INTERNATIONAL STANDARD

ISO 18647

First edition
2017-08

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

Industries du pétrole et du gaz naturel — Spécifications pour une foreuse modulaire à bord de plateformes fixes offshore

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Reference number
ISO 18647:2017(E)

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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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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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*.

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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.

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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.

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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*

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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*

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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

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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

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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

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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

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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.

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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.

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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.

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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.

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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.

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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.

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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 kN		1 800	2 250	3 150	4 500	6 750	9 000
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.

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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.

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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.

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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 constrains, 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.

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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;

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— 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.

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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.

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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.

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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.

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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.

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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 port 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.

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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 ±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.

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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.	

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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.

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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.

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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.

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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.

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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;

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— 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 stairways;

— 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.

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The weighing report for each module shall be used for confirming the loadout, transportation and installation procedure (see Clause 10). All weighing equipment shall be calibrated before weighing.

9 Pre-commissioning

9.1 Pre-commissioning scope

In this document, pre-commissioning refers to tests and preparations for operation undertaken on-shore prior to loadout and transportation of the MDR and commissioning refers to those tests and preparations undertaken after lifting the MDR onto the platform and hook up.

The pre-commissioning scope includes:

— hoisting system (derrick/mast and drawworks or hydraulic ram, rack and pinion drives);

— rotary system (TDS and rotary table);

— circulation and solids control system (mud pump, drilling fluid manifold, charging pump, mixing pump, mud agitator, mixing hopper, shale shaker, mud cleaner, degasser and centrifuge);

— power and electrical system [diesel generator set (if equipped), emergency diesel generator set, transformer, medium-voltage distribution board, low-voltage distribution board, electrical control system, UPS, electrical control system including harmonic filtering devices and braking resistance];

— well control system (BOP and control unit, diverter control system, choke and kill manifolds);

— cementing system (cementing manifold);

— pipe handling system (monkey board, breakup and out devices, mouse hole, guiding equipment, V-door as well as pipe conveying, moving and hoisting equipment in pipe rack area);

— safety system (water sprinkler system and fixed fire-fighting systems);

— instrument communication system (fire and gas detection equipment, drilling instrument equipment and P-tank instrument equipment);

— auxiliary system (compressed air system, drilling water system, fire water system, seawater system, diesel system, hydraulic skidding equipment, fan, air damper and air conditioner);

— other equipment, as appropriate.

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9.2 Pre-commissioning preparation

Pre-commissioning procedures should include test requirements and appropriate inspection. Witnessing of testing should be arranged and shall be prepared in advance detailing all operation, tests and test results required. The manufacturers' pre-commissioning recommendations should be incorporated into the pre-commissioning plans. The pre-commissioning procedure shall be approved as required and shall detail any third-party inspection and witnessing required.

Prior to commencing pre-commissioning, all material and conformity certificates should be reviewed and confirmed to be complete and to satisfy the design requirements. It should be confirmed that all relevant equipment and auxiliary equipment are installed and connected by visual inspection.

Electrical and mechanical check should be completed before starting any equipment.

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9.3 Hoisting equipment

The pre-commissioning of the hoisting system equipment should include:

— checking that the alignment between the derrick/mast and the rotary table is within 20 mm (0,75 in);

— identification of the electric driven cabinet and main motor of the drawworks;

— pre-commissioning of the pneumatic control system and brake system;

— pre-commissioning of the transmission device of the drawworks;

— undertaking a brake test, pressure and operation test of the control system, test of operation of the gear shift mechanism, test of the automatic driller;

— setting up the crown-saver in position .and adjust the electronic anti-collision device;

— checking the instrument indicator and alarm system on the drawworks console to ensure function of the equipment.

After completing pre-commissioning, measurements of the lube oil pressure, oil bath temperature rise and the temperature rise of each bearing shall be taken.

9.4 Rotating equipment

The pre-commissioning of the top drive should include the following function tests of the hydraulic system, electrical and drilling instrument system:

— checking the hydraulic fluid level/pressure/temperature meets the manufacture's requirement for hydraulic system;

— checking all connectors for tightness and lockwire;

— checking and setting the air-operated pressure, which should meet the manufacture's requirement for air system;

— checking and setting the air pressure for pressurized enclosure system of TDS;

— checking the function for alarm and protecting system of over load/over temperature/low oil level;

— checking the motor's rotating direction and fan volume for cooling system;

— assign inverter by selecting forward or reverse on the driller's console;

— rotating the drill stem using the throttle on the driller's console and observe proper operation;

— checking operation of meters.

Other relevant function tests include brake test, link tilt test, IBOP control system test and link rotary system test. The pre-commissioning of the rotary should include:

— a no-load test on the rotary table which shall run at the highest speed for 30 minutes; the rotary table shall run smoothly without abnormal noise and the seals of the rotary table shall be free of leakage;

— an inertial braking test and a forward and reverse gear operational test of the rotary table during no-load running of the rotary table and its driven unit.

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9.5 Circulation and solids control equipment

The pre-commissioning of the rotary components should conform to the relevant provisions of ISO 13501 and should include:

— a function test of the safety valve of the mud pump, at which its deviation shall not exceed ±10 % of the calibration value;

— a function test of the mud pump;

— an operational test at 25 %, 50 % and 75 % of the rated working pressure step by step, at which the running time of each level shall not be less than 30 min;

— measurement of pump pressure, lube oil and the temperature of all drive bearings;

— a parallel operational test of the mud pump in anticipated operating conditions, at which every parallel running shall be at least 6 h.

The relief pressure of the safety valve should be set according to the rated working pressure of the mud pump.

9.6 Power and electrical equipment

9.6.1 Diesel generator set

If the drilling rig has its own power system, pre-commissioning should include:

— check cold alignment of generators;

— check all the connection of pipe and cable;

— check all the necessary supply, including start air/battery, cooling water, fuel.

— a functional test on generator shutters(air cooled type generator set);

— load test and overload test of the diesel generator set and main protection function test of the integrated protective relay;

— overspeed test of the diesel generator set;

— synchronization and parallel operation multiple generator sets.

When multiple generator sets are used in parallel, their load should be balanced and the speed difference among them should be less than 50 rpm.

9.6.2 Transformer

The pre-commissioning of transformer equipment should include:

— checking of the insulation resistance of transformer coil winding, transformer iron core and all connecting cables of the transformer;

— check the transformer phase of all connecting cables;

— check voltage ratio of tap;

— check the connection group of three-phase transformer and the line polarity of single-phase transformer;

— measurement of the DC resistance of transformer coil winding, transformer iron core;

— AC withstand voltage test of transformer coil winding, transformer iron;

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— impact closing test under rated voltage;

— function tests of the transformer, including the functional test of the temperature controller and cooling fan and the load test of the transformer.

9.6.3 Medium voltage switchboard, low voltage switchboard and motor control centre

The pre-commissioning of the medium voltage switchboard, low voltage switchboard and motor control centre equipment should include:

— an insulation resistance measurement on the medium voltage switchboard and low voltage switchboard, involving the measurement of the insulation resistance of the bus, input and output cables and space heater and control cables;

— function tests, including the functional test of the components such as all switches/control buttons/indicator lights, the functional test of the integrated protective relay of the medium voltage switchboard, the functional test of the low voltage switchboard/motor control centre and the functional test of the insulation monitoring device;

— an ESD test in cooperation with the fire and gas system.

9.6.4 UPS

The pre-commissioning of UPS should include:

— an on-load running test of UPS;

— a charging mode test of UPS charger;

— a switch test for power supplied by UPS and bypass to loads;

— a power test for battery discharging;

— a power supply test from batteries to inverters.

9.6.5 Electric control system equipment

The pre-commissioning of the electric control system equipment should include:

— measurement of the insulation resistances;

— function tests, including linkage test of the 600 V/690 V power switch and function pre-commissioning of the PLC integrated control cabinet, performance test of the converter cabinet, load test of the electric control system and the automatic driller test. The interlock test should be included in the functional test. For example, the interlock of BOP and drawworks, the interlock of IBOP valve and mud pump.

9.7 BOP handling equipment

Load tests and functional tests (including horizontal movement and vertical lifting and lowering within the travel range) shall be undertaken on the BOP handling system. For guidance, see A.9.7.

9.8 Cementing equipment

If the MDR is equipped with cementing system, pre-commissioning shall be conducted according to the design requirements.

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9.9 Pipe handling equipment

The pre-commissioning of the pipe handling equipment, if equipped, should include load and functional tests. In particular for integrated pipe handling and operation systems, stringent calibration and testing shall be undertaken for the initial setting parameters under different operating conditions to avoid errors in the operating procedures and to avoid interference and collisions during operation.

9.10 Fire and gas detection system equipment

The pre-commissioning of the fire system equipment should include:

— a functional test of the water sprinkler system, comprising an automatic start of the sprinkler valve and a manual start of the fire and gas control panel;

— automatic control procedure operation test and manual operation test on the fixed fire-fighting system.

The pre-commission of the fire and gas detection system equipment should include:

— calibration test of the combustible gas detectors, H_2S detectors, smoke detectors, heat detectors and flame detectors;

— alarm and shut-off signal test of the combustible gas detectors, H_2S detectors, smoke detectors, heat detectors and flame detectors;

— digital signal test of manual buttons including manual fire alarm station, platform abandonment button, manual button of the fire-fighting system,

— function test of visual and audio alarms including their visibility and audibility;

— function tests of the fire and gas control panel and fire and gas addressable panel, including failure alarm function test, self-checking function test, silencing function test, reset function test and alarm memory function test;

— database and program diagnosis test of the fire and gas control panel and fire and gas addressable panel;

— control and interlock function test of the fire and gas control panel.

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9.11 Instrument

9.11.1 Drilling instrument

The pre-commissioning of the drilling instrument equipment should include:

— calibration test of drilling instrument sensors;

— analogue, digital and pulse signal test of drilling instrument sensors;

— failure alarm function, silencing function and reset function test of the data acquisition unit;

— joint test of the data acquisition unit, display in driller's cabin and remote monitoring computer.

9.11.2 P-tank instrument

The pre-commissioning of the P-tank equipment should include:

— calibration test of the material level sensor and weight sensor;

— signal test of material level sensor and weight sensor;

— failure alarm function, silencing function and reset function test of the local control panel.

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9.12 Hydraulic system

The pre-commissioning of the hydraulic system shall include:

— achievable oil cleanliness in accordance with ISO 4406;

— hydraulic pump operational test and manual reversing valve function test on the hydraulic station;

— a functional test of the hydraulic users such as cathead, power tongs(e.g. iron rough neck);

— a simulation test of the pulling force of the hydraulic cathead under simulated operating conditions;

— hydraulic pipe flushing, ensure the hydraulic system cleanness meet the requirement.

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9.13 Skidding equipment

The pre-commissioning of the skidding equipment should include:

— hydraulic pump operational test and manual reversing valve function test on the hydraulic station;

— a skidding function test of the both X and Y direction.

9.14 HVAC equipment

The pre-commissioning of the HVAC system equipment shall meet the requirements of ISO 15138 and shall also include:

— a running test of the fan, at which the continuous running time shall be at least 1 h and the air flow-rate shall be measured;

— an action test of the fire damper; in addition, remote control and manual control tests for different fire zones (point-to-point commissioning shall be performed in cooperation with the fire and gas system);

— operational tests and automatic control function tests on the air conditioner, at which the air flow-rate and room temperature shall be measured.

10 Installation, hook up and commissioning

10.1 Loadout and marine transportation

Loadout, marine transportation and onsite hook-up scheme procedures shall be prepared in advance detailing all operations. The procedures shall be agreed by all parties involved in each stage of the operations.

Loadout and marine transportation shall meet the requirements of ISO 19901-6. Any structural parts required for loadout, marine transportation and installation shall be designed according to the provisions of ISO 19901-3 and ISO 19901-6.

The MDR can be loaded out by lifting or skidding. The parameters including the weight, centre of gravity position and overall dimension of modules, the bearing capacity of the front of the site dock, floating crane capacity and the capacity of the transportation barge, shall be considered in the determination of the module loadout mode.

Before loadout, the contractor shall submit complete management and design documents for supervising site construction and inspection and obtain approval, including marine warranty approval as required. A list of typical loadout and seafastening design document is given in Annex D.

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The environment conditions for the loadout operation shall meet the requirements of the installation design and the wind speed shall be at a maximum of 10 m/s. The loadout, positioning and seafastening of modules and accessories shall meet the installation and design requirements.

10.2 Installation

The lifting and installation operations for the MDR shall follow the requirements of ISO 19901-6.

All lifting equipment, including load indication system, brake system, alarm system, lifting hook and luffing wire of the lifting unit, shall be inspected (where appropriate) prior to undertaking the lifting operations.

The personnel participating in lifting operation shall demonstrate competency in accordance with ISO 15513.

After installation, each module shall be secured in place in accordance with the design and all welds involved in installation shall be inspected.

10.3 Hook up

10.3.1 Equipment hook up

The following requirements shall be met:

— the derrick/mast, travelling block and top drive centreline shall be aligned with the centre of the rotary table with offset less than 20 mm (0,75 in);

— a device for fixing the safety belt and the facilities for personnel escape in case of emergency shall be installed at the monkey board of the derrick/mast;

— all lighting and ancillary fittings in the derrick/mast shall be provided with secondary retention devices to prevent falling;

— the installation of power tongs and spinner shall conform to the requirements of manufacturers and field operations;

— the installation of the drill floor monitoring system shall facilitate the driller's observation and shock-avoidance and shock-absorption measures shall be provided;

— the seawater pump and emergency fire pump (if applicable) shall be installed in accordance with the design documents and manufacturer's requirements;

— all electrical equipment shall be installed according to the requirements of API RP 14F;

— all guards for mechanical and electrical equipment shall be fitted;

— all electrical grounding locations shall have a clean, smooth and flat contact surface, with a grounding resistance compliant with design requirements.

NOTE It is unnecessary to provide a special conductor for grounding if the electrical equipment is directly secured to the metal structure of the fixed platform or to the base or support with reliable electrical connection with the metal structure of the fixed platform.

10.3.2 Piping system hook up

Piping hook up shall comply with the requirements of ISO 13703 and ISO 6807.

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Hose connections shall also meet the following requirements:

a) the drilling fluid hose, choke and kill hoses and oil, water and powder hoses shall be connected firmly and provided a means of restraining the end of the hose if the end fitting becomes disconnected;

b) the connection hoses between well control system and BOP and diverter (if applicable), hydraulic valve shall be connected with unions fitted with a check valve.

10.3.3 Electrical hook up

The connection of electrical system, power supply, voltage and frequency of major equipment, distribution system and circuit protection shall meet the requirements of the design documents and IEC 61892-6.

Intrinsically safe instrument circuits shall be laid separately from non-intrinsically-safe instrument circuits.

The electrical equipment, lighting devices, instrument control devices and communication equipment shall be installed and the power cable, control cable, lighting cable and communication cable shall be laid in such a way as to avoid interference with the instrument control system and communication system.

10.4 Commissioning

10.4.1 General

Commissioning procedures should include checks and test requirements and should be prepared in advance detailing all operation, tests and test criteria required. The manufacturers commissioning recommendations should be incorporated into the commissioning plans. Vendors commissioning recommendations should be incorporated in to procedures, results to be recorded. The commissioning procedure shall be approved as required and shall detail any third-party inspection and witnessing required.

The system commissioning includes two stages, i.e. function commissioning and load commissioning.

Safety risk analysis shall be undertaken before commissioning. It is required to perform safety isolation and hazard identification for the commissioning area.

All testing and measuring instruments shall have a valid certificate.

Commissioning personnel shall be properly trained and qualified.

10.4.2 Preparations before commissioning

10.4.2.1 Documents and plans

The commissioning procedures should include:

— equipment description and main functional parameters;

— technical information for equipment installation and operation;

— certificates and inspection reports for the equipment;

— design documents related to the equipment;

— emergency plans.

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10.4.2.2 Function and load testing procedures

The commissioning procedures should include:

- system function description;
- definition of system scope, list of equipment included;
- commissioning purpose, working scope;
- contents and standards of function test;
- contents and standards of pressure test and load test;
- commissioning organization;
- list of commissioning tools and materials;
- commissioning methodology;
- safety precautions.

10.4.2.3 Mechanical completion

Before commissioning, each module shall be mechanically complete in each of the following disciplines (see also A.10.4.2.3):

- mechanical;
- electrical;
- fire and gas;
- instrumentation;
- communication;
- piping;
- HVAC;
- safety.

10.4.2.4 Site preparation

Before commissioning, the following documents shall be prepared and included in the commissioning procedures:

- system drawings;
  - piping and instrumentation diagram (P&ID);
  - block diagram;
  - single line diagram;
  - duct and instrument diagram;
  - electric and instrument diagram;
- mechanical installation drawings;

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— activity documentation;
  — mechanical completion records (MCR);
  — mechanical completion (MC) certificate;
  — punch list;
— procedures for commissioning.

10.4.3 System function testing

10.4.3.1 Fresh water, seawater, drilling water, fuel and lubricating oil systems

The function testing for the fresh water, seawater, drilling water, fuel and lubricating oil systems should include the following steps.

— Testing of all piping under working conditions. Where it is not possible to carry out the required hydrostatic tests for all segments of pipes and integral fittings before installation, the remaining segments, including the closing seams, may be so tested.

— Momentary start up of the equipment with the inlet and outlet valves including the safety valves closed, to check the rotation direction and no-load current are in line with the design.

— Testing of the safety valve with the outlet valve closed and the equipment is running.

— Testing of the various in-line valves with the equipment running.

In general, a pneumatic test in lieu of a hydrostatic test is not permitted. Where it is impracticable to carry out a hydrostatic test, a pneumatic test can be considered. In such cases, the procedure for carrying out the pneumatic test shall take the safety of personnel into consideration.

10.4.3.2 Power and electrical systems

The function testing of the power and electrical systems shall be conducted while the mechanical equipment of each system and the main drilling equipment are in joint operation.

All auxiliary apparatus shall be tested under working conditions. Each generator shall be run for a time sufficient to show satisfactory operation and parallel operation with all possible combinations shall be demonstrated. Each auxiliary motor necessary to the operation of the drilling unit shall be run for a time sufficient to show satisfactory performance at such load as can readily be obtained. All main switches and circuit breakers shall be operated, but not necessarily at full load. The operation of the lighting system, heaters, shall be demonstrated to be satisfactory. The drop in voltage on any part of the installation shall not exceed 6 %.

The function test for the following items shall be performed:

— grounding system test;

— performance parameter test of the motor control centre;

— remote control test of control equipment (rotary table, drawworks, mud pump and TDS) within the driller's cabin and the PLC switching and interlocking test;

— active power filter (APF) function test, if applicable;

— UPS discharge test;

— emergency shutdown test;

— function test of the emergency generator;

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— integral power loss and restart test.

10.4.3.3 Compressed air system

The function testing for the compressed air system should include:

— measuring the rotation direction, vibration, noise, temperature, current and other technical parameters of air supply equipment;

— testing for no leakage from the air lines for the drilling rig and for powder transfer;

— the functioning of the safety valves of the drilling air storage tanks, the air storage tanks for powder transfer and the bulk material storage tanks;

— the functioning of the safety valve and drain valve of the air supply equipment;

— the functioning of the front end of the air-consuming equipment, the positive pressure explosion-proof air source and any air inlet pressure regulating valve controlled by an air damper;

— the functioning of all air-consuming equipment.

10.4.3.4 Ventilating system

Each piece of ventilating equipment of the system shall be started up and measured for its rotation direction, vibration, noise, temperature, current and other technical parameters. The effectiveness of the positive pressure explosion-proofing shall be tested.

10.4.3.5 Seawater fire protection and fixed fire extinguishing system

The function testing for the seawater fire protection and fixed fire extinguishing system should include:

— a performance test of the seawater fire pump and emergency fire pump, if applicable;

— a water test of the seawater fire protection system (see A.10.4.3.5);

— the functioning of the fire hoses, fire guns and fire monitor (see A.10.4.3.5).

For the fixed fire extinguishing system, the fire pumps driven by two power sources shall be functionally tested for local and remote operation. Logic test and a manual analogue release test shall be conducted. The control function and combined function test of the system shall be checked by using both the main power supply and the standby power supply separately. An analogue function test of the system shall be conducted for audible and visual alarms and automatic fire extinguishing when smoke and fire are detected.

10.4.3.6 Drilling fluid circulation and solid control system

The function testing for the drilling fluid circulation and solid control system should include:

— checking the rotation direction and for vibration;

— measurement of temperature, current and other technical parameters of equipment in system;

— the functioning of the mud pump, charging pump, mixing pump, shear pump (if applicable), mixing hopper, shale shaker, desander, desilter, degasser, agitator and cuttings disposal system;

— seal test of piping as follows:

  — fresh water or water with additive shall be used as the medium;

  — manifold shall be tested part by part;

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- — the initial test shall be conducted at a pressure between 5 % and 10 % of the rated working pressure which shall be held for 3 min to 5 min and then be dropped to zero; the pressure shall then be increased to the rated working pressure for a second time and be held for at least 15 min;
- — there shall be no leakage during the pressure hold time;

— the functioning of the safety valve of the mud pump;

— the functioning of the drilling fluid backflow.

10.4.3.7 Fire and gas detection system

The function testing for the fire and gas detection system shall include:

— the functioning of the fire and gas detection and alarm system in accordance with ISO 13702;

— the functioning of the emergency stops and emergency shutdown system, which shall be verified by random activation/testing;

— verification of the alarms of the fire detection system during the trial by random activation and testing of the system;

— verification of the alarms of the gas detection system by random activation and testing of the system.

Further guidance is shown in A.10.4.3.7.

10.4.3.8 PA and GA system

The function testing for the public announcement and general alarm systems should include:

— audibility of announcements;

— audibility and visibility of alarms.

10.4.3.9 Monitoring and intercom system

The function testing for the monitoring and intercom system should include:

— CCTV cameras through remote control of rotation and zoom;

— video monitor;

— monitor display for switching between cameras;

— recording and replay systems;

— functioning of the talk-back system between the driller and derrick man.

10.4.3.10 Drilling instrument system

The function testing for the drilling instrument system should include:

— drilling fluid volume and its gain/loss;

— indication and alarm of drilling fluid returned flow;

— indication of the pump strokes for the mud pump;

— indication of standpipe pressure;

— indication of travelling system hook load;

— indication of opening/closing of hydraulic choke valve;

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— indication of tongs pulling force;

— indication of well depth;

— indication of rotating speed and torque of top drive/rotary table.

10.4.3.11 Hoisting and rotating system

The function testing for the hoisting and rotating system should include:

— checking of the rotation direction, vibration of equipment in system;

— check and set the main motor's torque value and adjust the over load system;

— measurement of the temperature, current and other technical parameters of equipment in system;

— drawworks, top drive and rotary table for their rotating direction control;

— crown block saver;

— drawworks brake device;

— inertia brake of rotary table;

— interlocking function between the drawworks and BOPs, if available.

10.4.3.12 Pipe handling equipment

The pipe handling equipment, if equipped, shall undergo stringent calibration and testing for initial parameter settings under different operating conditions according to the design and operation requirements to avoid errors in the operating procedure and interference and collision during operation. In particular for integrated pipe handling and operation system, the transition and transfer sections of the continuous working procedure shall be tested.

10.4.3.13 Well control system

The function testing for the well control system should include:

— motor-driven pumps from all control stations and air-operated pump for the accumulator unit;

— remote control of the BOP stack;

— BOP stack and drilling spool hydraulic valve set;

— choke, kill manifolds and control systems;

— diverter control systems shall be functionally tested (if equipped).

The function testing procedures for the well control system shall meet API Std 53.

10.4.3.14 DES skidding system

The rotation direction, vibration, temperature, current and other technical parameters of equipment in the DES skidding system shall be measured. The DES shall be moved to the four extreme wellhead positions in succession. The centres of the crown block, the rotary table and the wellhead shall be checked for alignment and verticality and the offset between the three centrelines shall be less than 20 mm.

10.4.3.15 Oily sewage treatment system (if equipped)

The function testing for the oily sewage treatment system should include:

— checking of the rotation direction, vibration of equipment in system;

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— measurement of the temperature, current and other technical parameters of equipment in system;

— performance testing of the oily sewage treatment system;

— the functioning of the oily sewage treatment equipment for cleanliness of discharge, the discharge oil content shall conform to the requirements of local laws and regulations.

10.4.3.16 Preparation and submission of function testing report

After all systems are functionally tested, a function commissioning report on each system of the MDR shall be prepared and submitted.

10.4.4 System load testing

10.4.4.1 General

The load test part of the commissioning should include the power and electrical systems, drilling fluid circulation and solid control system, hoisting and rotating system and well control system.

10.4.4.2 Power and electrical systems

The load testing procedures for the power and electrical systems should include:

— a system linkage test, at which the drawworks, rotary table, mud pump, shale shaker, agitator and other drilling and auxiliary equipment shall be started and run for at least 8 h. Each parameter of the power and electrical system shall meet the system design requirements.

— a test of power switching and automatic operation in case of emergency.

10.4.4.3 Drilling fluid circulation and solid control system

The load testing procedures for the drilling fluid circulation and solid control system should include:

— a load test of the individual mud pump; a running test shall be performed at 25 %, 50 % and 75 % of the rated working pressure step by step and the running time shall at least 30 min;

— a combined running test of all mud pumps, which shall be conducted at 3,5 MPa working pressure and the corresponding pump strokes to be gradually increased to the rated working pressure and corresponding pump strokes; in addition, the pressure difference between two adjacent grades shall be at a maximum of 7 MPa, the total number of grades shall be at least 3 and the running time at each grade of pressure shall be at least 30 min;

During the above-mentioned test, the pressure and temperatures of relevant components should be recorded.

10.4.4.4 Hoisting and rotating system

The load testing procedures for the hoisting and rotating system should include:

— the testing of the IBOP of the TDS at its rated working pressure, which shall hold for at least 10 min and the sealed part shall be free of leakage;

— the load test of the braking system of the TDS, which shall hold times accordance with the requirement of original equipment manufacturer (OEM);

— running the rotary table under no load condition at the highest speed for 1 h, during which the rotary table should run smoothly and stably without abnormal sound or leakage at the sealing position. In addition, the measured bearing temperature rise should be in accordance with the requirements from vendors.

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10.4.4.5 Well control system

The load testing procedures for the well control system shall meet API Std 53.

10.4.4.6 Preparation and submission of system load test report

After all systems are load tested, a load test commissioning report on each tested system shall be prepared and submitted.

11 Quality control, quality assurance and documents

Quality control, quality assurance and documents shall meet the following requirements in addition to those specified in ISO 19902.

— Construction of the MDR shall follow the national or local construction specification which is a beneficial supplement to the design specification. Construction offset shall be within the range permitted by design.

— Drawings and specifications shall clearly and unanimously describe the purpose of design. All material definitions and any special construction ideas, offset, inspection requirements as well as operation restrictions shall be clearly indicated.

— All engineering information necessary for safe use of the drilling rig shall be easily obtained and understood and handed over to the operation personnel. This information should include drilling rig layout drawing, escape route, maintenance requirements and maximum operation weight. The areas to be inspected on a regular basis for continuous safe operation shall be identified.

A list of typical quality assurance and quality control documents is shown in Table 5.

Table 5 — List of typical quality assurance and quality control documents

No.	Document name
1	Inspection and test plan
2	Control procedure for construction process of quality
3	Inspection and test control procedure
4	Dimension inspection control procedure
5	Welding inspection procedure
6	Control procedure for welding materials
7	Control procedure for identification and tracking of materials
8	Control procedure for calibration and testing tools
9	NDT procedure
10	Welding personnel qualification
11	Non-destructive inspection personnel qualification
12	Inspection of equipment certification
13	Welding equipment qualification

A typical acceptance report for an MDR is shown in Annex E.

A typical completion acceptance document and record for an MDR is shown in Annex F.

12 In-service inspection and integrity management

In-service inspection and integrity of an MDR shall conform to the requirements of ISO 19901-3. A typical in-service inspection plan is shown in Annex G.

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13 Reuse

MDR structure and equipment can be reused. The reuse of these structures shall conform to the relevant requirements of ISO 19902 and the reuse of equipment or facilities shall be evaluated as required from a comparison of the specifications of the equipment to the new-build requirements.

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Annex A
(informative)

Additional information and guidance

NOTE This annex provides additional information and guidance on the clauses in this document. The same numbering system and heading titles have been used for ease in identifying the subclauses in the body of this document to which it relates.

A.1 Scope

No guidance is offered.

A.2 Normative references

No guidance is offered.

A.3 Terms and definitions

No guidance is offered.

A.4 Abbreviated terms

No guidance is offered.

A.5 Overall considerations

A.5.1 General

No guidance is offered.

A.5.2 Functional equipment

No guidance is offered.

A.5.3 Layout

A.5.3.1 General

The MDR is divided into DES, DSM, P-tank, cementing module, logging module and mud logging module in general, as shown in Figures A.1, A.2 and A.3.

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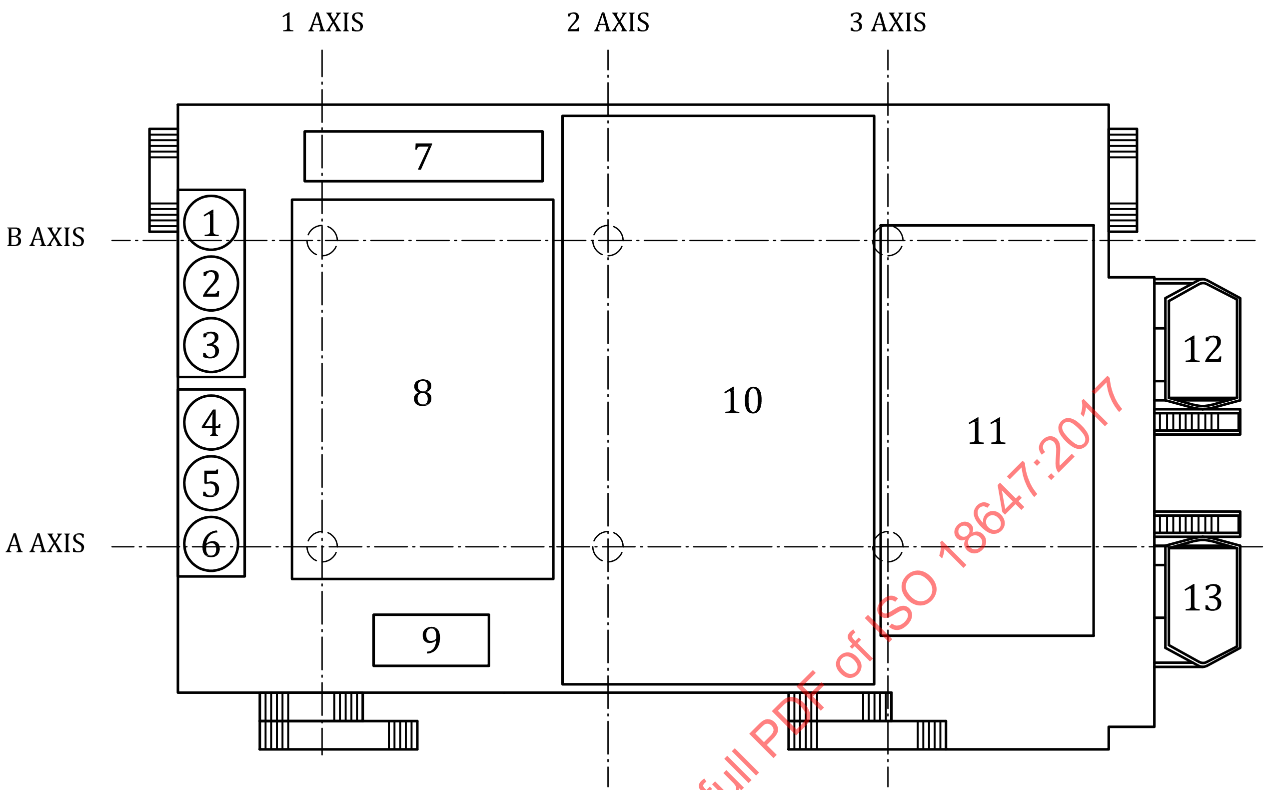

Key

1-6	P-tank
7	cement unit
8	DES
9	mud logging unit
10	DSM
11	living quarter
12-13	lifeboat

Figure A.1 — Typical MDR layout

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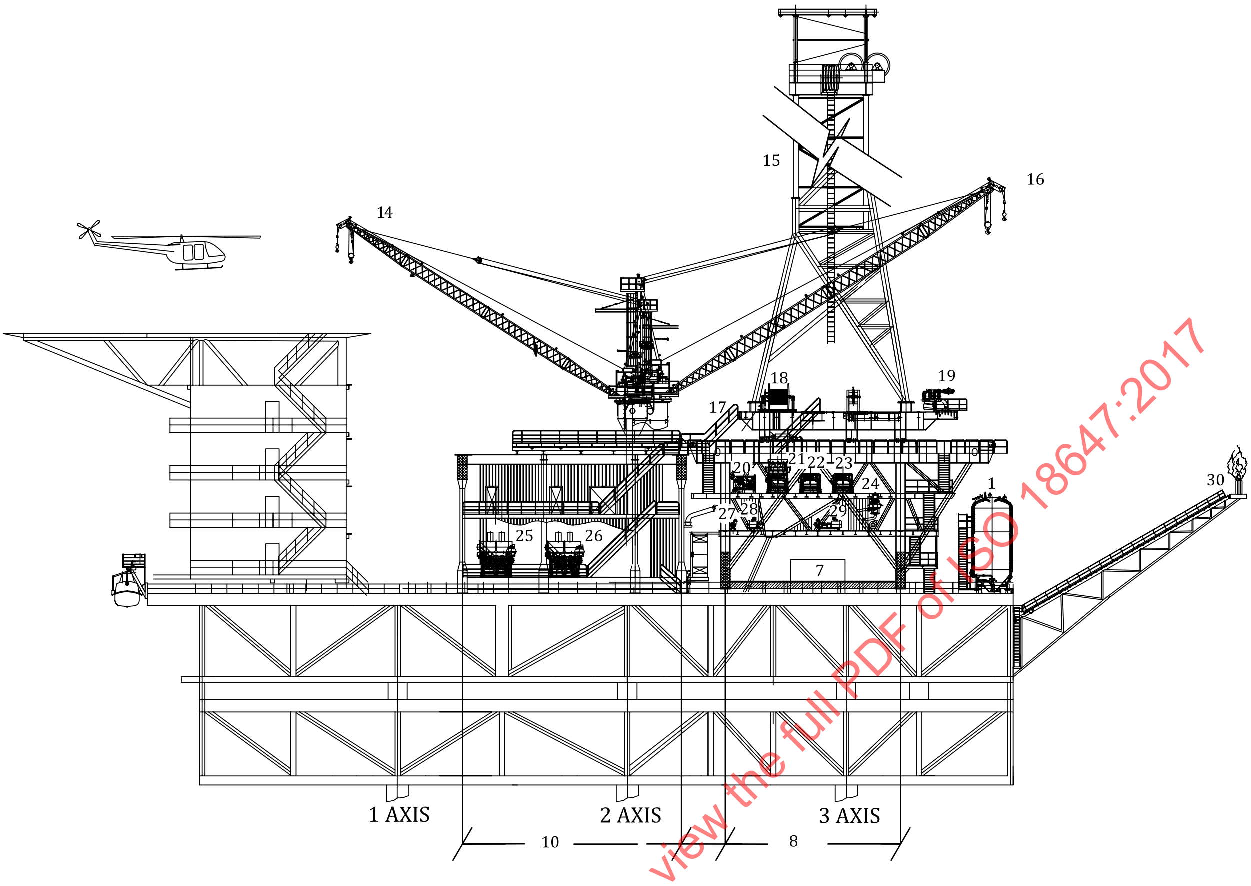

Key

1	P-tank	19	choke/kill manifold
7	cement unit	20	centrifugal pump
8	DES	21-23	shale shaker
10	DSM	24	degasser
14	crane	25-26	drilling pump
15	derrick/mast	27	trip pump
16	crane	28	desilter pumps
17	catwalk	29	desander pump
18	drawworks	30	flare arm

NOTE For other keys, see Figure A.1.

Figure A.2 — Typical MDR elevation looking south

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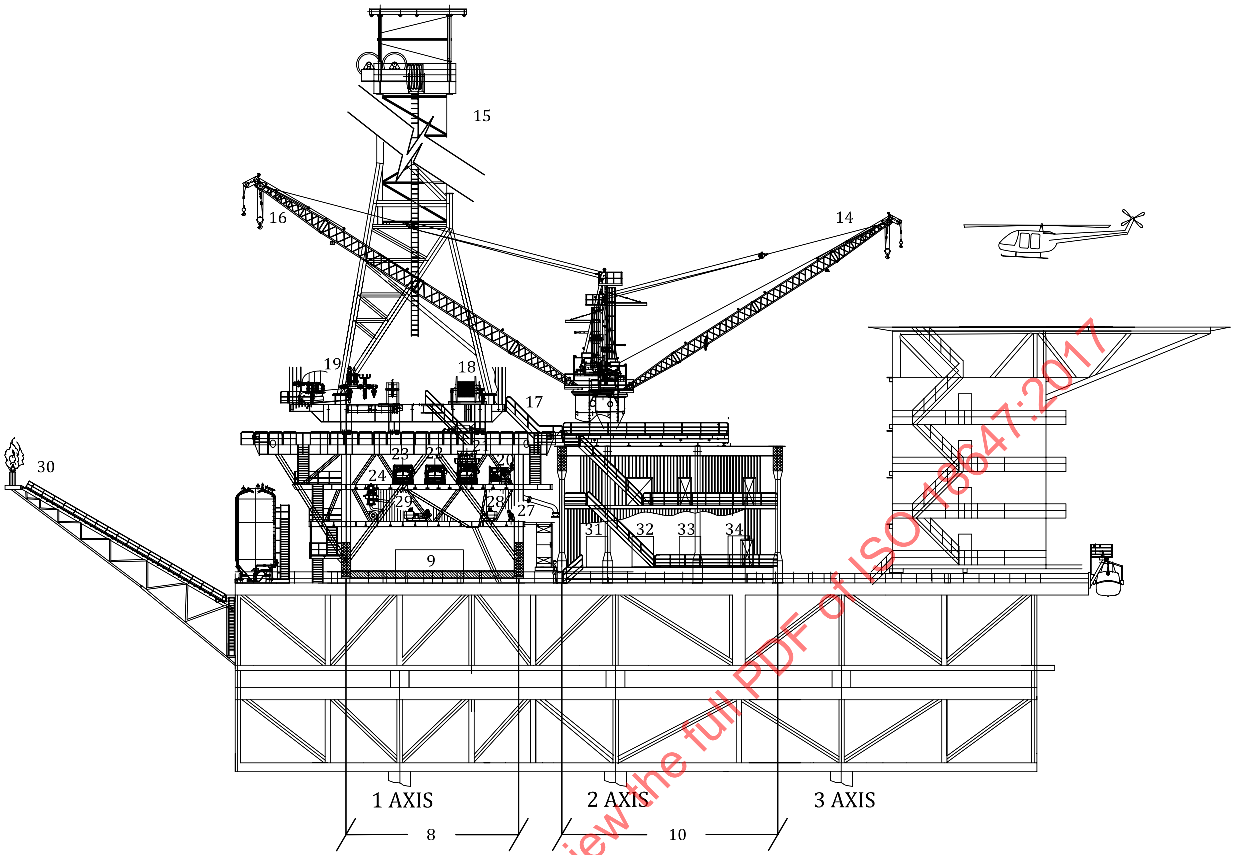

Key

6 P-tank
8 DES
9 mudlogging unit
10 DSM
14 crane
15 derrick/mast
16 crane
17 catwalk
18 drawworks
19 choke/kill manifold
20 centrifugal pump
21-23 shale shaker
24 degasser
25-26 drilling pump
27 trip pump
28 desilter pumps
29 desander pump
30 flare arm
31-34 generator

NOTE For other keys, see Figure A.1.

Figure A.3 — Typical MDR elevation looking north

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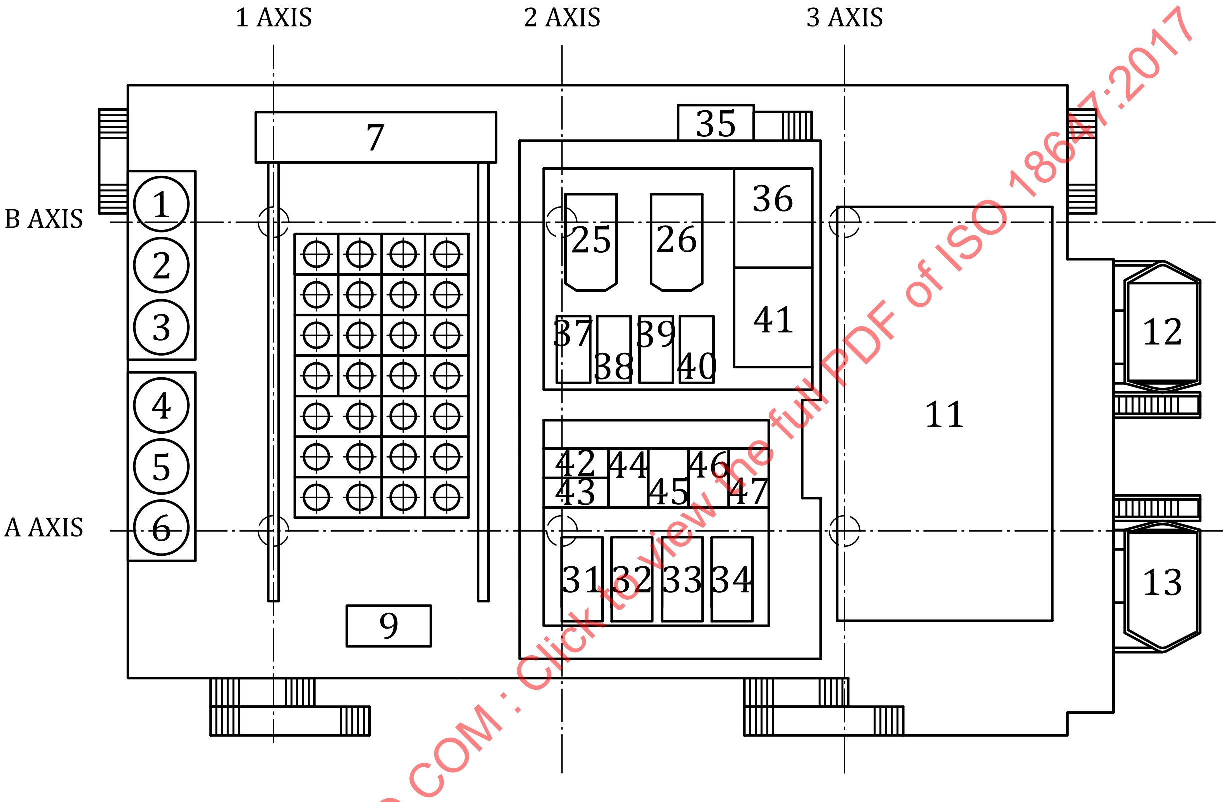
A.5.3.2 Drilling equipment set

A lower substructure generally has upper, middle and lower decks, and the lower deck arranged with substructure skidding equipment, etc., as shown in Figure A.4.

The middle and upper decks can be set with drilling fluid solids control equipment and drill floor skidding system respectively, as shown in Figure A.5 and Figure A.6. The upper substructure can be arranged with the derrick/mast, drill floor equipment and BOP handling system, etc., as shown in Figure A.7.

The layout of HPU of the skidding system should be easy to take operation and maintenance; the operator at control panel should have good view. The layout of the air receiver and air treatment devices should be easily accessible for liquid filling, water discharge, pressure observation and maintenance. The layout of all hydraulic and pneumatic components should meet the safety requirements and convenient operation as well as easy connection and replacement of piping joints.

The shale shaker should be arranged at the outlet of drilling fluid return line and the related equipment including degasser, desander, desilter and centrifuge, etc. should be arranged on the middle deck of DES, as shown in Figure A.4. When the drilling fluid flow line is downward sloping, the included angle between the centreline of the pipe and the horizontal plane should be at least 5°. The mud/gas separator should be arranged at the edge of the drill floor near one side of the choke manifold.



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Key

1-6	P-tank	37	mixing pump
7	cement unit	38	charge pump
9	mudlogging unit	39	mixing pump
11	living quarter	40	charge pump
12-13	life boat	41	storing area
25-26	drilling pump	42	chemical tank
31-34	generator	43	mixing tank
35	laydown area	44-47	mud tank
36	mechanical room		

NOTE For other keys, see Figure A.1 and Figure A.2.

Figure A.4 — Typical layout of lower deck of MDR modules

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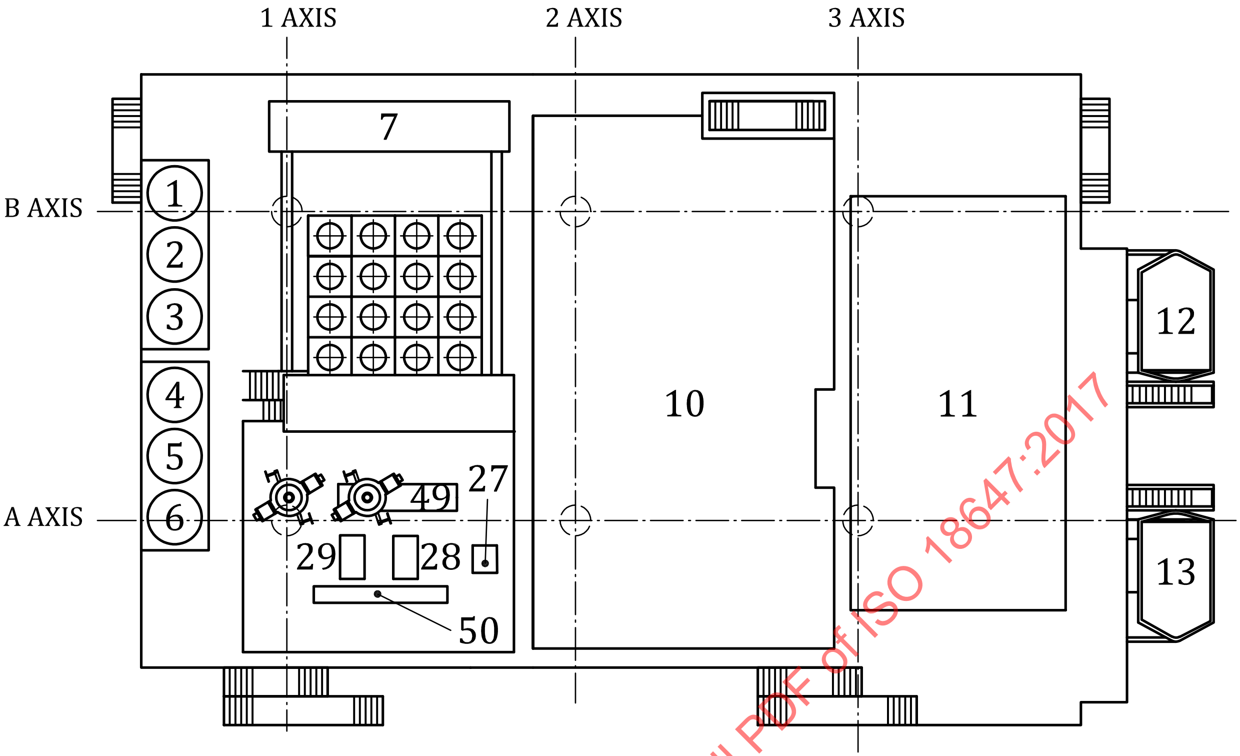

Key

1-6	P-tank	28	desilter pumps
7	cement unit	29	desander pump
10	DSM	49	open slot
11	living quarter	50	cutting chute
12-13	life boat		
27	trip pump		

NOTE For other keys, see Figures A.1, A.2, A.3 and A.4.

Figure A.5 — Typical layout of lower-middle deck of DES modules

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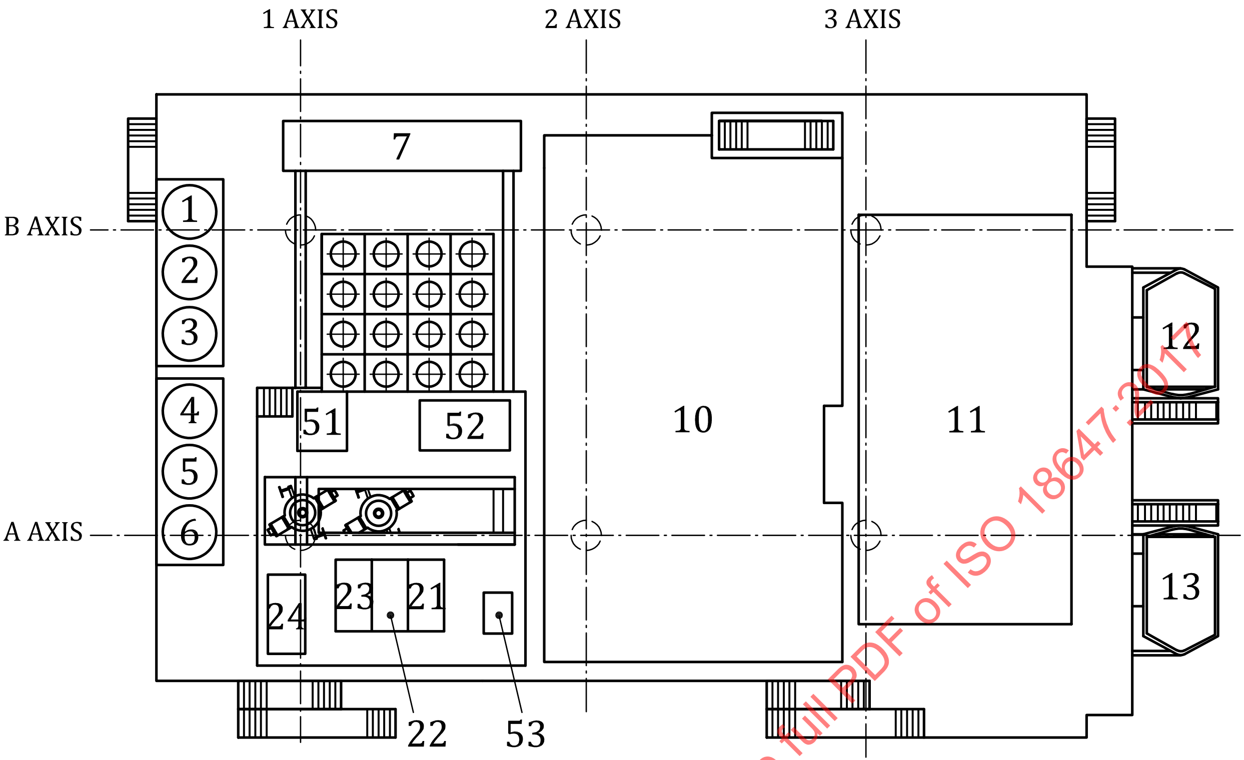

Key

1-6	P-tank	21-23	shale shaker
7	cement unit	24	degasser
10	DSM	51	mud lab
11	living quarter	52	drawworks cooling
12-13	life boat	53	trip tank

NOTE For other keys, see Figures A.1, A.2, A.3, A.4 and A.5.

Figure A.6 — Typical layout of upper-middle deck of DES modules

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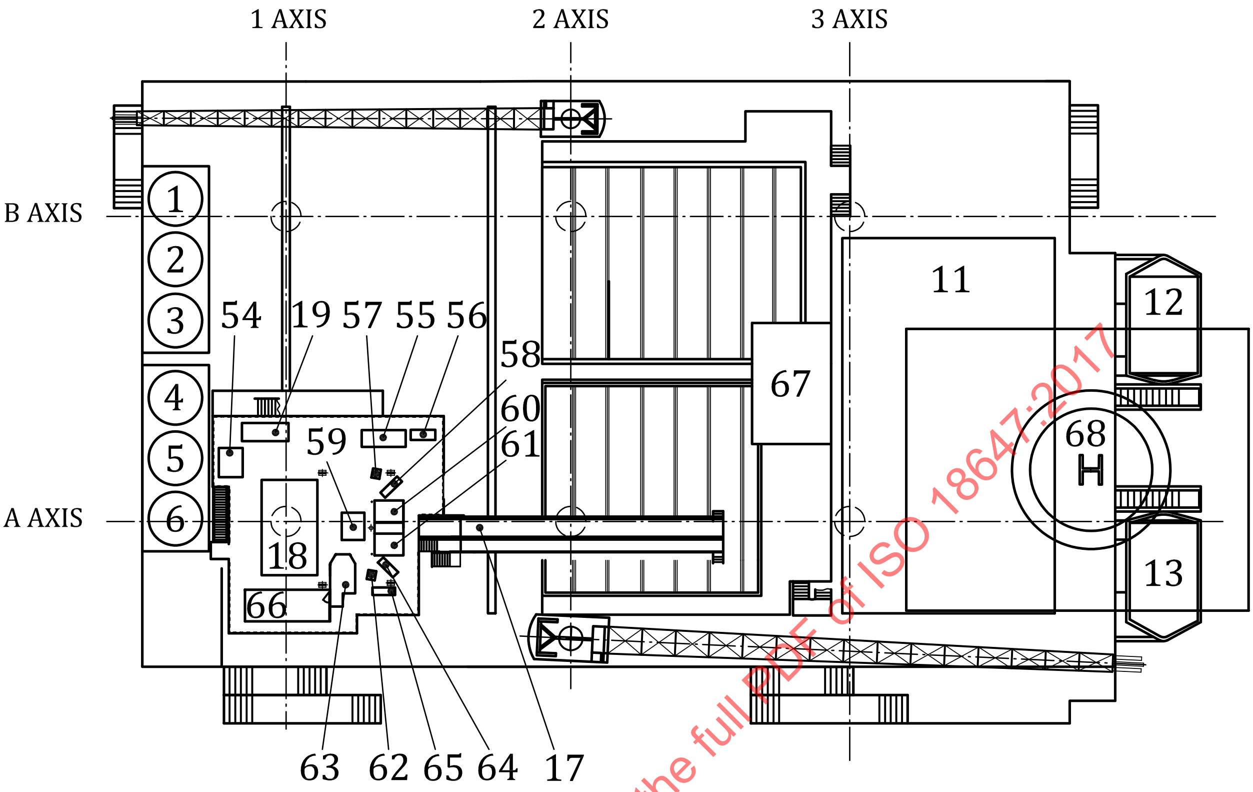

Key

1-6	P-tank	19	choke/kill manifold	60-61	setback
7	cement unit	54	mud/gas separator	62	tong
10	DSM	55	choke/kill manifold	63	dog house
11	living quarter	56	cementing standpipe	64-65	winch
12-13	life boat	57	tong	66	DES switch
17	catwalk	58	winch	67	logging unit
18	drawworks	59	rotary table	68	helicopter area

NOTE For other keys, see Figures A.1, A.2, A.3, A.4, A.5 and A.6.

Figure A.7 — Typical layout of upper deck of MDR modules

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A.5.3.3 Drilling support module

Drilling support equipment can be arranged in front of the V-door of derrick/mast and should be arranged symmetrically with the centreline of the well slot area along the V-door direction of the derrick/mast with three levels, i.e. upper, middle and lower level. The generator set, fuel tank, mud pump and mud tank can be arranged on the lower level, as shown in Figure A.4. The power transformer and distribution cabinet, generator set control cabinet and air compressor can be arranged on the middle level, as shown in Figure A.8. The pipe rack area should be arranged on the upper level, with the width of at least 15 m, as shown in Figure A.7. It should be equipped with a pipe ramp and cranes to handle drill string, casing and tools.

The mud pump should be arranged near the mud tank. The installation of mud pumps should meet the requirements of normal operation, maintenance and escape and trolley beams (with lifting eyes) and hoisting tools of appropriate tonnage for maintenance should be provided. The trolley beam should be tested and stencilled with SWL rating. Repair and maintenance space should be provided for the mud pump, drilling fluid manifold and motor, charging pump and other auxiliary equipment; with isolation valves installed between the mud tanks. The mixing hopper should be arranged to be easily accessible

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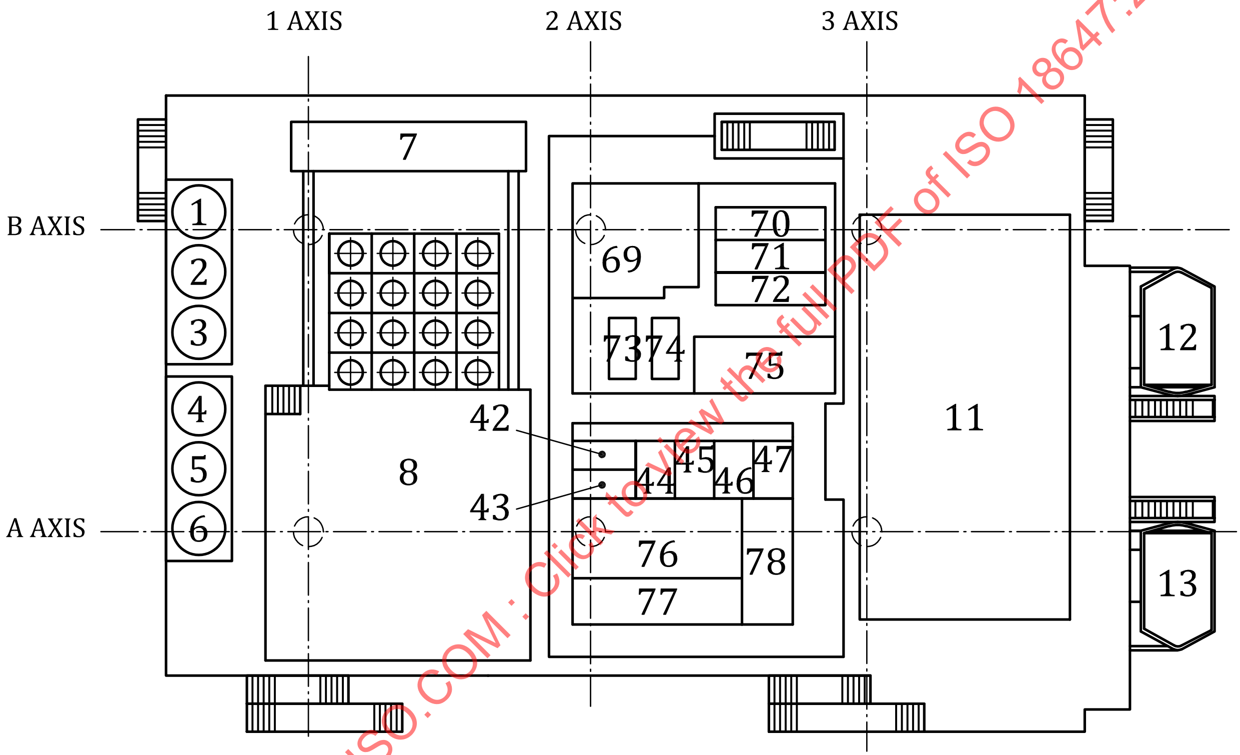
for adding materials and for operation and should be able to supply materials to each mud tank. Lines and valves should be labelled and colour coded to enable rapid line up of systems. The metering tank should be arranged on the middle level of DES lower substructure and the metering pump should be arranged near the metering tank.

If provided as part of the drilling support equipment, the power generator set can be arranged on the lower level of the power module. The layout of the generator set should provide space for equipment installation, maintenance and ventilation; trolley beams (with lifting eyes) and hoisting tools of appropriate capacity for maintenance should be provided. The trolley beam should be tested and stencilled with SWL rating. The layout of the generator set should meet the explosion-proof and anti-shock requirements of the generator set and the location and direction of its exhaust should take account of safe operation and prevailing wind directions. The power distribution and electrical control system can be arranged on the middle level of the power module and should be convenient for laying and connection of power cables and control cables.



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Key

1-6	P-tank	43	mixing tank	74	mixing pump
7	cement unit	44-47	mud tank	75	mud equipment control
8	DES	69	sack area	76	main switch room
11	living quarter	70-72	air compressor	77	emergency switch room
12-13	life boat	73	shear pump	78	HVAC control room
42	chemical tank				

NOTE For other keys, see Figures A.1, A.2, A.3, A.4, A.5, A.6 and A.7.

Figure A.8 — Typical layout of middle deck of DSM modules

A.5.3.4 Drilling utilities

The P-tank module, cement module and mud logging module can be arranged on the main deck of the platform, as shown in Figure A.1. The well logging module can be arranged on the top of the DSM, as shown in Figure A.7.

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A minimum of three P-tanks should be provided and they should be arranged near the DSM. P-tanks should be skid-mounted. Each P-tank should be vertically orientated with elliptical top and conical bottom. Each P-tank should be equipped with a weighing system and provision of level measuring systems should be considered. Appropriate safety valves and manholes should be installed on each P-tank. The type and volume of the stored materials in each P-tank should be determined according to anticipated drilling procedures and supply period. Sufficient pipework should be provided between P-tanks to permit materials transfers between them.

The cement module should be arranged near the P-tank and the well slot area. If cement unit is to be diesel powered consideration should also be given to location of exhaust-wind direction. Fuel, electricity, gas, seawater, drilling water, drilling fluid and cement pipeline interfaces with the platform should be provided near the cement module.

The mud logging module with consideration to hazardous areas/zones should be arranged on the main deck near one side of the shale shaker.

The well logging module, though preferably should have its own dedicated permanent platform, should be arranged in the pipe rack area where the logging operations can be completed easily.

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A.5.4 Health and safety considerations

A.5.4.1 General

No guidance is offered.

A.5.4.2 Escape and alarms

No guidance is offered.

A.5.4.3 Hazardous areas and storage of hazardous goods

No guidance is offered.

A.5.4.4 Fire and explosion protection

Each fire hose station should be equipped with a 38 mm or 50 mm fire hose with sufficient length to cover the hazardous area. Each fire hose should be provided with a water-spraying and mist-spraying fire gun. The water volume of the fire water system should at least conform to the consumption of two fire monitors and two fire guns. Fire gun nozzles are to be adjustable from straight stream to full fog and to have a nozzle diameter of at least 12 mm.

The standard calibre of fire gun is 13 mm, 16 mm or 19 mm. It is better to select a 19 mm fire gun to protect the wellhead.

A.5.4.5 Safety equipment

No guidance is offered.

A.5.5 Operational considerations

No guidance is offered.

A.5.6 Corrosion control

No guidance is offered.

A.5.7 Structural considerations

No guidance is offered.

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A.5.8 Removal and abandonment

No guidance is offered.

A.6 Design

A.6.1 General

No guidance is offered.

A.6.2 Rig rating

No guidance is offered.

A.6.3 Drilling equipment set

A.6.3.1 General

No guidance is offered.

A.6.3.2 Derrick/Mast

No guidance is offered.

A.6.3.3 Maximum hook load

Formula (A.1) should be used to calculate the maximum pipe string weight during drilling and completion operations.

$$F_{string} = \left(L_1\ G_{air} + L_2\ G_{air}\ f\right) \cdot \left(1 - \frac{2\gamma_{fluid}}{3\gamma_{pipe}}\right) \quad \text{(A.1)}$$

where

F_{string} is the maximum drill string weight or the maximum casing string weight, whichever is the greater, in kN;

L_1 is the total vertical projected length of the pipe string in a well, in m;

L_2 is the total horizontal projected length of the pipe string in a well, in m;

G_{air} is the weight of pipe string per unit length in air, in kN/m;

f is a friction factor: 0,25 in to 0,30 in casing and 0,3 in open hole;

γ_{fluid} is the density of drilling fluid, in g/cm^3;

γ_{pipe} is the density of drilling pipe material, in g/cm^3.

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The maximum hook load of the drilling rig should be no less than the following:

$$Q_{h1} \geq 1{,}2F_{string} + 500 \quad (A.2)$$

where

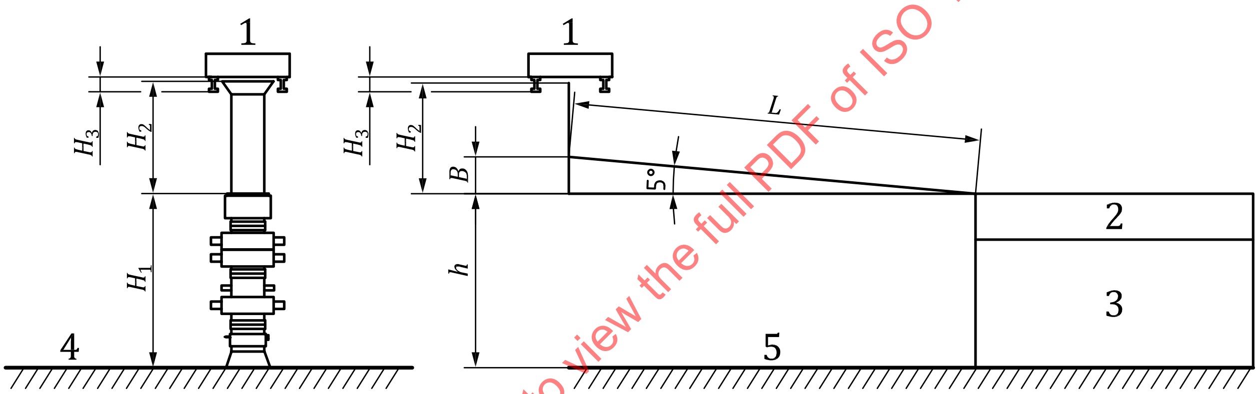
Q_{h1} is the hook load as the basis for selection of the MDR, in kN;

1,2 is the recommended safety factor that can be increased to account for accelerations, decelerations and impact loads;

500 is an empirical value for releasing stuck, in kN.

A.6.3.4 Drill floor clearance

The drill floor clearance should be larger than either of the values calculated from Formula (A.3) and Formula (A.4), based on the heights and distances given in Figure A.9.



Key

1 drill floor

2 shale shaker

3 drilling fluid pit

4 BOP deck

5 drilling fluid pit deck

Figure A.9 — Diagram for drill floor clearance calculation

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To meet the installation requirements for the wellhead equipment and the BOP stack, see Formula (A.3):

$$H \geq H_1 + H_2 \quad (A.3)$$

where

H is the drill floor clearance;

H_1 is the total height of the wellhead equipment and BOP stack;

H_2 is the total height of bell nipple (or diverter).

Equipment related to managed pressure drilling (MPD) should be considered if applicable.

In calculating H_2, the minimum distance between the bell nipple top and the centreline of the drilling fluid return line should be taken as 0,8 m.

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To meet the normal operating requirements of the solids control system, see Formula (A.4):

$$H \geq h + B + 0{,}5H_2 \quad (A.4)$$

where

h is the height from the drilling fluid inlet of the shale shaker to the upper deck;

B is the height as required by the slope of the drilling fluid return line and calculated as Formula (A.5):

$$B = L\tan(\alpha) \quad (A.5)$$

where

L is the length of the drilling fluid return line;

α is the slope of the drilling fluid return line relative to the horizontal.

The length of the drilling fluid return line, L, should normally be assumed to be between 5 m and 8 m.

A.6.3.5 Top drive system

Maximum TDS torque and power is related to the drilling rig rating as shown in Table A.1.

Table A.1 — Maximum TDS torque and power

Drilling rig rating	Maximum continuous output torque kN m	Maximum intermittent output torque kN m	Maximum continuous output power kW
40/2 250 and below	≥19	≥24	≥350
50/3 150	≥29	≥32	≥500
70/4 500	≥40	≥45	≥580
90/6 750	≥57	≥65	≥800
120/9 000	≥81	≥114	≥800

A.6.3.6 Well control equipment

No guidance is offered.

A.6.3.7 BOP handling system

No guidance is offered.

A.6.3.8 Circulation and solids control system

No guidance is offered.

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A.6.4 Drilling support equipment

A.6.4.1 Power of the mud pump set

The total power required by a mud pump set for each well section (DG alternative) can be calculated from Formula (A.6):

$$P_{nj} = \frac{Q\ P}{1{,}02\,\eta_y\ \eta_j\ j} \tag{A.6}$$

where

P_{nj} is the total mud pump set power requirement, in kW;

Q is the flow rate in each well section, in L/s;

P is the pump pressure corresponding to the flow rate in each well section, in MPa;

η_y is the volume efficiency of the mud pumps, which is usually taken as 0,95;

η_j is the mechanical efficiency of the mud pumps, which is usually taken as 0,90;

j is an empirical coefficient, which is usually taken as 0,80.

A.6.4.2 Mud tank volume

The mud tank volume should be taken as the larger of the values calculated from Formulae (A.7) and (A.8):

$$Q_{ych} = \lambda Q_{k,max} + Q_{ch} + Q_b + Q_{zh} \tag{A.7}$$

$$Q_{ych} = Q_{k,max} + Q_{ch} + Q_b + Q_{zh} + 20\ m^3 \tag{A.8}$$

where

Q_{ych} is the total mud tank volume;

λ is a coefficient, which should be between 1,2 and 1,5 depending upon the characteristics of the oil/gas well;

$Q_{k,max}$ is the maximum volume of the hole;

Q_{ch} is the volume of the sand trap;

Q_b is the volume of the reserve tank;

Q_{zh} is the slurry tank volume.

The volume of the reserve tank should be at least 40 m^3, that of the sand trap at least 40 m^3 and that of the slurry tank at least 10 m^3.

A.6.4.3 Generator set

The total power requirement for the generator can be calculated from Formula (A.9):

$$P = \alpha P_{nj} + \beta P_{dq} + \gamma P_{jch} + \theta P_{fzh} \tag{A.9}$$

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where

P is the total power requirement for the generator set of the drilling rig, in kW;

P_{nj} is the total mud pump set power requirement, in kW;

P_{dq} is the power rating of the TDS, in kW;

P_{jch} is the power rating of the drawworks, in kW;

P_{fzh} is the sum of the power ratings of all electrical equipment (auxiliary equipment) of the drilling rig excluding the mud pumps, TDS and drawworks, in kW;

α is a load factor for the mud pump power demand dependent upon the drilling conditions (see Table A.2);

β is a load factor for the TDS power demand dependent upon the drilling conditions (see Table A.2);

γ is a load factor for the drawworks power demand dependent upon the drilling conditions (see Table A.2);

θ is a load factor for the power demand of other auxiliary electrical equipment dependent upon the drilling conditions (see Table A.2).

Table A.2 — Load factors for drilling rig equipment under various drilling conditions

Drilling condition	Load factor			
	α	β	γ	θ
Normal drilling	0,5–0,6	0,5	0,2	0,5–0,7
High-pressure, high-flow rate drilling	0,6–0,8	0,4	0,2	0,6–0,75
Back reaming	0,4–0,6	0,5	0,2–0,3	0,5–0,6

A.6.4.4 Electrical equipment and cabling

No guidance is offered.

A.6.4.5 Emergency power supply

No guidance is offered.

A.6.4.6 UPS

The emergency power supply should be able to supply power for at least 18 h simultaneously. The UPS power supply should be sufficient to satisfy the duration demands of the following systems:

— communication system: 0,5 h;

— fire and gas detection system: 0,5 h;

— distribution board dropout control: 0,5 h;

— control system: 0,5 h.

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A.6.4.7 Fuel tank

The volume of the main fuel tank, V, shall be determined according to the supply vessel supply frequency and travel time, calculated as the larger value from Formula (A.10) or Formula (A.11):

$$V \geq 1,2 \cdot T_1 \cdot V_{rj} \quad \text{(A.10)}$$

$$V \geq T_2 \cdot V_{jj} \quad \text{(A.11)}$$

where

V_{rj} is the average daily diesel consumption during the drilling and completion operations of the drilling rig;

V_{jj} is the maximum diesel consumption under emergency conditions;

T_1 is the longest routine supply period of the supply vessel;

T_2 is the longest time needed for a supply vessel to arrive at the platform in an emergency.

The day tanks should have a volume sufficient for 24 h continuous running of the diesel engine unit. If the rig power supply is from the platform generators, the total capacity of the main fuel tank(s) can be considered together.

A.6.4.8 P-tanks and pipework

No guidance is offered.

A.6.4.9 Auxiliary systems

Clean agent fire extinguishing system should conform to the requirements of NFPA.

A.6.4.10 Other requirements

No guidance is offered.

A.7 Structural design

A.7.1 General

No guidance is offered.

A.7.2 Structural simulation

No guidance is offered.

A.7.3 Design checks

No guidance is offered.

A.7.4 Material selection

No guidance is offered.

A.7.5 Skid rail strength analysis

No guidance is offered.

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A.8 Construction and assembly

A.8.1 General

No guidance is offered.

A.8.2 Planning

It is advisable to provide a structure prefabrication area, material stack area, general assembly slideway, coating workshop and piping shop. The foundation bearing capacity and the setting of embedded parts should meet the construction requirements. The bearing capacity of the general assembly slideway should be greater than the maximum supporting counterforce of any pivot of modules and the spacing between slideways should meet the requirements of placing structural columns. The bearing capacity of the front of the dock should meet the requirements of module loadout (lifting loadout or skidding loadout). The construction site should be provided with public utilities and safety environmental protection facilities.

A.8.3 Equipment and materials handling

A.8.3.1 Arrival inspection of materials and equipment

No guidance is offered.

A.8.3.2 Storage and tracking of materials and equipment

No guidance is offered.

A.8.4 Structural steelwork fabrication

A.8.4.1 Cylindrical tubular members

No guidance is offered.

A.8.4.2 Non-cylindrical sections

The following provisions are relevant for welded I-steel.

a) The dimensions, appearance and permissible deviation of welded H-steel should conform to the provisions of Table A.3.

b) The permissible deviation for weld shape should conform to the provisions of Table A.4.

c) The permissible deviation for weld reinforcement and misalignment should conform to the provisions of Table A.5.

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Table A.3 — Dimensions, appearance and permissible deviation of welded I-steel

All dimensions in mm

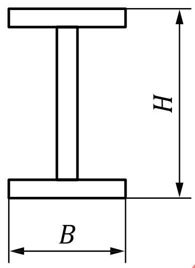
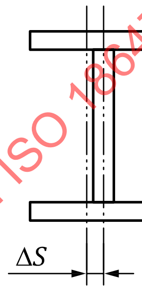
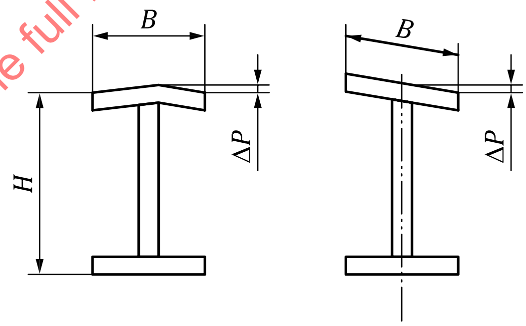
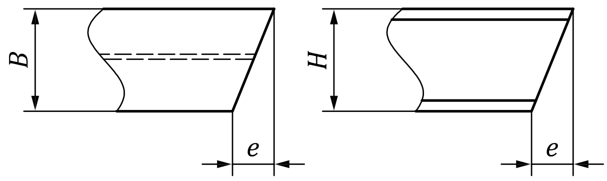
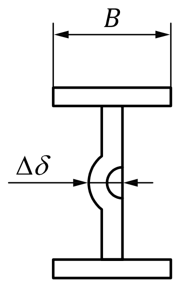
Item		Permissible deviation	
Length, L	$L \leq 6\ 000$	+3	
	$L > 6\ 000$	+5	
Width, B	$B \leq 200$	±2	
	$B > 200$	±3	
Height, H	$H < 500$	±2	
	$500 \leq H \leq 1\ 000$	±3	
	$H > 1\ 000$	±4	
Web plate eccentricity ΔS	$B \leq 200$	$\pm B/100$	
	$B > 200$	±2	
Chord plate inclination ΔP	$B \leq 200$	$\pm B/100$	
	$B > 200$	±2	
Deviation of curvature		$\leq L/1\ 000$ and $\leq 5{,}0$	
Deviation of distortion		$\leq H/250$ and $\leq 5{,}0$	
Permissible deviation for end bevel, e		≤1,6 % H or ≤1,6 % B; and ≤3,0	
Levelness of chord plate and web plate, $\Delta\delta$		≤2,0	

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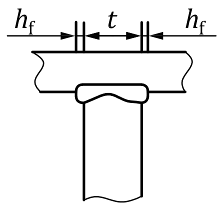
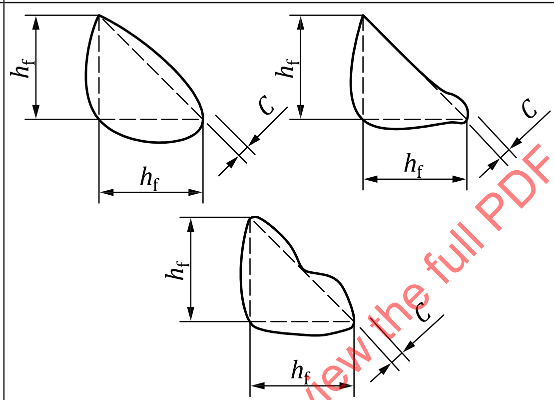
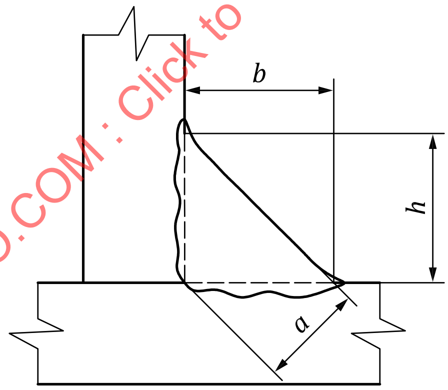
Table A.4 — Permissible deviation for weld shape

All dimensions in mm

No	Item	Schematic	Permissible deviation
1	General complete-penetration corner and butt joint composite welds		$h_f \geq \left(\frac{t}{4}\right)_{0}^{+4}$ and ≤10
2	Complete-penetration corner and butt joint composite welds subject to fatigue analysis		$h_f \geq \left(\frac{t}{2}\right)_{0}^{+4}$ and ≤10
3	Fillet welds and partial-penetration corner and butt joint composite welds		When $h_f \leq 6$, 0~1,5; When $h_f \leq 6$,0~3,0
4	Fillet welds insufficient		When $a \leq 6$, $b–h \leq 3$ mm; When $6 < a \leq 13$, $b–h \leq 5$ mm; When $13 < a$, $b–h \leq 8$ mm

NOTE 1 For fillet welds with $h_f > 8,0$ mm, the local leg size is permitted to be 1,0 mm lower than the required design value, but the total length should not exceed 10 % of the weld length.

NOTE 2 The two weld ends of the welded H-beam web plate and chord plate should be located within a range that is two times of the chord plate's width, and the weld leg size should not be lower than the required design value.

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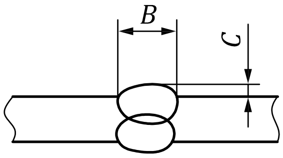
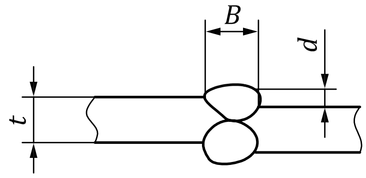
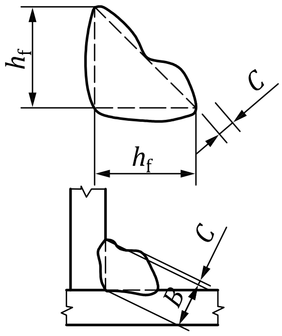
Table A.5 — Permissible for weld reinforcement and misalignment

All dimensions in mm

No	Item	Schematic	Permissible deviation
1	Butt weld reinforcement (C)		Groove welds should be made with minimum face reinforcement unless otherwise specified. In the case of butt and corner joints, face reinforcement should not exceed 3 mm in height.
2	Butt weld misalignment (d)		For primary structural member and special member, d < 0,1t and d ≤ 2,0. For second member, d < 0,15t and d ≤ 3,0.
3	Fillet weld reinforcement (C)		When h_f ≤ 6,0~1,5. When h_f ≤ 6,0~3,0.

A.8.4.3 Skid rail fabrication

No guidance is offered.

A.8.4.4 Tolerance for skid rail installation

No guidance is offered.

A.8.5 Welding and inspection

A.8.5.1 Basic requirements

No guidance is offered.

A.8.5.2 Visual inspection

No guidance is offered.

A.8.5.3 Non-destructive inspection

No guidance is offered.

A.8.5.4 Additional inspection requirement

No guidance is offered.

A.8.6 Prefabrication and installation of the piping

No guidance is offered.

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A.8.7 Outfitting

A.8.7.1 Heat insulating materials

No guidance is offered.

A.8.7.2 Penetrations

No guidance is offered.

A.8.7.3 Fire doors

No guidance is offered.

A.8.7.4 Installation of ladders and guardrails

No guidance is offered.

A.8.8 Corrosion control

No guidance is offered.

A.8.9 Installation of equipment

A.8.9.1 General

No guidance is offered.

A.8.9.2 Hoisting equipment

A.8.9.2.1 Crown block

Before installing the crown block, its components should be checked to ensure that they are free from any apparent distortion. The crown block should be fastened to the upper portion of the derrick and the guide pins inserted. All crown block accessories such as the hoisting frame and the auxiliary pulley should be installed. The clearance between the rope plate and the main pulley outer edge should be checked to make sure that it is between 7 mm and 10 mm.

A.8.9.2.2 Travelling block and hook

All bolts and pins to the travelling block should be checked to ensure that they are in place and fastened, while the protective hood should be inspected for damage.

The hook and lock pins of the hook mouth should be able to move freely and the hook safety lock pins should be checked to ensure that they are complete and correctly and securely fitted.

A.8.9.2.3 Drawworks

A.8.9.2.3.1 Installation requirements

The drawworks should be firmly connected to its beam. The drawworks and its transmission system should be inspected that they are complete, intact, and securely fixed.

A.8.9.2.3.2 Adjustment of drawworks brake device (if applicable)

Adjustment of brakes on drawworks should following equipment manufacturer’s instructions.

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A.8.9.2.3.3 Drawworks drilling line guider

The pulley on the drawworks drilling line guider should be checked to ensure that it rotates freely while also moving freely from left to right, and vice versa.

A.8.9.2.3.4 Auxiliary brake

The following should be considered as part of the installation of the auxiliary brake:

a) after connection, the cleaning and purging of the piping should meet the requirements of the design document and those of 8.6;

b) after the electro-magnetic brake or water brake is leveled, it should be checked to ensure that it is coaxial with respect to the drum shaft to within 0,4 mm, and that the brake clutch engages and disengages freely;

c) the pneumatic disc brake should be leveled and aligned to ensure that it is coaxial with respect to the installation shaft to within 0,5 mm, and the brake operates in a responsive and reliable manner.

A.8.9.2.3.5 Crown block saver

There are three types of crown block saver, toggle valve, heavy hammer or mechanical, and digital. The installation of each should proceed as follows:

a) Toggle valve:

- — the length and position of the toggle valve's shifting lever should be adjusted according to the position of the wire rope on the drum when the travelling block moves up to the height limit required for operation (as per the operation instructions or field equipment requirements);
- — the gas path should be free from any leakage, and in case of collision, the arm should be able to react promptly;
- — the brake should be checked to ensure that it operates in a responsive and reliable manner;
- — the working clipper should be activated to check that they brake properly and that the indicator operates correctly;
- — the master clutch and the high- and low-speed clutches should be examined to see that they bleed simultaneously, and that the brake cylinder or hydraulic disc brake operates immediately to stop the drum.

b) Heavy hammer or mechanical:

- — the distance between the blocking rope and the lower plane of the crown block beam should be checked to ensure that it complies with the operating instructions or field equipment requirements;
- — the leading rope should be inspected to ensure that it is of 6,4 mm diameter wire rope, set at its correct tension, and that it cannot twist, tie or interfere with the derrick and other cables so that it provides responsive and prompt braking.

c) Digital:

- — the data acquisition sensor should be checked to confirm it is firmly connected and that it correctly indicates the working conditions;
- — the saver should be checked to ensure that it reacts promptly and operates correctly.

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A.8.9.2.4 Reeving the wire rope

The following should be considered as part of the wire rope reeving.

a) Before reeving, the various bearings of the travelling block and crown block should be inspection to check they are sufficiently charged with grease, and that the crown block pulley, travelling block pulley, hoisting rope guide pulley on the derrick, A-frame pulley, hoisting rope guide pulley on the substructure, and hoisting triangular frame pulley, rotate freely without obstruction.

b) Before reeving, the wire rope should be firmly connected to the reeving machine.

c) While the rope is being reeved, the wire rope should be attached to a winding machine or dedicated frame that rotates.

d) When manually pulling a coir rope onto the derrick, personnel at the higher and lower levels should cooperate closely to prevent any accident due to the friction between the coir rope and the derrick

e) The live end of the drilling wire rope should be reeved into the drawworks drum and fixed with rope clamps. The bolts and rope clamps should be inspected to confirm that they are securely in place and hold the rope firmly.

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A.8.9.3 Rotating equipment

A.8.9.3.1 Rotary table

The rotary table should be installed and fixed as per the requirements of the operation.

A.8.9.3.2 Swivel and lift lug

The following should be considered as part of the swivel and lift lug installation.

a) The lift lug should be inspected to ensure that it is free from any apparent distortion or cracking and that it is fitted with a safety wire rope of at least 12,7 mm diameter.

b) The swivel should be checked to ensure that it rotates freely without leakage, and the locking shoe of the lifting ring pin should be inspected to check it is intact and holds the pin firmly.

c) The water hose should be checked to ensure that it is fitted with a safety chain the ends of which are fixed to the swivel gooseneck bracket and the standpipe elbow.

d) The pneumatic make-up unit should be firmly fixed with a safety rope attached. The shell of the pneumatic make-up unit should have a wire rope of diameter not less than 12,7 mm which is firmly connected to the swivel body.

A.8.9.3.3 TDS

The following should be considered as part of the TDS installation.

a) The various sections of the dolly track should be firmly and securely connected.

b) The hydraulic lines of the TDS should be connected properly and firmly without any leakage, and the electrical circuits should be connected properly and safely. Straightness of TDS rail should confirm to the manufacturers requirements.

A.8.9.3.4 Transmission equipment

The following should be considered as part of the transmission equipment installation, if applicable:

a) the parallel operation linkage, rotary table drive box and cathead drawworks should be correctly placed, aligned with each other and firmly fixed;

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b) the lubricating lines of the transmission system should be connected;

c) all the cardan shafts should be connected and should be inspected to see whether eccentric wear occurs on the air clutch;

d) the protective hoods should be installed and fixed in their various positions;

e) the pneumatic lines should be connected in accordance with their labels.

A.8.9.4 Circulation and solids control equipment

A.8.9.4.1 General

No guidance is offered.

A.8.9.4.2 Mud tank

No guidance is offered.

A.8.9.4.3 Shale shaker

No guidance is offered.

A.8.9.4.4 Degasser

No guidance is offered.

A.8.9.4.5 Desander and desilter

No guidance is offered.

A.8.9.4.6 Centrifuge

No guidance is offered.

A.8.9.4.7 Continuous circulation system (if equipped)

No guidance is offered.

A.8.9.5 Power and electrical equipment

No guidance is offered.

A.8.9.6 Well control equipment

No guidance is offered.

A.8.9.7 Pipe handling equipment

No guidance is offered.

A.8.9.8 Fire and gas detection equipment

A.8.9.8.1 General

Before installation of an automatic fire alarm system, the fire and gas detection system control block diagram, fire and gas alarm detection devices layout, fire and gas detection system detail wiring

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diagram, instrument installation drawing, cause and effect diagram for fire and gas detection system and other necessary technical documents should be provided and approved.

During installation of the automatic fire alarm system, the construction team should undertake any necessary works (including concealed work acceptance), inspection (including insulation resistance and earthing resistance), commissioning, design changes and other relevant records.

After installation of the automatic fire alarm system, the construction team should conduct a full inspection to check the quality of the installation of the system.

When the automatic fire alarm system is completed, the construction team should complete the as-built drawings and completion report.

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A.8.9.8.2 Wiring

The following should be considered as part of the wiring installation.

a) The wiring within pipe or cable tray should be no water and sundries within pipe or wire casing.

b) The location of support installation should avoid these places which are magnetic field, high temperature, corrosive materials and the mechanical damage. For the installation of the process pipe rack, the support should be installed in the side of the pipe or above. For high temperature pipelines, the support should not be above the parallel installation.

c) Automatic fire alarm system should be separated wiring. Fire and gas control cable and power cable should be laid separately. For 10 kV and below cable power, the control cable and power cable parallel spacing should be at least 10 cm. When crossing, the spacing should be at least 50 cm with partition or cable wear tube can be 25 cm.

d) The cable within cable penetration or cable tray should have no joints or snarls within the pipe or wire casing. The joint of conductor should be welded within the junction box or connected through terminal.

e) When various pipings and wire casings are laid in exposed manner, the independent clamping apparatus or support should be adopted for hoisting and fixing respectively. The boom of hoisting wire casing or piping should have a diameter of at least 6 mm;

f) When laying wire casing, hoisting points and support points should be positioned as follows:

— at the beginning, at terminals and at joints in the wire casing;

— at corners or branches in the wire casing;

— for straight sections, no more than 3 m apart.

g) For piping laid in dusty or humid conditions, gaps between the pipe and any orifice through which it passes should be sealed.

h) For exposed piping or wire casing, independent clamping apparatuses and supports should be adopted for hoisting and fixing, respectively. Booms for hoisting the piping or wire casing should have a diameter of at least 6 mm.

i) Bracket installation should be horizontal even vertical, neat rows. The space between the bracket upper part and the structure should be easy operating and maintained. When the vertical arrangement of the cable turn the corner, the bending curve should be consistent.

j) Bracket is fixed by using bolt connection, it should use a smooth round head bolt, nut should be on the outer edge of the bracket, fixed firmly.

k) Cable bracket device should be reliable grounding. The joint of each tray shall use 6 mm^2 soft copper grounding wire. The two ends of cable bracket should be connected with grounding plate

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by 70 mm^2 soft copper grounding wire. For the long cable bracket, every 30 m to 50 m should be grounded again.

l) After the conductors of automatic fire alarm system have been laid, a 500 V megaohmmeter should be used to measure the insulation resistance of each return conductor with respect to ground, the value of which should be at least 20 Ω.

m) For conductors on any project, different colours should be selected to differentiate uses. For consistency, the colours selected for conductors of the same use should be the same. The colour of anodes of power cables should be red and the cathodes blue or black.

A.8.9.8.3 Controller

The following should be considered as part of the controller installation.

a) The fire alarm controller, power supply module, communication module, controller board, terminals and backup battery should be integrated in a metal cabinet, which uses the form of floor installation, and is placed in the safe and easy to monitor and operation room. At the bottom of the cabinet put oneself in another's position with the base. The bottom edge should be approximately 0,1 m to 0,2 m above the ground (floor).

b) Controllers should be installed vertically and fixed firmly to the wall. When installed on a lightweight wall, reinforcement measures should be adopted.

c) Cables or conductors connected to the controller should satisfy the following:

   — the wiring should be tidy and fixed securely, and should not cross;

   — the end of the cable core and the supported conductor should be marked with the same serial number as that on the drawing, and in a form that is clear and non-fadable;

   — the numbers of wires to each post of the terminal board should be limited to two;

   — the tails of cable cores and conductors should not be less than 200 mm in length;

   — conductors should be tied in a bundle;

   — after conductors have crossed pipes and wire casings, the orifices and notches should be plugged.

d) Fire and flammable gas detection alarm system and fire control system of power supply system should be double power supply, including one way for emergency power supply.

e) The controller should be securely earthed and marked clearly and permanently.

f) The installation should be subject to a full inspection using dipstick metering, when necessary, and other appropriate observational and inspection techniques.

A.8.9.8.4 Fire detector

The following should be considered as part of the fire detector installation.

a) The installation of spot-type smoke detectors and spot-type heat detectors should satisfy the following:

   — a minimum horizontal distance from a wall or a beam of 0,5 m;

   — a minimum horizontal clearance around a detector of 0,5 m;

   — a minimum horizontal distance from the nearest edge of air conditioner outlet of 1,5 m;

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— when fixed to a ceiling of an inner corridor of less than 3 m in width, installed centrally. Spot-type heat detectors should be installed at intervals not exceeding 10 m, and spot-type smoke detectors at intervals not exceeding 15 m. The distance between a detector and an end wall should not be greater than half of the installation interval.

— installed horizontally but if inclined, the inclination should not be greater than 45°.

b) The installation of combustible gas detectors should satisfy the following:

— determine position according to the density of detectable gas; if less than the density of air, position the detector above a possible source of a leak or above the highest possible accumulation point of detectable gas; if greater than or equal to density of air, position the detector below a possible source of a leak;

— reserve adequate clearance around the detector for replacement and calibration;

— where explosion-proof conditions are required, execute construction in accordance with appropriate requirements.

c) The installation of air-breathing smoke fire detectors which samples through piping should satisfy the following:

— sampling pipe securely fixed;

— the length and sampling aperture of the sampling pipe (including branch pipe) conforms to the product specification;

— the ceiling height for non-highly-sensitive air-breathing smoke fire detectors is not higher than 16 m;

— the ceiling height for highly-sensitive air-breathing smoke fire detectors when set to high sensitivity can be higher than 16 m, but at least two sampling apertures are positioned below 16 m;

— when installed in a large space, the protection area of each sampling aperture is the same as that appropriate for spot-type smoke fire detectors.

d) The installation of spot-type flame detectors and image-type fire detectors should satisfy the following:

— positioned so that the field angle covers the detection area;

— no source of interference between the detector and the protected object;

— dust-proof and water-proof measures for detectors installed outdoors.

e) The detector base should be installed firmly and undergo reliable compression joint or welding when connecting to a conductor. When welding is adopted, corrosive scaling powder should not be used.

f) The conductor connecting the detector base should be provided with a reserve tail allowance of at least 150 mm, and marked with obvious sign at its end.

g) The thread hole of the detector base should be plugged, and protective measures are adopted for the installed detector base.

h) The detector alarm lamp should be oriented towards the main entrance for ease of observation by personnel.

i) The detector can be installed following quality control checks on correct operation, suitably protected prior to commissioning, and provided with proper dust-proof and moisture-proof coverings and with anti-corrosion measures.

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j) The installation should be subject to a full inspection using dipstick metering, when necessary, and other appropriate observational and inspection techniques.

A.8.9.8.5 Manual fire alarm button

The following should be considered as part of the manual fire alarm button installation.

a) The manual fire alarm button should be installed at obvious and easy-to-operate parts. When it is installed on the wall, the height from its bottom edge to the ground (building surface) should be approximately 1,3 m to 1,5 m. Each fire area should be set at least a manual fire alarm button, from a fire anywhere within the partition to the nearby the distance of a manual fire alarm button should not be more than 30 m. Manual fire button should be set at the entrance of public places out.

b) The manual fire alarm button should be installed securely and vertically.

c) The conductor connecting the manual fire alarm button should be provided with a reserve tail allowance of at least 150 mm, and marked with obvious sign at its end.

d) The installation should be subject to a full inspection using dipstick metering and other appropriate observational and inspection techniques.

A.8.9.8.6 Fire and electrical control device

The following should be considered as part of the fire and electrical control device installation.

a) A functional inspection should be carried out before installation of fire and electrical control devices. No rejected devices should be installed.

b) The external conductor end of a fire and electrical control device should be marked with a clear and permanent sign.

c) Within the casing of fire and electrical control devices, terminals of different voltage classes and of different current categories should be arranged separately, and marked with clear and permanent signs.

d) Controllers should be installed vertically and fixed firmly to the wall. When installed on a lightweight wall, reinforcement measures should be adopted.

e) The installation should be subject to a full inspection using dipstick metering and other appropriate observational and inspection techniques.

A.8.9.8.7 Fire emergency public address speakers and fire alarms

The following should be considered as part of the fire emergency public address speakers and fire alarms installation.

a) Fire emergency public address speakers and fire alarms should be fixed firmly to their mounting surfaces, without damage.

b) Visual fire alarms should be installed at obvious locations near an emergency exit, and at least 1,8 m above the ground. Visual fire alarm indicator signs and fire emergency evacuation indicator signs should not be installed on the same wall, however, if installed on the same wall, they should be separated by a distance of at least 1 m.

c) Speaker and fire alarms should be installed evenly within one alarm area.

d) The installation should be subject to a full inspection using dipstick metering and other appropriate observational and inspection techniques.

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A.8.9.8.8 Special fire telephone

The following should be considered as part of the fire telephone installation.

a) A fire telephone, telephone jack or manual alarm button with telephone jack should be installed at obvious and easy-to-access locations. When installed on the wall, the height of their bottom edges above the ground (building surface) should be between 1,3 m and 1,5 m.

b) A fire telephone and telephone jack should be marked with clear and permanent signs.

c) The installation should be subject to a full inspection using dipstick metering and other appropriate observational and inspection techniques.

A.8.9.8.9 Emergency power supply for fire equipment

The following should be considered as part of the emergency power supply for fire equipment installation:

a) the battery of an emergency power supply for fire equipment should be installed in a well-ventilated space or, if installed in the sealed environment, provided with appropriate ventilation equipment;

b) an acid battery should not be installed in an alkaline environment and an alkaline battery should not be installed in an acid environment;

c) an emergency power supply for fire equipment should not be installed near piping, warehouses or operating rooms., containing combustible gas;

d) fire equipment with single-phase or three-phase power supply rated higher than 30 kW or 120 kW, respectively, should be installed with an independent fire emergency power supply;

e) the installation should be subject to a full inspection using dipstick metering and other appropriate observational and inspection techniques.

A.8.9.8.10 System earthing

The following should be considered as part of the system earthing installation:

a) the metal casing of fire electrical equipment that is either AC-powered or DC-powered in excess of 36 V should be reliably earthed, and the earth wire should be connected to the electrical protective main earth line (PE);

b) after installation, earth resistance should be measured in accordance with regulations, and appropriate records kept;

c) the installation should be subject to a full inspection using dipstick metering and other appropriate observational and inspection techniques;

d) the relevant regulations in NFPA can also be used as a reference for gas fire extinguishing.

A.8.9.9 Drilling instrument communication system

No guidance is offered.

A.8.9.10 Boiler and steam system

A.8.9.10.1 Inspection of transport damage

The following should be considered as part of inspection:

a) upon delivery, the wet steam generator should be carefully and critically inspected for transport damage and missing parts;.

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b) an internal inspection should be carried out to check for the damage to the fireproof materials of boiler;

c) all transport damage should be immediately recorded and reported to the carrier.

A.8.9.10.2 Foundation

The following should be considered as part of the foundation.

a) The skid foundation for the wet steam generator should be kept horizontal, and have adequate load carrying capacity. The maximum load on the foundation is generally under the convection section.

b) Adequate space should be allocated and reserved for installation and maintenance of the wet steam generator. This space is necessary in order that the furnace tube of the convection section or of radiation section can be replaced and then removed in its entirety.

A.8.9.10.3 Lifting

Lifting should be conducted in accordance with the manufacturer's recommendations.

A.8.9.10.4 Removal of transport straps and protection sleeve

The straps installed to prevent the coil pipe from moving during transportation and the transportation protection sleeve should be removed.

A.8.9.10.5 Connection of water and steam pipes

Pipe connection should refer to the manufacturer's drawings.

A.8.9.10.6 Fuel piping connection

No guidance is offered.

A.8.9.10.7 Connection of waste discharge piping

The wet steam generator can be connected to corresponding discharge systems through an independent blowdown interface or a central blowdown system.

A.8.9.10.8 Connection of purging piping

The wet steam generator can be installed with a blowdown valve upstream of the outlet cut-off valve. The terminal of the purging pipe should be fixed securely so as to discharge the waste liquid to the designated site.

A.8.9.10.9 Connection of pyrophoric fuel piping

The following should be considered as part of the connection of pyrophoric fuel piping.

a) The boiler requires an ignition burner or other burners to ignite the main burner. The fuel of ignition burner is usually natural gas or liquefied petroleum gas (LPG). The supply of fuel gas should conform to the requirements in the manufacturer's specification.

b) The ignition gas supply system is checked and the regulator is regulated to reduce the low ignition gas to the designated pressure.

c) Under special circumstances, a light oil ignition burner can also be used in place of the gas ignition burner.

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A.8.9.10.10 Electrical connection

The following should be considered as part of the electrical connection.

a) The wet steam generator is generally connected through single power supply. Refer to the manufacturer's specification for the requirements of full load power supply.

b) The manufacturer generally completes and tests all circuits before shipment. The wiring between the skid and the electrical components dismantled for transport should conform to the manufacture's specification and all relevant standards.

c) All the devices required earthed should be grounded with electrical systems according to the manufacturer's specification and all relevant standards.

d) The manufacture's drawing and specification of control lines between boiler control panel and relevant equipment should be verified.

A.8.10 Weighing

No guidance is offered.

A.9 Pre-commissioning

A.9.1 Commissioning scope

No guidance is offered.

A.9.2 Commissioning preparation

No guidance is offered.

A.9.3 Hoisting equipment

No guidance is offered.

A.9.4 Rotating equipment

No guidance is offered.

A.9.5 Circulation and solids control equipment

No guidance is offered.

A.9.6 Power and electrical equipment

A.9.6.1 Diesel generator set

No guidance is offered.

A.9.6.2 Transformer

No guidance is offered.

A.9.6.3 Medium voltage switchboard, low voltage switchboard and motor control centre

No guidance is offered.

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A.9.6.4 UPS

No guidance is offered.

A.9.6.5 Electric control system equipment

No guidance is offered.

A.9.7 BOP handling equipment

No guidance is offered.

A.9.8 Cementing equipment

No guidance is offered.

A.9.9 Pipe handling equipment

No guidance is offered.

A.9.10 Fire and gas detection system equipment

No guidance is offered.

A.9.11 Instrument

No guidance is offered.

A.9.11.1 Drilling instrument

No guidance is offered.

A.9.11.2 P-tank instrument

No guidance is offered.

A.9.12 Hydraulic system

No guidance is offered.

A.9.13 Skidding equipment

No guidance is offered.

A.9.14 HVAC equipment

No guidance is offered.

A.10 Installation, hook up and commissioning

A.10.1 Loadout and marine transportation

No guidance is offered.

A.10.2 Installation

No guidance is offered.

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A.10.3 Hook up

A.10.3.1 Equipment hook up

No guidance is offered.

A.10.3.2 Piping system hook up

No guidance is offered.

A.10.3.3 Electrical hook up

No guidance is offered.

A.10.4 Commissioning

A.10.4.1 General

No guidance is offered.

A.10.4.2 Preparations before commissioning

A.10.4.2.1 Documents and plans

No guidance is offered.

A.10.4.2.2 Function and load commissioning

No guidance is offered.

A.10.4.2.3 Mechanical completion

The mechanical completion state of the following systems should be verified before commissioning.

a) Mechanical:

- visual inspection for complete and correct installation;
- internal inspection of tanks and vessels;
- alignment of machinery;
- load test of BOP handling equipment and deck cranes (where appropriate supervised by a certifying body).

b) Electrical:

- visual inspection for complete and correct installation;
- insulation and continuity testing of cables;
- insulation testing of generators, transformers and motors, panels, distribution boards;
- earthing checks;
- static checks of switches and control devices
- battery preparations;
- lighting and socket outlet checks;

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— area completion;

— heat tracing.

c) Fire and gas:

— visual inspection for complete and correct installation;

— insulation and continuity testing of cables;

— mechanical damage;

— earthing checks;

— static checks of nameplates and tags;

— preservation and accessibility.

d) Instrumentation:

— calibration and testing of instruments prior to installation;

— visual inspection for complete and correct installation;

— insulation and continuity testing of cables;

— cleaning and pressure testing of pneumatic and hydraulic tubing;

— adjustment of control, alarm and shutdown settings;

— loop testing.

e) Telecommunication:

— calibration and testing of facilities prior to installation;

— visual inspection for complete and correct installation;

— insulation and continuity testing of cables;

— loop testing.

f) Piping:

— removal of all unnecessary items during flushing, cleaning and pressure testing;

— flushing of pipe-work for sea water, fire-fighting water and potable water;

— chemical cleaning of pipe-work for hydraulic oil and fuel;

— air sweeping of pipe-work for powder material transfer;

— bolt tensioning.

g) HVAC:

— visual inspection for complete and correct installation;

— cleaning of duct;

— leak testing of duct;

— function checks of equipment.

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h) Safety:

— visual inspection for complete and correct installation;

— life preservation equipment.

A.10.4.2.4 Site preparation

Prior to commissioning, the site should be prepared as follows:

a) electric equipment system tested for earthing and insulation with resistance values in accordance with IEC 61892-6;

b) collection, treatment and drainage facilities for oily sewage and drilling fluid in accordance with normal working conditions;

c) driller to observe the operation activities on the drill floor and in the monkey board either directly or with the help of auxiliary video equipment;

d) during hoisting operation, operator should observe the hoisted equipment/personnel;

e) bulk materials and chemicals stored, conveyed and mixed safely in a manner so as to prevent injury from spilling or exposure evaporation;

f) working platform where personnel operate and maintain the equipment/facilities in a complete and safe condition;

g) at least two barrier-free access passages to the drill floor safety area;

h) emergency escape facilities provided at the monkey board of the derrick;

i) electrical room dry and well-ventilated;

j) facilities, components and parts in the electrical cabinet clean and tidy;

k) all mechanical equipment in good condition, clean, well-lubricated, secured, anticorrosive, and adjustable;

l) the safety protection hood of rotating components of equipment complete and in good condition;

m) tools, materials, special communication facilities, measuring apparatus and instruments for commissioning ready for use;

n) the piping system and each valve in its normal commissioning state;

o) personal protective equipment (PPE) is complete and intact;

p) emergency brake and shutdown systems working properly.

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A.10.4.3 System function testing

A.10.4.3.1 Fresh water, seawater, drilling water, fuel and lubricating oil systems

No guidance is offered.

A.10.4.3.2 Power and electrical systems

No guidance is offered.

A.10.4.3.3 Compressed air system

No guidance is offered.

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A.10.4.3.4 Ventilating system

No guidance is offered.

A.10.4.3.5 Seawater fire protection/fixed fire extinguishing system

A.10.4.3.5.1 General

The water fire extinguishing system consists of the fire pumps, main fire pipe, fire hose station, and fire hose and fire gun (or gun-type injector). In areas subject to freezing conditions, pipes or facilities of the water fire extinguishing system usually filled with water should be provided with antifreeze measures.

A.10.4.3.5.2 Fire pumps

The configuration of fire pumps should meet the following requirements.

a) At least two fire pumps driven by different power sources are equipped. The displacement of each pump should meet the requirement of 100 % of the water volume for a fire in any protected area in the fire protection zone, divided in accordance with the adopted specifications and standards, and available at any time. For a fire pump driven by a diesel engine, local and remote starting device should be equipped.

b) The location of fire pumps should draw seawater directly into the fixed main fire pipe. The high-suction-head platform can be installed between the water tank and the booster pump. The seawater suction inlet and power source of these pumps are arranged in such way that both pumps will not be simultaneously out of action in the event of a fire anywhere on the platform.

c) The pressure to each pump is sufficient to maintain a pressure of 350 kPa at the corresponding fire hose station when water is sprayed from any two water guns with a calibre of 19 mm. If a foam system is installed, the pump should maintain a pressure of at least 700 kPa.

d) Pumps at not normally visible locations should be fitted with automatic start-up equipment and remote control valves.

e) An overflow (or pressure relief) valve fitted to the pump to the main fire pipe if the pump pressure can exceed the design pressure of the main fire pipe, fire hose station and fire hose should be equipped.

f) For a platform with a water injection line or connected to a water supply platform, if the injection water or fire water supplied by the water supply platform can be reliably used for firefighting on the platform, upon the approval of an inspection agency, the platform need not be fitted with fire pumps.

A.10.4.3.5.3 Main fire pipe

The production platform should be equipped with a fixed main fire pipe which can transfer water of the quantity and pressure necessary to safely and effectively supply the water to connected equipment. The main fire pipe should not have any connections without relation to fire fighting.

A.10.4.3.5.4 Fire hose station

Each deck should be equipped with at least two fire hose stations at relatively safe locations, each of which fitted with a fire hose of diameter 38 mm ($1^1/_2$ in) or 50 mm (2 in) and of length generally not greater than 20 m.

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A.10.4.3.5.5 Fire hose and fire gun

Each fire hose should be provided with a water-spraying gun and mist-spraying fire gun. The standard calibres of fire guns are 13 mm, 16 mm and 19 mm. The 13 mm fire gun is generally used in accommodation and service spaces; fire guns of larger calibre can be used in open spaces.

The fire gun and fire hose should be stored within the special container of the same position, and the special box should be placed besides the fire hose, or in the container.

A.10.4.3.6 Drilling fluid circulation and solid control system

No guidance is offered.

A.10.4.3.7 Fire and gas system

The configuration of fire and gas system should be consistent with the requirements of the FES (fire and explosion strategy) and national regulations appropriate to the location.

FES should describe the basis of determining the position, quantity and type of probe. It first should identify the fire and gas risks that can occur in each area, and evaluate whether it is necessary to detect these risks reliably.

The fire and gas detection equipment should be selected according to their response characteristics and response conditions.

Fire probes should be selected based on the type of fire that can occur in the area in which they are located.

All fire and gas equipment should be suitable for its intended position, and approved by the relevant authorities.

The configuration of the fire and gas system should be such that it is easy to test the on-site equipment, internal function and execution output.

A control station should be established to operate the internal fire and gas alarm and control measures.

An audible alarm signal should normally be used to alert personnel except for areas where high noise continues after an emergency shutdown which should also be provided with a supplementary visual alarm signal.

The fire and gas detection system should undergo functional testing as follows:

— temperature and smoke sensing of the fire detection and alarm system, including self-checking and sending of an alarm fault;

— calibration test of the H_2S and combustible gas detection and alarm system, including self-checking and sending of an alarm fault;

— manual fire alarm device;

— platform state visual indication system.

A.10.4.3.8 PA/GA system

No guidance is offered.

A.10.4.3.9 Industrial monitoring and intercom system

No guidance is offered.

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A.10.4.3.10 Drilling instrument system

No guidance is offered.

A.10.4.3.11 Hoisting and rotating system

No guidance is offered.

A.10.4.3.12 Pipe handling equipment

No guidance is offered.

A.10.4.3.13 Well control system

No guidance is offered.

A.10.4.3.14 DES skidding system

No guidance is offered.

A.10.4.3.15 Oily sewage treatment system

No guidance is offered.

A.10.4.3.16 Preparation and submission of function commissioning report

No guidance is offered.

A.10.4.4 System load testing

A.10.4.4.1 General

No guidance is offered.

A.10.4.4.2 Power and electrical systems

A.10.4.4.2.1 General provisions

Electrical equipment can include the main generating set (if equipped), emergency generating set, power distribution equipment, motor, transformer, accumulator battery, electric protection facility, lighting facility, electric tracing facility and electric heating equipment and cable includes power cable, lighting cable, control cable and communication cable.

All electrical equipment and every cable should have a certificate of conformity for meeting the requirements, and electrical equipment installed in explosion-proof areas should have an explosion-proof grade certificate issued by the qualified unit and be in line with the requirements of explosion-proof areas.

Electrical equipment and cable selection and installation should ensure the safety of personnel and the platform. The operator can determine which particular electrical equipment and cable requires ex-factory testing in accordance with the adopted specifications and standards as well as the importance of the electrical equipment and cable. However, an ex-factory test is considered necessary for the generator set and power distribution equipment for main power supply, the emergency generator set and the emergency power distribution equipment. During testing, the agency inspectors should be present at the site to confirm and sign the test report, and issue the inspection report.

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The power supply should satisfy the following requirements.

a) General:

— adequate supply of power to electrical equipment for normal production, operation and personnel occupation without resorting to use of the emergency power supply;

— provide power to electrical equipment necessary for safety in the case of failure of main power supply;

— ensure to supply power to electrical equipment necessary for safety under the failure of main power supply.

b) Environmental conditions for supply:

— maximum and minimum temperatures in the area where platform is located;

— vibration and shock generated during normal platform operations;

— offshore moist air;

— salt mist, oil mist and chemically reactive substances that react with sulfur dioxide and hydrogen sulphide, under special circumstances;

— oil gas and natural gas in the hazardous area.

c) Voltage and frequency:

— Voltage and frequency are listed in Table 2;

— under normal operation conditions, the allowable voltage deviation value (indicated by percentage of nominal voltage) at the terminal of electrical equipment should be +6 % to +10 %, and the frequency deviation should be ±5 %. The allowable voltage deviation value for equipment powered by storage battery should be ±20 %;

— AC electrical equipment to work normally when the proportion of harmonic components in the power supply is not larger than 5 %.

d) Arrangement and installation:

— safe and easy maintenance when arranging and installing electrical equipment;

— protection-type enclosures of electrical equipment as per IEC 529. Selection of the type of enclosure to be consistent with the demands of the location of the installation;

— avoid electrical equipment working in hazardous areas where combustible gas or steam readily accumulate. If unavoidable, the electrical equipment should conform to the explosion-proof demands of the location.

e) Lighting system:

— lighting model selection and installation and corresponding protective measures in line with the environmental conditions at the location;

— fit firm guard gating to lighting installed on external walkways and other locations susceptible to mechanical damage;

— provide fire prevention and heat insulation measures to lighting fixed directly to wooden board or other flammable material;

— lighting power supplied by special transformer, switchboard and power distribution box;

— lighting and lighting control switch materials, performance, structure and brightness degree as per adopted specifications and standards;

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— avoid glare from fluorescent lamps installed at locations with rotatable parts.

f) Electric tracing facility:

— provide a suitable corrosion resistant insulating layer to electric tracing present in a corrosive gas or medium;

— provide electric tracing band and installed control and electrical equipment with detection, control and protection devices against overload, short circuit and current leak;

— protection requirements and explosion-proof level of electric tracing equipment to meet the demands of the area in which the equipment is located.

g) Electric heating facility:

— electric heating equipment enclosure to be corrosion resistant for the medium to be heated;

— fit control and protection equipment to the electric heating equipment to automatically cut-off the power supply when the temperature exceeds its limiting value;

— insulation resistance of electrical heating devices rated at less than 380 V to be less than 0,5 Ohm;

— electric heating equipment installation not to pose an overheating risk to surrounding buildings, equipment and articles;

— protection requirements and explosion-proof level of electric heating equipment to meet the demands of the area in which the equipment is located.

h) Accumulator battery:

— the automatic discharge device of the emergency accumulator battery to supply power to the emergency circuit at any time automatically irrespective of whether the accumulator is on charge or not;

— equip the accumulator battery with appropriate charging equipment and provide appropriate protection to both;

— accumulator battery should not be installed in living quarters;

— mark the accumulator room with a clear and permanent sign to indicate the power in kW of the installed battery.

i) Cable trays:

— fit cable trays to main cables of power cables and control cables. Use cable trays on different layers to mount power and control cables and high voltage and low voltage cables;

— cable trays should be arranged to avoid any dropping or dropping of cables in a fire situation. Cable ties should be of a type suitable for offshore environment use;

— provide cable trays with reliable electrical connection and earthing;

— the anticorrosive performance of cable trays to meet the demands of the environmental conditions at the installation site.

A.10.4.4.2.2 Power supply

The following should be considered as part of the power supply system function.

a) Main power supply

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The main power supply generally includes the main generator set (if equipped), power distribution equipment, transformer and convertor.

When a generator set is adopted as the main power supply, the number of sets and capacity should satisfy the electricity demands and the number and capacity of the standby generators established. If there is none, when one of the generators with the largest capacity damages or stops working, the safety production and living requirements should be met.

The back and above of main switchboard should not be set with water pipe, oil pipe, steam pipe, oil tank and other liquid vessels. If it cannot be avoided, reliable protective measures should be provided.

When the main switchboard exceeds 4 m in length, the two ends of its backward channel should be set with outlet, and the two ends of the power distribution room should be equipped with doors that open outwards.

The front and back of the main switchboard should be laid with an anti-skidding and oil-resistant insulating rubber mat. Insulation rating is recommended as no less than 15 KVa.

The platform should be equipped with an independent emergency power supply and a supporting emergency power distribution system.

b) Emergency power supply setup

The emergency power supply can be composed of some or all of the following: diesel engine generator set (the emergency generator); accumulator battery; AC UPS.

The emergency generator should ensure automatic start-up and power supply within 45 s of failure of the main power supply. The capacity of the emergency generator should be able to satisfy its emergency load requirements.

The accumulator battery should be able to supply power automatically upon failure of the main power supply, and to provide the normal power utilization for all emergency loading without need for recharging within a specified power-on time. Within the whole power-on time, the voltage should be maintained to within 12 % of the rated value.

AC UPS should be able to supply power immediately and uninterruptedly in the case of failure of the main power supply. Changes to its voltage and frequency should conform to the adopted specifications and standards.

c) Emergency power supply capacity

A.10.4.4.3 Drilling fluid circulation and solid control system

No guidance is offered.

A.10.4.4.4 Hoisting and rotating system

No guidance is offered.

A.10.4.4.5 Well control system

No guidance is offered.

A.10.4.4.6 Preparation and submission of system load test report

No guidance is offered.

A.11 Quality control, quality assurance and documents

No guidance is offered.

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A.12 In-service inspection and integrity management

No guidance is offered.

A.13 Reuse

No guidance is offered.

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Annex B
(informative)

Guidance for load and resistance factor design/working stress design method

B.1 Modular structural design

B.1.1 Design contents

The design contents cover the design of the main structure and accessory structures of the MDR, mainly involving material selection, general structure layout, selection of action and action coefficient, action combination mode, and calculation result analysis.

B.1.2 Materials selection

Materials should be selected considering the factors including strength, working environment, the position in the structure, possibly used processing methods.

The plates for critical tubular joints, skidding bases and main lifting points should use steel products with Z-directional properties.

B.1.3 General structure design principle

Each member of the structure should have sufficient strength under design action. The structure design should realize reasonable general layout, short load path, good comprehensive utilization of members and high material utilization ratio and meet the requirements of other specialities for structural form. The structure should be arranged symmetrically when the weight of equipment is allocated in balance.

B.1.4 Structural components and connections

This section mainly deals with the modules of an MDR such as DES, DSM and P-tank, as well as relevant structural components and connections of system equipment. In addition to the requirements of ISO 19901-3, the following recommendations should also be considered.

The ratio of the outer diameter of a tubular member to its wall thickness should not be larger than 60; the ratio of the outer diameter of a wrapped welded steel pipe to its wall thickness should not be less than 20. The slenderness ratio of a compression member bar should be less than 120, and that of a tension member bar should be less than 200.

B.1.5 Structure simulation

B.1.5.1 Basic principle

All members and details affecting the structure design should be subject to structure simulation.

B.1.5.2 Coordinate system

The coordinate system is a rectangular coordinate system, where Z-up means positive, X and Y axes are horizontal axes, y-axis is consistent with the north of the platform, and the direction of x-axis is determined according to the right-hand rule. The chart datum is defined as the zero elevation, all other elevation are measured relative to this point.

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B.1.5.3 Model

The structure model is a simplified frame structure including all plans and elevations. Joints and members should be classified and numbered as per the name designated in the procedure and their action and boundary constraint conditions should be simulated accurately.

B.1.6 Actions and action coefficient

B.1.6.1 Permanent action

B.1.6.1.1 Structure dry weight

According to the simulation accuracy of the calculation model and different design phases, the recommended structure dry weight coefficient is taken as follows:

a) concept design: 1,30–1,40 (not simulating appurtenant structures);

b) basic design: 1,10–1,20 (according to the simulation degree of appurtenant structures, e.g. detailed simulation of bases, secondary members, floor plates, gratings, bulkheads, ladder access platforms, 1,10 is recommended.);

c) detailed design: 1,05–1,10 (according to the simulation degree of appurtenant structures, e.g. detailed simulation of bases, secondary members, floor plates, gratings, trunk bulkheads, ladder access platforms, lifting eyes, guardrails, joint ring plates, 1,05 is recommended.).

B.1.6.1.2 Equipment action

Equipment actions include equipment dry weight, vessel actions, pipeline actions, cable actions, storage area actions, outfitting weight. during operations. According to different design phases, the equipment action coefficient should be taken as:

a) concept design: 1,30;

b) basic design: 1,20;

c) detail design: 1,10.

B.1.6.1.3 Drilling operation actions

Drilling operation actions belong to variable actions, including rotary /hook load, setback action, mud tank action, pipe-rack area action, drilling tool action. The maximum rated value can be adopted in the structural calculation.

B.1.6.2 Variable actions

B.1.6.2.1 Liquid weight in vessels, storage tanks and pipings

According to different design phases, the action coefficient of the liquid weight in vessels, storage tanks and pipings should be taken as:

a) concept design: 1,30;

b) basic design: 1,20;

c) detail design: 1,10.

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B.1.6.2.2 Bulk cargo stacking actions and other variable actions

According to their location and operation needs, bulk cargo stacking actions and other variable actions should be considered as per the values listed in Table B.1.

Table B.1 — Variable actions for different location in structure analysis

Location	Varible action kN/m2	
	Local calculation	**Overall calculation**
Roofs/walkways for inspection and maintenance	3,0	1,5
Walkway and stairway	5,0	2,5
Non-equipment area of deck	5,0	2,5
Laydown area, maintenance area, storage area	10,0	5,0
Fork lift activity area	10,0	5,0

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B.1.6.3 Environmental actions

B.1.6.3.1 Wind action

Wind action should be simulated in eight directions. For the wind actions under operating conditions, the average wind speed with the return period of 1 year and the duration of 3 s should be selected; for the actions under extreme storm conditions, the average wind speed with the return period of 100 years and the duration of 1 min should be selected. The wind speed is at 10 m above mean sea level.

B.1.6.3.2 Seismic action

The seismic action should be calculated in accordance with ISO 19902.

B.1.7 Structure analysis of LRFD method

B.1.7.1 General

The partial action factors provided in this subclause are intended to cover variations in the intensity of direct actions from the specified representative valves and as far as appropriate the uncertainties in predicting internal forces.

The values have been primarily calibrated to conditions experienced in the Gulf of Mexico.

In no instance partial action factors should be used as substitute for rational analysis, e.g. to account for dynamics.

Partial action factors can be obtained from national application documents or where sufficient information is available by an appropriate reliability analysis.

B.1.7.2 Design action combinations and factors

B.1.7.2.1 Factored gravity action

The strength of each member, joint, and foundation component should be checked for the internal force Q resulting from the following factored gravity actions:

$$Q = 1{,}3G_1 + 1{,}3G_2 + 1{,}5Q_1 + 1{,}5Q_2 \qquad \text{(B.1)}$$

where G_1, G_2, Q_1 and Q_2 are defined in B.1.7.2.2 to B.1.7.2.5.

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B.1.7.2.2 Permanent action G_1

Permanent action G_1 is the self-weight of the structure, including:

— weight of the structure in air;

— weight of the equipment and other objects permanently mounted on the MDR that does not change with the mode of operation.

The nominal value of G_1 is the value computed from nominal dimensions and densities.

B.1.7.2.3 Permanent action G_2

Permanent action G_2 is the action imposed on the MDR by weight of equipment and other objects. These actions can change from one mode of operation to another or during a mode of operation but otherwise remain constant for long periods of time. Permanent action G_2 should include the following:

— the weight of drilling and production equipment that can be added or removed from the MDR;

— the weight of living quarters, life-support equipment, and utilities equipment, which can be added or removed from the MDR.

The nominal value of G_2 should be the estimated lift weight of the object plus any field installed appurtenances.

B.1.7.2.4 Variable action Q_1

Variable action Q_1 includes the weight of consumable supplies and fluids in pipes and tanks, and ice and snow accretion. The nominal value of Q_1 is computed from the nominal weight of the heaviest material and the largest capacity under the mode of operation considered.

B.1.7.2.5 Variable action Q_2

Variable action Q_2 is the short duration force exerted on the structure from operations such as lifting of drill string, lifting by cranes, machine operations. The nominal value should be the action caused by the rated maximum capacity of the equipment involved and should include dynamic and impact effects.

B.1.7.2.6 Factored wind actions

Each member, joint and foundation component should be strength checked for the internal force Q caused by the action of these factored actions:

$$Q = 1{,}1G_1 + 1{,}1G_2 + 1{,}1Q_1 + 1{,}35E_I \quad \text{(B.2)}$$

where E_I is the extreme wind action, being the force applied to the structure due to the combined action of the extreme wind (typically 100-year return period), and G_1, G_2, and Q_1 are defined in B.1.7.2.2 to B.1.7.2.4 and include those parts of each mode of operation that can reasonably be present during an extreme storm.

When internal forces due to gravity actions oppose the internal forces due to wind actions, the gravity action factors should be reduced so that:

$$Q = 0{,}9G_1 + 0{,}9G_2 + 0{,}8Q_1 + 1{,}35E_I \quad \text{(B.3)}$$

For this check, the G_2 and Q_1 should exclude any parts of that mode of operation that cannot be ensured of being present during an extreme storm.

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B.1.7.2.7 Operating wind action

An operating wind condition can also be specified for design. Each member, joint, and foundation component should be strength checked for the internal force Q caused by the action of the following factored actions:

$$Q = 1{,}3G_1 + 1{,}3G_2 + 1{,}5Q_1 + 1{,}5Q_2 + 1{,}2E_e \quad \text{(B.4)}$$

where E_e is the owner-defined operating wind action and G_2, Q_1, and Q_2 are maximum values for each mode of operation.

B.1.7.2.8 Seismic actions

Each member, joint and foundation component should be strength checked for the internal force Q caused by the action of these factored actions:

$$Q = 1{,}1G_1 + 1{,}1G_2 + 1{,}1Q_1 + 0{,}9E \quad \text{(B.5)}$$

where E is the inertia action induced by the ELE ground-motion and determined using dynamic analysis procedures such as response spectrum analysis or time-history analysis and G_1, G_2, and Q_1 are defined in B.1.7.2.2 to B.1.7.2.4 and include only those parts of each mode of operation that can reasonably be present during an earthquake. When internal forces due to gravity actions oppose the internal forces due to earthquake actions, the gravity action factors should be reduced so that:

$$Q = 0{,}9G_1 + 0{,}9G_2 + 0{,}8Q_1 + 0{,}9E \quad \text{(B.6)}$$

B.1.7.2.9 Fabrication and installation actions

The primary objective of this subclause is to ensure that a structure begins its service life with its designed strength and structural integrity intact. Installation encompasses the operations of moving the MDR components from the fabrication site (or prior offshore location) to the offshore location, and installing them to form the completed platform.

Because of equilibrium requirements, it cannot be possible to apply different factors for each of the gravitational, environmental, buoyancy, and inertial actions for some phases of fabrication and installation. In such cases, the analysis should be performed with all action factors equal to 1,0, and an action factor of 1,3 should be applied to the nominal internal action effects calculated.

The following factors apply to situations where the external actions can be factored independently before actions are combined. For loadout and lift, the effects of limiting environmental conditions cannot predominate; thus an action factor of 1,3 on gravitational and environmental actions should be used in the absence of further rational analysis of factors. For situations where environmental actions can predominate, an environmental action factor of 1,35, combined with a gravitational action factor of 1,1, should be used.

The corresponding action factors for tow should be 1,1 for gravitational and 1,35 for environmental actions.

B.1.8 Structure analysis of WSD method

B.1.8.1 In-place analysis

In-place analysis includes static analysis and seismic analysis. Static analysis should involve extreme storm conditions and operating conditions; the operating conditions should cover all extreme well slots. Seismic analysis should meet the requirements of API RP 2A-WSD for strength analysis and should be made using the seismic response acceleration on the top deck of the platform and the quasi static method. Under extreme storm conditions and seismic conditions, the variable action of equipment

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(difference value of the equipment wet weight and dry weight) can be taken as 75 %. The action combination conditions and combination coefficients for in-place analysis are shown in Table B.2.

Table B.2 — Action combination conditions and combination coefficients (in-place analysis)

Design action	Combination of operating conditions				
	Operating conditions Rated hook load	Operating conditions Rated rotary table action	Extreme storm conditions	Seismic conditions Hook load	Seismic conditions Rotary table action
Permissible stress increase factor	1,00	1,00	1,33	1,33	1,33
Structure dry weight	100 %	100 %	100 %	100 %	100 %
Dry weight of equipment	100 %	100 %	100 %	100 %	100 %
Variable action of equipment	100 %	100 %	75 %	75 %	75 %
Mud actions	100 %	100 %	100 %	100 %	100 %
Variable actions	100 %	100 %	75 %	75 %	75 %
Wind actions under operating conditions	100 %	100 %	0	0	0
Wind actions under extreme operating conditions	0	0	100 %	0	0
Seismic action	0	0	0	100 %	100 %
Hook load	100 %	0	0	100 %	0
Rotary table action	0	100 %	100 %	0	100 %
Stand action	100 %	100 %	100 %	100 %	100 %

B.1.8.2 Installation analysis

B.1.8.2.1 Action combination conditions

The action combination conditions and combination coefficients for installation analysis are shown in Table B.3.

Table B.3 — Action combination conditions and combination coefficients (installation analysis)

Design action	Combination of installation conditions		
	Loadout conditions	Towing conditions	Lifting conditions
Permissible stress increase factor	1,00	1,33	1,00
Structure dry weight	100 %	100 %	100 %
Dry weight of equipment	100 %	100 %	100 %
Loadout drag force	100 %	0	0
Wind force under towing conditions	0	100 %	0
Inertial force generated by barge movement during towing	0	100 %	0

B.1.8.2.2 Lifting analysis

For lifts to be made at open, exposed sea (i.e. offshore locations), padeyes and other internal members (and both end connections) framing into the joint where the padeye is attached and transmitting lifting forces within the structure should be designed for a minimum action factor of 2,0 applied to the calculated static actions. All other structural members transmitting lifting forces should be designed using a minimum action factor of 1,35.

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