
- intended primarily for onshore use.

This document does not apply to those parts and functions of an offshore platform that are not directly related to drilling.

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 4406, *Hydraulic fluid power — Fluids — Method for coding the level of contamination by solid particles*

ISO 6807, *Rubber hoses and hose assemblies for rotary drilling and vibration applications — Specification*

ISO 13501, *Petroleum and natural gas industries — Drilling fluids — Processing equipment evaluation*

ISO 13535, *Petroleum and natural gas industries — Drilling and production equipment — Hoisting equipment*

ISO 13626, *Petroleum and natural gas industries — Drilling and production equipment — Drilling and well-servicing structures*

ISO 13702, *Petroleum and natural gas industries — Control and mitigation of fires and explosions on offshore production installations — Requirements and guidelines*

ISO 13703, *Petroleum and natural gas industries — Design and installation of piping systems on offshore production platforms*

ISO 14693, *Petroleum and natural gas industries — Drilling and well-servicing equipment*

ISO 15138, *Petroleum and natural gas industries — Offshore production installations — Heating, ventilation and air-conditioning*

ISO 15513, *Cranes — Competency requirements for crane drivers (operators), slingers, signallers and assessors*

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

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

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

IEC 61892-6, *Mobile and fixed offshore units — Electrical installations — Part-6: Installation*

API RP 2FB, *Recommended Practice for the Design of Offshore Facilities Against Fire and Blast Loading*

API RP 14G, *Recommended Practice for Fire Prevention and Control on Open Type Offshore Production Platforms*

API RP 505, *Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Zone 0, Zone 1 and Zone 2*

API Spec 16A, *Specification for Drill Through Equipment*

API Spec 16D, *Specification for Control Systems for Drilling Well Control Equipment and Control Systems for Diverter Equipment*

API Std 53, *Blowout Prevention Equipment Systems for Drilling Wells*

AWS D1.1/D1M, *Structural Welding Code — Steel*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1 cementing module

modularized facilities that include cementing pump, mixing device and manifold system, used to provide cementing services

3.2 **drilling equipment set** **DES**

set of equipment that includes derrick/mast, substructure, drawworks, crown block, traveling block, hook, TDS, rotary table, BOP, driller's cabin, drill floor equipment, choke and kill manifold and can also include shale shakers, degasser, desander, desilter, centrifuge, cuttings dryer, pipe handling system and BOP handling system etc., used to implement hoisting and rotating functions during drilling operations

Note 1 to entry: The drilling equipment set is generally movable by means of skid rails such that the centre can be positioned over one of a number of well slots.

3.3 **drill floor clearance**

clear distance between the bottom of the rotary table support beam and the BOP deck of the platform

3.4 **drilling support module** **DSM**

structure that can include diesel generator set, fuel tank, air compressor and storage tank, sack storage and mud mixing, electric drive and associated control system, mud tank, mud pump and auxiliary equipment, pipe deck area, piping and cable tray used to provide power, circulation and other functions to the drilling rig

3.5 **interface**

relations between a modular drilling rig and various systems (such as safety, oil, gas, water, electricity, instrumentation, communication, structures, etc.) on the platform

3.6 **modular drilling rig** **MDR**

modularized facilities for drilling from a fixed offshore platform consisting of drilling equipment set, drilling support, P-tank, cementing, well logging, mud logging and other equipment

3.7 **monkey board**

platform called racking platform located at a distance above drill floor for laterally supporting the upper end of racked downhole tubulars/drill string that also provides a space for derrickman to handle the tubulars/drill string when trip out and in during drilling operation

3.8 **mouse hole**

opening in the rig floor near the rotary table, in which joints of drill pipe are temporarily placed for later connection to the drill string

Note 1 to entry: The mouse hole is usually fitted underneath with a length of casing, usually with a bottom.

3.9 **mud logging module**

modularized facilities that include mud logging room, data acquisition system and display terminal, used to provide mud logging services

3.10 **powder tank module** **P-tank**

modularized facilities that include bentonite tank, barite tank, cement tank, weighing equipment, control equipment, and manifold system, used to store powder materials for drilling fluid and cement slurry preparation

3.11

recognized classification society

RCS

member of the International Association of Classification Societies (IACS), with recognized relevant competence and expertise of petroleum and natural gas activities, and with established rules and procedures for classification/certification of installations in the petroleum and natural gas industries

3.12

skid rail

structural steelwork that provides smooth flat surfaces for the drilling equipment set to move in an X-Y planes to allow access over all well slots

Note 1 to entry: The upper skid rail is the slide skid rail of the upper substructure of the drilling rig; the lower skid rail is that of the lower substructure.

3.13

skidding system

equipment that can include the skid rails, skid shoe, fwd/aft skidding claws, skidding cylinders, locking claws, skidding hydraulic power unit (HPU), locking and control unit, used for horizontal movement of the DES, covering the well slot area

Note 1 to entry: Alternative rig skidding systems can be used as well.

3.14

well logging module

modularized facilities that include well logging winch, well logging room, wellhead lubricator and cable, used to provide well logging services

3.15

well slot

opening provided for individual wells that allows a path from the underside of the drilling equipment set to the seabed

Note 1 to entry: In general lateral supports are provided below each well slot from the platform structure through the topsides and through the water column to support the well tubular to withstand environmental forces and prevent excessive stress and displacements.

4 Abbreviated terms

AC	alternating current
APF	active power filter
BOP	blow out preventer
CCTV	closed circuit television
DC	direct current
DES	drilling equipment set
DSM	drilling support module
EEBA	emergency escape breathing apparatus
EER	evacuation, escape and rescue
ESD	emergency shut down
FES	fire and explosion strategy

GA	general alarm
HAZID	hazard identification
HAZOP	hazard and operability
HPU	hydraulic power unit
HVAC	heating, ventilation and air conditioning
IBOP	internal blow out preventer
LAN	local area network
LRFD	load and resistance factor design
LPG	liquefied petroleum gas
MC	mechanical completion
MCR	mechanical completion records
MCT	multi-cable cabin transit
RCS	recognized classification society
MDR	modular drilling rig
MT	magnetic particle testing
NDT	non-destructive testing
P-tank	powder tank
PA	public address
P&ID	piping and instrumentation diagram
PLC	programmable logic controller
PPE	personal protective equipment
PT	penetrant flaw testing
RT	radiographic testing
SCBA	self-contained breathing apparatus
SWL	safe working load
TDS	top drive system
UPS	uninterruptable power supply
UT	ultrasonic testing
VSD	variable speed drive

WPS	welding procedure specification
WPQR	welder performance qualification record
WSD	working stress design

5 Overall considerations

5.1 General

A modular drilling rig is essentially a device to safely and efficiently drill a well through the geological formation under an offshore installation; the central piece of the equipment is a derrick/mast and rotary system to handle and rotate a drill string and well tubular. A modular drilling rig generally includes drilling equipment such as derrick/mast and substructure; support equipment such as mud, cement and chemical storage, mixing, monitoring and control and power generation set (if equipped). The derrick/mast with its ancillaries and controls on drill floor can be moved on drilling support structure or by skidding the drilling support structure on skid rails to cover all well slots on platform.

A modular drilling rig is grouped in a number of modules to allow the equipment to be lifted into place on a platform; the allocation of the equipment between modules depends on the functionality of the equipment and the limitations envisaged for the offshore installation.

Design conditions include all operating requirements, temporary operating conditions, environmental conditions as well as accidental and abnormal operating conditions. Sufficient planning shall be undertaken before starting detailed design to ensure a safe, functional and economic layout of equipment throughout the modular drilling rig.

5.2 Functional equipment

5.2.1 Hoisting system

A hoisting system can include equipment such as derrick/mast, deadline anchor, crown block, travelling block, hook and drawworks to handle pipe in and out of the well. Pipe handling system should also be considered.

The hydraulic or rack and pinion hoisting rigs may also be used.

5.2.2 Rotary system

A rotary system includes equipment such as top drive, rotary table (swivel and kelly, if equipped) to rotate pipe.

5.2.3 Circulation and solids control systems

A circulation system includes equipment such as mud pump, mud pit, mud piping, charging pump, transfer pump and mixing pump. The circulation system provides performance control of drilling fluid and pressure control within the well to prevent uncontrolled fluid flow.

A solids control system includes equipment such as shale shaker, degasser, desander, desilter, centrifuge, cuttings disposal system. The solids control system is provided to separate the drilling debris (cuttings) from the drilling fluid such that the fluid can be re-circulated and the drill cuttings disposed of.

5.2.4 Power and electrical systems

The power system can include equipment such as main generator set, the emergency generator set and transformer. A modular drilling rig is powered normally by dedicated generator sets or supplied by the main platform power.

The electrical system includes equipment such as distribution system (consisting of switchboards, transformers, lighting distribution boards, DC drivers or VSDs, emergency power supply, UPS, batteries and lighting equipment).

5.2.5 Well control system

The well control system includes equipment such as a diverter and diverter control unit, BOP stack and its adapter/spacer, BOP pressure test device, choke and kill manifolds, BOP control unit, mud/gas separator and vent system.

5.2.6 BOP handling system

The BOP handling equipment includes BOP storage, skidding and hoisting equipment.

5.2.7 Cementing system

The cementing system, if equipped, includes equipment such as a cementing pump skid (diesel engine, torque converter and cementing pump), cementing manifold, cement surge tank, cement mixing unit and metering unit.

5.2.8 Pipe handling system

The pipe handling system, if equipped, includes equipment inside the derrick/mast (such as monkey board), on the drill floor (such as string make-up/break-out devices, mouse hole, guiding equipment) and ramp as well as pipe conveying, moving and hoisting equipment in the pipe rack area. The pipe handling equipment with suitable anti-clash protection can be configured to be automatically operated locally or remotely.

5.2.9 Instrument communication system

The instrument communication system includes equipment such as drilling instrument, television monitoring and intercom system, broadcasting system, emergency shutdown system (including fire and gas system) and LAN.

5.2.10 Auxiliary system

The auxiliary system includes equipment such as safety related equipment, hydraulic system, compressed air system, P-tank, HVAC, steam boiler system, oil and water (such as fresh, drill and seawater, fire-fighting water) supply system.

5.3 Layout

5.3.1 General

The following factors shall be considered in the determination of the deck size when an MDR is arranged on the platform:

- a) number and arrangement of well slots;
- b) safety, fire control, personnel escape and lifesaving;
- c) demands of drilling operation;
- d) maintenance of drilling equipment;
- e) platform azimuth and supply vessel berthing direction and position;
- f) platform crane position and capacity, flare direction and position.

The method of dividing the MDR depends on the wellhead platform type, oilfield development stage, lifting facilities and installation programme. Normally there are two methods when dividing the MDR. One method is dividing the MDR into two blocks, which are DES and DSM (including utility system). The other method is dividing the MDR into multiple blocks of a weight compatible with the installation method.

Annex A provides more information for reference.

5.3.2 Drilling equipment set

The drilling equipment set shall slide on the upper and lower skid rails, such that the drilling rig can work above any well slot.

This document does not require any particular layout, but guidance is given in A.5.3.2 on typical layouts for drilling equipment.

5.3.3 Drilling support module

Drilling support module is generally divided into a power unit and a drilling fluid unit. The power unit can include generator set, transformer, electrical driven system, battery and other equipment; the drilling fluid unit includes mud pump, mud tank, and drilling fluid mixing devices.

A crane shall be able to cover laydown areas; the size of the laydown areas shall be able to meet the requirements of drilling and completion operations.

This document does not require any particular layout, but guidance is given in A.5.3.3 on typical layouts for drilling support equipment.

5.3.4 Drilling utilities

The drilling utilities include the P-tank module, cementing module, directional unit, mud logging module and well logging unit. For an inherently safer design, monitoring and control of these equipment should be arranged in a safe area.

This document does not require any particular layout, but guidance is given in A.5.3.4 on typical layouts for drilling utilities.

5.4 Health and safety considerations

5.4.1 General

The health and safety system consists of equipment for ventilation, fire protection, explosion protection, fire and gas detection, alarms, fire fighting (deluge and monitors), evacuation, escape and rescue (EER), emergency procedures and training, safety sign, personal protective equipment (PPE).

The safety requirements for the MDR shall be considered in accordance with safety policy for the entire platform.

5.4.2 Escape and alarms

At least two independent escape routes shall be provided from each area of the platform. The width of each escape route should be at least 800 mm, and the height clearance should be at least 2 m. Escape routes shall be obstruction free and clearly identified by use of signage. Stair escape route should be considered as well.

The alarms systems and public address systems of the MDR shall be connected with the platform alarm and public address systems.

5.4.3 Hazardous areas and storage of hazardous goods

Hazardous areas of the MDR shall be identified in accordance with API RP 505.

The storage and isolation of hazardous goods including combustible and explosive goods, radiation sources, chemical hazards, and storage facilities shall be considered in the design. Natural and forced ventilation shall be used to prevent accumulation of combustible gas from contribution to an explosion.

5.4.4 Fire and explosion protection

The provision of fire and explosion walls and decks shall be considered in the design.

At least two fire hose stations shall be provided on any deck with fire hazards. The fire gun and fire hose shall be stored within the fire box of the same position, and the special box shall be placed besides the fire hose station. The fire provision, blast and control system shall keep in accordance with API RP 14G and API RP 2FB.

5.4.5 Safety equipment

The MDR shall be equipped with emergency escape breathing apparatus (EEBA) and self-contained breathing apparatus (SCBA), breather, protection suit and other PPE, eyewash and shower station for drilling and completion operation personnel at locations such as drill floor, mud processing area, bulk powder handling area.

Hazardous areas of the MDR shall be identified; in addition, escape routes, emergency assemblage points and at least two escape exits shall be arranged. Clear signs shall be posted at the positions containing occupational health, safety, and fire control, rescue and escape information.

Life-saving appliances and escape and evacuation facilities shall be provided.

Fire wall and fire resistant decks should be considered in the layout, or if necessary, safety places should be established in hazardous areas.

The specific requirements shall meet local regulations.

5.5 Operational considerations

The designer shall consider the functional requirements of an MDR, including drilling and completion operations as well as its process, access, safety and auxiliary systems. Special attention shall be paid to the requirement that system integrity is consistent with that specified in the offshore platform safety regulations and any current standards.

Operational considerations against vent, spillage, overflow and potential pollution shall be considered during design. For the deck discharge system, considerations shall be given to collection and storage of leakage, overspill liquid and disposal of solids from mud processing and utility system.

5.6 Corrosion control

All equipment of the MDR shall be provided with corrosion control suitable for the operating and environmental conditions where the drilling rig will operate.

5.7 Structural considerations

The structural design, fabrication and in-service integrity management of the MDR shall be undertaken in accordance with the requirements of ISO 19901-3.

5.8 Removal and abandonment

Removal requirements shall be specified in the design stage. The characteristics of the members during removal of the drilling rig shall be considered in its structural construction phase. During management for the structural integrity of the MDR, any in-service reconstruction that will affect later removal should be managed with a Management of Change process.

6 Design

6.1 General

A modular drilling rig includes the equipment to drill wells including handling and transferring pipe. Systems are provided to maintain pressure control within the well and to anchor casing within the well by cementing. The design process of an MDR can be divided into concept, basic, detailed and fabrication design.

The engineering disciplines involved include general (layout), mechanical, electrical, structural, process, piping, outfitting, corrosion control, HVAC, instrument, communications, and safety.

Appropriate HAZID and HAZOP studies shall be undertaken in according with a recognized standard.

6.2 Rig rating

The MDR is generally categorized according to the ratings as presented in Table 1, depending on the maximum hook load, indicative parameters for each rating are shown in Table 1.

Table 1 — Indicative parameters for MDR ratings

Drilling rig rating		30/1 800	40/2 250	50/3 150	70/4 500	90/6 750	120/9 000
Maximum hook load		1 800	2 250	3 150	4 500	6 750	9 000
kN							
Nominal drilling depth m	127 mm (5 in) drill pipe	1 500–2 500	2 000–3 200	2 800–4 500	4 000–6 000	5 000–8 000	7 000–10 000
	114 mm (4 1/2 in) drill pipe	1 600–3 000	2 500–4 000	3 500–5 000	4 500–7 000	6 000–9 000	7 500–12 000
Rated power of the drawworks	kW	400–550	735	1 100	1 470	2 210	2 940
	hp	550–750	1 000	1 500	2 000	3 000	4 000
Drill line	Number of drill line falls	8	8	10	12	14	14
	Maximum number of drill line falls	10	10	12	14	16	16
Drill line nominal diameter	mm	29, 32		32, 35	35, 38	42, 45	48, 52
	in	1 1/8, 1 1/4		1 1/4, 1 3/8	1 3/8, 1 1/2	1 5/8, 1 3/4	1 7/8, 2

The rating of hydraulic and rack and pinion hoisting rig could refer to Table 1.

6.3 Drilling equipment set

6.3.1 General

The drilling equipment shall meet the requirements of ISO 14693.

The maximum permissible working load of any associated system shall be calculated from the weakest component of the system.

The structural form and working space shall be arranged to suit anticipated drilling and completion operations.

The layout of the skid rail shall meet the requirements of substructure stability, drilling and completion operations. The two skid rails of the lower substructure should cover the whole well slot area and the spacing between them should be determined by the well slot arrangement.

The rail of the lower substructure of skidding system is fixed to the top deck of the platform, and that of the upper substructure is mounted on the lower substructure. The skid rails of the upper and lower substructures shall be arranged perpendicular to each other.

The DES provides functions such as hoisting, rotating, drilling fluid solids control and vertical and horizontal movement for drilling operations, and consists of upper and lower substructures.

Conventional rigs should meet the following provisions.

- The upper substructure generally supports equipment such as derrick/mast, crown block, drawworks, TDS, travelling block, hook, rotary table, driller's cabin, choke and kill manifold, standpipe and cement manifold, wellhead tools, flowback equipment (if applicable), winch and BOP handling devices.; the lower substructure mainly generally supports equipment such as drilling fluid solids control, hydraulic power units and air receivers.
- The equipment on the drill floor should include derrick/mast, drawworks, rotary table, driller's cabin, choke/kill manifold, standpipe manifold, cement manifold. The centre of the rotary table, the centreline of the V-door, the centreline of the ramp and the centre of the drawworks drum shall be within the same vertical plane.
- The drill floor should in relevant areas be designed for dropped objects protection. A heavy tool store with designed laydown area should be provided. Efficient and safe handling of tools between the tool store and the drill floor shall be given due consideration.
- The driller's cabin shall be positioned to provide a clear view of the drill floor, rotary table, drawworks, V-door, pipe setback. It should be positioned to the right of a line running from the drawworks to the rotary table. Drilling equipment operation panels, drilling monitoring system and instruments shall be installed in the driller's cabin. The hook load indicator shall be positioned such that the driller can monitor it while watching operation around the rotary table.
- The pipe handling equipment, if equipped, should be installed on the derrick/mast and drill floor in accordance with anticipated operation and installation requirements.
- The choke/kill manifold and standpipe manifold should be arranged to the opposite position of the driller's cabin. The hydraulic cathead should be installed between the rotary table and the drawworks. The mouse-hole should be arranged on the central plane of the derrick/mast and the rotary table centre on the drill floor, directly in front of the rotary table and near it. Auxiliary winches including man-riding ones shall be provided.
- The opening diameter of the rotary table shall meet the requirements of anticipated drilling operations. The tongs shall be fitted with safety ropes. The pressure system for power tongs shall be fitted with a safety valve set no higher than the system's maximum working pressure.

Hydraulic rigs and rack and pinion rigs should follow the manufacturer's instructions and operation requirements.

6.3.2 Derrick/Mast

The derrick/mast design shall meet the requirements of ISO 13626.

The derrick/mast design shall fully consider the accessories installed on it. When using the pipe handling system, the additional load and operating space requirements as a result of these accessories shall be considered.

If other types of hoisting are used, such as hydraulic ram or rack and pinion, it should follow the requirements of manufacturers.

6.3.3 Maximum hook load

The maximum hook load is the major parameter for rig selection. The maximum value that can be encountered in various well sections during drilling operations shall be considered when calculating the maximum hook load. The maximum hook load of the selected rig shall not be smaller than that required by rig hoisting operation. A.6.3.3 gives the recommended practice for selecting drilling rig and calculating its maximum hook load.

6.3.4 Drill floor clearance

The drill floor clearance shall be sufficient for BOP stack installation/handling and return flow. A.6.3.4 gives a method for calculating the drill floor clearance.

6.3.5 Top drive system

The rated load of the TDS shall match the maximum hoisting capacity of the drilling rig (see A.6.3.5). The final value of the parameter should be selected when the requirements of the drilling engineering have been finalized. The design of the TDS shall be in accordance with ISO 13535.

6.3.6 Well control equipment

The well control equipment consists of a BOP stack and its adapter/spacer, BOP control unit, and choke/kill manifolds. The well control equipment shall meet the requirements of API Spec 16A and API Std 53. The well control equipment shall meet the requirements of offshore environment, wellbore medium, pressure and temperature rating.

Every installed ram BOP shall have, as a minimum, a Rated Working Pressure (RWP) equal to the maximum anticipated wellhead pressure (MAWHP) to be encountered. The pressure rating of the adapter/spacer, choke and kill manifolds shall be consistent with that of BOP stack.

The BOP control system shall meet API Spec 16D. In addition, the following requirements should be considered: The pump set for the control device should be equipped with at least two independently driven power sources. The accumulator system should be designed so that the loss of an individual accumulator and/or bank should not result in more than 25 % loss of the total accumulator system capacity.

The BOP control system shall be located in an open space in a safe area (for more details about hazardous area see 5.4.3), be near an escape route and be convenient for operation. Diverter control unit, if equipped, should be located near BOP control system. The hydraulic choke valve control panel shall be arranged near the driller. There shall be at least two BOP remote control panels, which are installed respectively on the drill floor and within the tool pusher's (or company's) office.

6.3.7 BOP handling system

The BOP handling system shall ensure BOP can be moved off the well slot area for inspection and maintenance.

6.3.8 Circulation and solids control system

The mud gas separation system of the drilling fluid shall be designed for the maximum anticipated flow rate during drilling operations, and gas vented from the degasser shall be discharged from a vent line pipe on the derrick/mast.

The MDR should be provided with drilling fluid solids control equipment including shale shaker, degasser, desander, desilter and centrifuge, if equipped. The treatment capacity of the shale shaker, degasser, desander and desilter shall be generally 100 % to 125 % of the maximum flow rate during drilling operation. The treatment capacity of the centrifuge shall be generally configured reasonably according to the requirements of drilling operations. The MDR shall also be equipped with corresponding cuttings treatment equipment as stipulated by national and local laws and regulations. The selection of solids control equipment will be determined by the reservoir, hole conditions and drilling operation requirements.

For specific operations constraints, where the total control of both pressure and mud flow rate is required, the installation of a continuous circulating system should be considered. The use of hands free or automatic continuous circulation systems is encouraged.

Circulation and solids control facilities shall keep in accordance with ISO 13501.

6.4 Drilling support equipment

6.4.1 Power of the mud pump set

The total power of mud pumps [excluding pump(s) standby] should be equal to or larger than the maximum pump power required in each well section. Two or more mud pumps of the same power should be provided. A.6.4.1 gives a recommended method for selecting the power of a mud pump set.

6.4.2 Mud tank volume

The deepest anticipated well should be selected as the basis for calculating mud tank volume by well section in conjunction with the drilling operation procedures. The tank volume shall satisfy drilling and completion operations in all anticipated sections. A.6.4.2 gives a recommended practice for calculating mud tank volumes.

The mud tanks should include storage pits, active pits, mixing pits, and heavy-weight drilling fluid pits, and the total number of storage pits and active pits shall be at least three. Two sets of drilling fluid mixing hopper systems and two independent mixing lines shall be provided, and be able to mix bulk materials simultaneously. Each mud pump set and each mud tank shall be isolatable for maintenance. Mud tanks shall be furnished with mud guns and agitators. Each mud tank should be fitted with a liquid level indicator, including local and facility for remote measuring/indicating. Effective ventilation of the drilling fluid tank shall be provided.

6.4.3 Generator set

One of the following power supply modes can be selected:

- using the central power supply from production;
- using the independent power of a generator set in the MDR.

When it is planned to use the generator set, it shall provide sufficient power for various operating conditions during drilling and completion operations. When selecting a power station, consideration shall be given to both self-power supply and supply the power to the production platform as well. At least three operating conditions of the total power for drilling and completion operations shall be considered, such as normal drilling, high-pressure high-flow rate drilling and back reaming. A.6.4.3 gives a recommended method for determining the power required for a generator set.

The overall harmonic voltage distortion in the system shall not exceed 8 %, and a single harmonic voltage distortion shall not exceed 5 %. If the harmonic content in the system exceeds these values, control measures shall be taken. All AC electrical equipment shall be able to work normally when harmonic components of the power supply is no larger than 8 %.

A main and standby transformer should normally be used in the power supply system of the MDR. Normal power distribution equipment shall be arranged separately from emergency power distribution equipment. An emergency battery system shall be provided to automatically supply power to the emergency circuit at any time. Batteries with charging power higher than 2 kW shall be installed in a special battery room. Accumulator battery shall not be installed in an area usually occupied by personnel.

6.4.4 Electrical equipment and cabling

Any electrical equipment installed in such areas shall conform to explosion-proof and ingress-protection requirements of the area.

Other requirements should be in accordance with IEC 61892-3 and IEC 61892-4.

6.4.5 Emergency power supply

The emergency power supply shall provide the power supply requirements of at least the following equipment:

- fire and gas detection system;
- fire-fighting system;
- BOP stack and its control system;
- emergency shutdown system;
- communication system;
- emergency escape system (if it requires power);
- emergency lighting and small power distribution board;
- UPS distribution board.

6.4.6 UPS

The time required to operate the system on UPS is an essential factor when designing the system, and will depend on the duration of availability of input power (main or emergency).

6.4.7 Fuel tank

If the MDR is equipped with a generator set, the main generator set and the emergency generator set shall be fitted with day tanks. All fuel tanks shall be arranged in the safety area and the lowest liquid level of day tanks shall be higher than the diesel suction inlet of diesel engines.

6.4.8 P-tanks and pipework

P-tanks for powder materials are sized on the following principles:

- the volume of Barite should meet the requirement of filling the casing for both the intermediate casing and production casing with weighted drilling mud;
- the volume of cement should meet the requirement of the worst case during cementing different casing size;

— the volume of bentonite should meet the requirement of mud mixing for each well section.

In addition, vessel supply period should be considered.

Right-angle bends in powder transfer lines should be avoided; when bends are required, the bend radius shall be no less than five times the nominal diameter of the pipeline. Powder transfer lines shall be fitted with an air purge system arranged to blow air in the same direction as the powder flow. Powder transfer lines shall be provided with conspicuous colour and flow direction marks.

6.4.9 Auxiliary systems

The auxiliary systems include the hydraulic system, utility system and safety system.

The maximum operating pressure and flow rate of the hydraulic system shall be calculated according to the relevant equipment loads. The design, operation and maintenance of the hydraulic system shall prevent pressure pulses. Hydraulic system should be configured to the open loop type. Consideration should be given to including built in filtration/conditioning equipment.

The compressed air consumption shall be calculated for various operating conditions (continuous and intermittent) during drilling, completion and other operations. The air system shall be fitted with an air dryer of a type appropriate to air usage and ambient conditions. In line air filters and lubricators shall be fitted as appropriate. Air receivers should be fitted with automatic moisture drains and should provide no less than 20 min continuous supply.

The DES power distribution room, DSM power distribution room, emergency power distribution room, electrician workshop, mechanical workshop, spare parts storage room, and mud lab should use independent air conditioning system. The ventilation system in the hazardous area and safety area shall be independent from each other and should meet with ISO 15138.

The cementing module should be arranged near the P-tank and wellhead slot. The interfaces for fuel, electricity, gas, seawater, drilling water, drilling fluid and cement pipeline shall be reserved near the cement module.

The discharge system shall be divided into solids discharge system and liquid discharge system. The solids discharge system should deliver cuttings to a collecting tank, and be disposed of in accordance with environmental requirements and regulations. The liquid discharge system can be divided into an open discharge system and a closed discharge system, and flushing joints shall be set on the pipeline.

6.4.10 Other requirements

The systems or equipment such as brake device of drawworks and rotary table, crown block saver and ESD system shall be provided with 2-stage or 3-stage protection, which shall be designed as independent control systems of same functions and different principles.

The materials of the components of the MDR shall be provided with corrosion control measures including surface treatment, painting. All steel gratings, ladder steps, stairways and other components requiring surface zinc treatment shall be hot-dip galvanized prior to welding. All equipment of the MDR shall be provided with corresponding corrosion control measures according to the environmental conditions of sea area where the drilling rig operates.

Suitable padeyes and fittings shall be provided overhead for lifting and transportation of equipment that requires maintenance. All padeyes shall be stencilled with SWL rating and individually stencilled/identified with unique serial numbers, recorded on a register of lifting equipment.

6.5 Interfaces

6.5.1 Seawater

An adequate supply of seawater to the MDR for its consumption should be available from the platform. The volume rate required shall take into account demands from drilling, work-over, cooling, deluge and fire fighting.

6.5.2 Fresh water

An adequate supply of fresh water to the MDR for its consumption should be available from the platform. The volume rate required shall take into account the demands from various users.

6.5.3 Fuel

An adequate supply of fuel to the MDR for its consumption should be available from the platform.

6.5.4 Compressed air

An adequate supply of compressed air to the MDR for its consumption should be available from the platform. The air supply to the instrument shall be dry and oil-free.

6.5.5 Discharge system

Reliable solid and liquid discharge pipeline interfaces shall be established from the MDR to the platform.

6.5.6 Electrical interface

An adequate supply of electricity for the operation of the MDR should be available from the platform. Electrical demand includes power supply, lighting, emergency power and UPS. The typical parameters are shown in Table 2.

Table 2 — Typical electrical parameters for an MDR

Electrical parameters	Power supply mode						
	Self-supplied power station		Centralized power supply from the platform		Emergency		UPS
	Power supply	Lighting	Power supply	Lighting	Power	Lighting	
Voltage, V	600/690	100–130/ 220–230	6 300/ 10 500	—	400/ 480	100–130/ 220–230	110/ 220/ 400
Frequency, Hz	50/60						—
Power, kW	See 6.4.3 and A.6.4.3						

6.5.7 Instrument communication interface

Instrument telephone interface shall be provided between the MDR and the platform. This includes fire and gas detection, control, LAN and program control switching systems.

6.5.8 Well control system interface

At least a remote control panel for the well control equipment should be installed in the tool pusher's (or company's) office for easily observing operations on the drill floor.

6.5.9 Safety system interface

The capacity of rescue and escape facilities on the platform shall meet the requirements of the operation personnel for the MDR in addition to the normal platform personnel.

6.5.10 Flowback system interface

If an MDR is equipped with a flowback system, the following provision should be considered.

A flange at the top of the standpipe for interface with flexible flow hose from temporary surface test tree to route well flowback fluids to the standpipe for further processing should be supplied.

A flange at the bottom of the standpipe for interface with temporary flowback equipment located on the drill floor (choke manifold, filter, sand cyclone or similar equipment), and/or a flow line routed to the platform pipe deck and/or platform test separator should be supplied.

7 Structural design

7.1 General

The structure shall be designed in accordance with ISO 19902. The LRFD method is recommended, but the WSD method is accepted as well.

Annex B provides a guide for the application of the LRFD method and WSD method.

7.2 Structure simulation

The structure simulation shall be performed in design; see B.1.5 for more details.

7.3 Design checks

The design checks should include member strength checks, joint strength checks and member deformation checks.

7.4 Material selection

The selection of material shall be in accordance with the requirements of ISO 19901-3.

7.5 Skid rail strength analysis

The finite element analysis of skid rail strength should be made using the largest reaction force on the skid rail.

8 Construction and assembly

8.1 General

The fabricator shall have a quality management system.

NOTE It is common that the fabricator has a quality management system that complies with the requirements of ISO 9001 and that is assessed for conformity by a third party.

Materials shall be selected based on performance compatible with the design code.

Construction and assembly shall be in accordance with the requirements of ISO 19901-3 and ISO 19902. The piping, valves and flanges shall follow the requirements of ASME B16.1, ASME B16.5, ASME B16.10, ASME B16.34, ASME B31.1 and ASME B31.3. Additionally, the requirements in 8.2 to 8.10 apply.

8.2 Planning

Before construction, the fabricator shall prepare organizational and technical documents necessary to manage the construction and testing. These documents should include quality control and quality assurance documents as well as construction design documents. A plausible project schedule with contingency for weather and other variable factors should be considered. A typical list of quality assurance and control document is shown in Clause 11 and a list of typical construction design document is shown in Annex C. All above documents shall be implemented only after being approved by recognized authority.

The yard facilities shall be suitable for the construction works and in particular the strengths of working areas, skidding areas and loadout areas shall be greater than the actions imposed during these activities.

8.3 Equipment and materials handling

8.3.1 Arrival inspection of materials and equipment

The fabricator shall perform delivery inspection of the materials for construction and the equipment to be installed. Materials and equipment shall be provided with quality inspection and test documentation issued by manufacturers and/or inspection agencies.

8.3.2 Storage and tracking of materials and equipment

The fabricator shall make a detailed scheme for storage of materials and equipment.

The material storage shall be able to prevent materials from being affected by mechanical damage and weather.

Equipment shall be stored in a dry, ventilated and clean environment. It is advisable to store equipment in a storehouse. If equipment is stored outdoors, protective and maintenance procedures shall be undertaken.

The fabricator shall identify and track the materials for construction such that certificates can be identified for individual components.

8.4 Structural steelwork fabrication

8.4.1 Cylindrical tubular members

Fabrication of cylindrical tubular members shall be in accordance with ISO 19902.

8.4.2 Non-cylindrical sections

The following provisions are examples of good practice from experience and should be considered.

For welded I-sections subject to major vibration actions and with a web thickness greater than 20 mm (such as main frame structure of drill floor), the web and chord plate should be welded by a combination of butt welding and fillet welding in partial or full penetration. For welded I-sections of other parts, the web plate and the chord plate may be welded by continuous double fillet welds.

The joint of the web plate and the chord plate of the welded I-section shall use full penetration welding at the splicing position and the butt-joint part of the chord plate shall be staggered by over 300 mm from that of the web plate. The length of splice plate for flange shall be greater than twice its width and the width of splice plate for web shall be more than 300 mm, whose length is more than 600 mm.

After completing prefabrication of the welded I-steel, the dimension inspection shall be performed and its permissible dimension deviation shall conform to the requirements of A.8.4.2.

8.4.3 Skid rail fabrication

The skid rail should use a reinforced beam structure. The web plate and flange plate of skid rail of the beam structure shall be connected using full penetration welding.

After completing prefabrication of the skid rail, its dimensional tolerance should meet the following recommendations:

- the flatness of the skidding surfaces should not be greater than 2 mm in any 2 000 mm length;
- the straightness of the skid rail should not be greater than 2 mm in any 2 000 mm length;
- the deviation between the vertical elevation of flange centreline and the design value should not be greater than 2,5 mm in the overall length;
- the camber variation of the flange should be within $\pm 1,6$ mm in the overall length;
- the variation in width of the flange should be within ± 1 mm;
- the variation in height of the skid rail should be within ± 2 mm;
- the deviation in width of butt joints in the flange should not be greater than 2 mm and the transitional slope shall not be greater than 1:500;
- the deviation in width of butt joints in the web should not be greater than 2 mm;
- the longitudinal and lateral deviation between stepping holes should not be greater than 2 mm;
- the deviation in the dimensions of stepping holes should be within ± 1 mm in width and ± 1 mm in length.

Skid rails for other skidding types shall meet design requirements.

8.4.4 Tolerance for skid rail installation

Skid rail installation should meet the following recommendations:

- the spacing between the two skid rails shall be within ± 2 mm of the design dimension;
- the parallelism between the two skid rails shall not be greater than 2 mm in any 2 000 mm length and shall be no greater than 5 mm in the overall length;
- the coplanar of the two skid rails shall not be greater than 5 mm;
- the difference of the two diagonal distances between the two skid rails shall not be greater than 10 mm;
- the parallelism between the skid rails and the topside upper deck shall not be greater than 2 mm in any 2 000 mm length and shall not be greater than 5 mm in the overall length.

Skid rails for other skidding types shall meet design requirements.

8.5 Welding and inspection

8.5.1 Basic requirements

Before welding, the fabricator shall submit the procedure documents related to welding operations and get the approval of the inspection agency and refer to Table C.10 for typical procedure documents.

The welder for construction including welding operator, tacker shall pass the examination and get the qualification certificate according to the relevant standards and specifications and the welding range shall not be beyond the provisions on the qualification certificate.

Steel structure welding shall be performed in accordance with the approved WPS and WPQR and shall conform to the requirements of ISO 19902 and those in AWS D1.1/D1M.

Inspection shall conform to the requirements of ISO 19902.

8.5.2 Visual inspection

Visual inspection of all the steel welds can be started by the minute completed welds cool to ambient temperature.

One hundred percent visual inspection of all welds shall be performed, stringer beads shall be uniform, weld edges shall be of smooth transition to the base metal and the outside dimension of welds shall conform to construction design requirements, or comply with the requirements in AWS D1.1 for weld's contour and shape. The surface of welds shall not be of cracks, included slag, lacking of fusion, air holes, welding beadings and arc craters. The welds of special members shall not be of undercuts; the undercut depth of primary structural members shall not exceed 0,5 mm and that of secondary members shall not exceed 0,6 mm.

8.5.3 Non-destructive inspection

The types of all structure members shall be clearly marked in the construction design document. The non-destructive testing methods and coverage of welds are shown in Table 3.

Table 3 — Non-destructive testing requirements of structure welds

Member type	Joint type	Testing method and coverage		
		Radiographic testing	Ultrasonic testing	Magnetic particle testing
Special member	Butt joint	20 %	100 %	100 %
	T-joint	—	100 %	100 %
Primary structural member	Butt joint	—	100 %	100 %
	T-joint	—	100 %	100 %
	Corner joint	—	—	100 %
Secondary member	Butt joint	—	5 %	10 %
	T-joint	—	5 %	10 %
	Corner joint	—	—	10 %

Non-destructive testing quality requirements of welds are shown in Table 4.

Table 4 — Non-destructive testing quality requirements of welds

Defect type	Member type	
	Special member and primary structural member	Secondary member
Crack	Not allowed	Not allowed
Lack of fusion	Not allowed	Not allowed
Incomplete penetration	Not allowed	Not allowed
Other defects	Penetrant flaw testing (PT) shall be in accordance with AWS D1.1/D1M, Clause 6.	
	Magnetic particle testing (MT) shall be in accordance with AWS D1.1/D1M, Clause 6.	
	Radiographic testing (RT) shall be in accordance with AWS D1.1/D1M, Clause 6.	
	Ultrasonic testing (UT) shall be in accordance with AWS D1.1/D1M, Clause 6.	

8.5.4 Additional inspection requirement

Non-destructive testing for welds which thickness is more than 50 mm shall be performed not less than 48 h after completion of the welds.

Padeye welds should be rechecked after lifting.

When less than 100 % weld NDT is implemented, if a particular weld appears to be defective, 100 % NDT shall be done.

8.6 Prefabrication and installation of the piping

Pipework design, installation and testing shall meet the requirements of ISO 13703. In addition, the following requirements apply:

- Before testing all process, piping shall be flushed and purged. Clean fresh water should be used for flushing. For stainless, nickel and nickel alloy piping, the chlorine ion content in the water shall not exceed 25 mg/l.
- Dry compressed air shall be used for gas delivering pipeline purging.
- The water velocity during water flushing shall be at least 1,5 m/s and the air velocity during air purging shall be at least 6 m/s.

8.7 Outfitting

8.7.1 Heat insulating materials

Where double-layer insulation is used, any joints in the insulation shall be offset by a minimum of 100 mm between the two layers. Joints shall be kept tight and flat and splices shall use fibreglass ropes.

Where fire resistant insulation is used, it should extend beyond the part being protected by no less than 450 mm at a bulkhead or deck for A-60 fire rating or 380 mm for grade A-0 rating. When fireproof insulating materials are laid, they shall overlap by at least 150 mm.

8.7.2 Penetrations

Where walls and floors are penetrated by cables or pipework, fire-rated penetrations equivalent to the wall or bulkhead protection shall be used.

8.7.3 Fire doors

Fire doors shall be installed as required and shall be connected with the steel bulkhead by means of continuous fillet welds. After installation, the fire door shall be checked in accordance with the following requirements:

- the plane height difference of the upper door frame and door leaf of the fire door open face shall not be greater than 1 mm;
- when the door is closed, the door leaf shall be closely integrated with the door frame; they shall overlap by at least 12 mm;
- the offset between the door leaf and the upper frame shall not be greater than 3 mm;
- the offset between the door leaf and the lower frame or the floor shall not be greater than 9 mm;
- the gap between the door leaf and the door frame on the hinge side, the lock side or between the door leaf and the binding face of the upper frame shall not be greater than 3 mm.

8.7.4 Installation of ladders and guardrails

The installation of ladders and guardrails shall meet the following requirements:

- foot steps and ladder beds shall be fixed with continuous weld;
- ladders shall not be distorted during installation;
- the distance from the lowest cross piece of guardrails to the deck shall not exceed 230 mm; the spacing between other cross pieces shall not exceed 380 mm.

8.8 Corrosion control

All structural steel shall be protected in accordance with ISO 19901-3 and pipework shall be protected in accordance with ISO 13703. Packaged equipment should be protected as necessary prior to delivery.

Any equipment shall be adequately protected during surface preparation and coating operations.

8.9 Installation of equipment

8.9.1 General

The installed position and the alignment of equipment shall conform to the design and any manufacturers' requirements and procedures. Exposed moving parts shall be fitted with appropriate guards.

8.9.2 Hoisting equipment

For guidance on the installation of hoisting equipment, see A.8.9.2.

8.9.3 Rotating equipment

For guidance on the installation of rotating equipment, see A.8.9.3.

8.9.4 Circulation and solids control equipment

8.9.4.1 General

The installation of the drilling fluid solids control equipment shall meet the following requirements:

- equipment shall be installed in a flat, steady, aligned, complete and secure manner; valves and pipework shall comply with the requirements of ISO 13703;
- no more than three sizing blocks shall be installed for levelling; they shall be welded to supporting steelwork securely;
- any guards, protection hoods and safety devices for rotary parts shall be complete and fitted securely;
- any connecting pins shall be complete with the correct type and safely installed with any appropriate locking devices;
- mud return lines shall be installed sloping downwards at an angle of no less than 5°;
- guardrails and all lightings on ladder, walkway and tank surface shall be complete, intact and firmly fixed;
- all equipment shall be lifted using any lifting points with SWL label provided by the manufacturer.

8.9.4.2 Mud tank

The mud tank shall be configured according to the type of the drilling rig and well design.

8.9.4.3 Shale shaker

The installation of the shale shaker shall meet the following requirements:

- the shale shaker shall be securely welded to deck beams and/or appropriate foundation;
- appropriate ventilation shall be installed to ensure that all fumes, gases, vapours, etc. are discharged to a safe area;
- space shall be provided around the shale shakers for maintenance and to replace screens.

8.9.4.4 Degasser

The installation of the degasser shall meet the following requirements:

- The inlet of the suction line shall be installed in a location where the drilling fluid is fully agitated. The location of the degasser and arrangement of the suction line shall ensure mud feeds into the degasser.
- The discharge gas line shall be connected to the vent pipe of the mud/gas separator.

8.9.4.5 Desander and desilter

The installation of the desander and desilter, if applicable, shall meet the following requirements:

- the cyclone overflow port of the desander and desilter shall be higher than the highest liquid level of the sand trap tank;
- the suction line to the desander and desilter shall be fitted with a washing line;
- the inlet of the suction line shall be fitted with a filter screen.

8.9.4.6 Centrifuge

The installation of the centrifuge, if applicable, shall meet the following requirements:

- the inclination of the overflow pipe shall be greater than 45°;
- the inclination of the underflow trough shall be greater than 60°;
- a horizontal centrifuge shall be installed horizontally with a horizontal height difference between supports of not greater than 10 mm.

8.9.4.7 Continuous circulation system

If equipped, the installation of continuous circulation system for constant mud flow rate and pressure shall be considered during the design and the commissioning of the drilling rig. The mud continuous circulation system shall be configured according to the type of the drilling rig and well design. If the continuous circulation system is not supplied as an integrated package with the drilling rig, the conventional circulation system shall be configured for the installation of a continuous circulation system in standalone version.

8.9.5 Power and electrical equipment

The installation of the power and electrical systems equipment shall meet the following recommendations in addition to the relevant provisions of IEC 61892-3:

- The bolts and nuts for electrical equipment connection and fastening shall use vibration-proof self-locking fasteners.
- Regulating resistances, starting resistances, charging resistances, dynamic braking resistances, electric heating appliances and other electrical equipment can generate high temperatures during operating. If these components are installed, measures for preventing overheating and ignition of adjacent objects shall be taken.
- Regulating resistances, starting resistances, charging resistances, dynamic braking resistances, electric heating appliances shall not be directly installed on walls of oil compartments or tanks and the distance between other electrical equipment and external walls of oil compartments or tanks shall be at least 50 mm;
- Measures for the prevention of contact with the electrified parts, for which the voltage to the ground or working voltage is greater than 50 V, shall be provided, unless the equipment located in special compartments.
- Guards shall be fitted for personnel protection if the outside temperature of electrical equipment exceeds 80 °C.

8.9.6 Well control equipment

The following requirements shall be considered as part of the well control equipment installation:

- a) When bell-nipple is installed on the top of the BOP, it shall be connected to the pipe using bolts, with unused bolt holes plugged with screws. The bell-nipple shall be of the two-piece combined type. Metal gasket rings or special rubber rings can be used to seal the connections between the bell-nipple and the BOP.
- b) After installation of the BOP, the centres of the wellhead, the rotary table and the crown block shall be calibrated so that their deviations are within 20 mm. Suitable wire rope shall be used to tighten and fasten the BOP stack on the diagonal line of the derrick/mast substructure.
- c) The ram BOP shall be equipped with manual or hydraulic locking device. The BOP with manual locking mechanism shall be installed with complete manual operating lever, the sideway handwheel end shall be supported securely and the handwheel shall be extended with derrick/mast substructure to build platform for easily operation, with the deflection between manual operating lever and lock spindle centreline of BOP within 30°. Handwheel of manual operating lever shall be labelled to indicate number of turns and directions of switch.

8.9.7 Pipe handling equipment

The pipe handling equipment, if equipped, shall be installed as appropriate on the derrick/mast, drill floor, pipe rack area. Any such equipment installed within the derrick/mast shall be fitted with a safety rope or safety chain anchored to the derrick/mast.

8.9.8 Fire and gas detection equipment

The installation of the fire and gas detection equipment shall meet the following requirements:

- combustible gas detectors shall be installed at the ventilation inlets, air inlets and the space where the combustible gas can accumulate;
- hydrogen sulphide gas detection shall be installed within 2 m from a potential release source and the detection height from deck shall be lower than 0,6 m;

- alarm lights shall be positioned to be easily visible to personnel;
- cable entries to detectors and alarm lights shall be fitted with glands and protection;
- metal cases of all fire and gas detection equipment, manual alarm buttons and alarms shall be grounded or be double-insulated.

8.9.9 Drilling instrument communication system

8.9.9.1 Installation

The installation of the drilling instrument should meet the following recommendations:

- the standpipe pressure sensor should be installed such that it is convenient for connection and disconnection;
- rig tong torque sensor should be installed such that its tail rope when tensioned in use is horizontal and at 90° to the long arm;
- optical step-type encoder mounted on the drawworks shaft end should be used for measuring well depth and drilling rate;
- if proximity switch type sensor is used, the installation distance should be approximately from 5 mm to 10 mm.
- the mud return flow sensor should be installed on the mud return pipeline between the bell nipple on the top of the BOP and the shale shaker (the pedestal for the mud flow sensor shall be kept flush with the mud flow liquid level for the plate type sensor);
- the mud pit level sensor hole should enable ultrasonic waves to pass (application parameters should be reviewed carefully to ensure the correct use of ultrasonic devices).

8.9.9.2 Communication equipment

Communication equipment shall meet the following requirements:

- public addressable (PA) and general alarm (GA) loudspeakers shall be installed to be audible throughout the MDR;
- outdoor automatic telephones shall be installed 1,3 m to 1,7 m above the deck near stair ways;
- closed circuit television system (CCTV) cameras shall be installed as required.

8.9.10 Boiler and steam system

Where a boiler and steam system is provided, its installation shall meet the following requirements:

- the exhaust duct shall use a flexible connection and should be supported by a U-shape slot or pipe shoe;
- the steam safety valve shall be connected using a steel line, the release port of the valve shall be led to a safe location and the height of the release port shall be lower than that of the valve;
- the electric boiler control cabinets shall avoid heat sources;
- the steam system piping shall be flushed and purged before connection.

Further guidance is given in A.8.9.10.

8.10 Weighing

The various modules of the MDR shall be weighed before loadout. See ISO 19901-5 for more details.