GUIDANCE NOTES
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CHINA CLASSIFICATION SOCIETY

GUIDELINES FOR CERTIFICATION OF DRILLING PLANTS

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BeiJing

Contents

Chapter 1 GENERAL

Section 1 General Provisions

1.1.1 General requirements

1.1.1.1 The Guidelines are applicable to the design, construction, test and survey of drilling plants located on mobile offshore drilling units, fixed offshore drilling units or other offshore structures.

1.1.1.2 Drilling plants and their equipment and systems are to be designed, constructed, tested and surveyed in accordance with the Guidelines including acceptable standards and additionally the applicable requirements of CCS offshore rules such as the Rules for Construction and Classification of Mobile Offshore Units and the Rules for Materials and Welding.

1.1.1.3 The relevant requirements of the Administration, e.g. the Regulations for Safety of Fixed Offshore Platforms promulgated by the National Economy and Trade Commission are to be complied with, if applicable.

1.1.2 Scope

1.1.2.1 The Guidelines cover the safety aspects of the systems and equipment related to drilling, completion, workover and well test operations and do not cover the operation of drilling plants.

1.1.2.2 The systems and equipment covered by the Guidelines include:

(1) Structures, including derrick/mast, drilling floor, flare boom, modules and skid structure;

(2) Bulk storage, circulating and transfer system;

(3) Heave compensating and tensioning system;

(4) Hoisting, rotating and pipe handling/blowout preventer handling system;

(5) Marine riser system;

(6) Well control system;

(7) Well test system;

(8) Other supporting systems, e.g. electrical system and control system.

1.1.2.3 The workover equipment may be referred to the applicable requirements of the Guidelines.

1.1.3 Classification and certification

1.1.3.1 The Guidelines specifies the procedures and requirements of classification and certification for the drilling plants to be classed with and certified by CCS. CCS will conduct classification survey, certification survey and assessment survey of the drilling plants in accordance with the Guidelines.

1.1.3.2 For the classification services, conditions of classification, applicable characters of classification and class notations of CCS, refer to CCS Rules for Construction and Classification of Mobile Offshore Units.

1.1.3.3 Upon request of the owner or his representative, a mobile offshore drilling unit, fixed offshore drilling unit or any other offshore structure classed with CCS may be assigned the class notation “Drill”, provided that the drilling plant installed on such offshore structure complies with the requirements contained in the Guidelines and that the plant is designed, constructed, installed and tested under survey by and to the satisfaction of CCS.

1.1.3.4 Upon request of the owner or his representative, CCS, as the certifying and surveying Party will conduct certification survey and assessment survey (including design review, construction survey and test) of a drilling plant or its equipment and systems and issue appropriate certificates and necessary documents in accordance with the Guidelines and/or applicable codes and standards provided by the owner.

1.1.3.5 Conditions for maintenance of validity of class notation or certificate:
(1) All the necessary surveys are to be carried out in accordance with the provisions of the Guidelines to confirm continued compliance of the technical condition with the requirements for the assigned class notation or the validity of the issued certificate;
(2) The drilling plant is to be maintained, managed and operated by competent persons; the operational and test procedures are to be followed; the operation loads and environment conditions are to be restricted within the prescribed design limits;
(3) CCS is to be timely notified of any damage, failure and repair that may affect the assigned class notation or the validity of the issued certificate. CCS will conduct evaluation and/or survey and accordingly give requirements and suggestions.

1.1.4 Equivalence and exemption

1.1.4.1 The design provisions inconsistent with the requirements of the Guidelines (including acceptable standards) may be accepted in lieu of the corresponding requirements of the Guidelines provided that such design provisions are demonstrated or shown in writing to have a safety level equivalent to the Guidelines and are agreed upon by all contractual parties and CCS.
1.1.4.2 Upon approval by CCS Headquarters, drilling plants of a new structure containing novel features may be exempted from any requirement of the Guidelines, if the application of such requirement will substantially prevent such drilling plants from using their features or seriously affect their operation.

1.1.5 Application of risk assessment

1.1.5.1 If the owner or his representative intend to have risk assessment for design, construction or operation of the drilling plant or a certain system or unit thereof, and upon satisfactory verification by CCS to the risk assessment documents, the risk control programs and measures adopted in risk assessment may wholly or partially replace the provisions in the Guidelines.
It is recommended that the risk assessment be performed in accordance with ISO 17776 Guidelines on Tools and Techniques for Hazard Identification and Risk Assessment.

Section 2 Definitions and Abbreviations

1.2.1 Definitions

1.2.1.1 Unless provided otherwise, for the purpose of the Guidelines:
(1) Drilling plant is the general term for all the equipment and systems required for drilling operations.
(2) Drilling units mean the mobile offshore drilling units, fixed offshore drilling units or other offshore structures with drilling plants engaged in offshore drilling, completion, workover or well test operations located thereupon, referred to as “unit”.
(3) Verification means confirmation by examination and provision of objective evidence that specified requirements have been fulfilled. Verification constitutes a systematic and independent examination of the various phases in the life of an asset to determine whether it is and/or continues to be in compliance with some or all of the asset specifications.
For the purpose of the Guidelines, CCS will conduct classification survey, certification survey, statutory certification survey or assessment survey as provided for in the verification contract.
(4) Assessment survey means verification pursuant to the requirements of the entrusting party and within the scope agreed upon by all relevant parties, inspection and test are carried out for conformity verification so as to confirm all the items prescribed by the contract satisfactory. These requirements are generally the recognized codes and standards, industrial standards and/or the Guidelines. When survey is completed, CCS is to provide/issue the relevant survey documents.

(5) Certification survey means verification pursuant to the requirements of the entrusting party so as to confirm that all the items prescribed by the contract comply with the requirements. These requirements are in general recognized codes and standards, industrial standards and/or the Guidelines. Upon completion of survey, CCS will issue the relevant certificates and provide/issue the relevant survey documents.
(6) Statutory certification survey means verification pursuant to the requirements of the Administration so as to confirm that the specified requirements are complied with. Upon completion of survey, CCS will issue the relevant statutory certificates and provide/issue the relevant survey documents according to the authority delegated to it.
(7) Classification survey means verification pursuant to the Guidelines and the relevant rules of CCS so as to confirm that the specified requirements are complied with. Upon completion of survey, CCS will issue CCS classification certificates and provide/issue the relevant survey documents.
(8) Essential system is generally defined as a system which supports equipment which needs to be in continuous operation. For the purpose of the drilling plant, the essential systems cover systems which are needed to be available on demand to prevent development of, or to mitigate the effects of an undesirable event, and to safeguard the personnel, environment and the installation.
(9) Important system is defined as s system supporting equipment which ensures reliable operation and maintains plant operation within operational limitations.
(10) Non-important system is defined as a system, which is neither essential nor important.
(11) Safety systems in the Guidelines include the following systems:
— Essential systems and important systems including essential functions;
— Systems to exert protective safety functions;
— Closing and discharge systems of a production unit in well test system;
— Emergency shutdown systems;
— Fire and gas detection and alarm systems;
— Any essential systems and components relating to safety.
(12) Applicable standards are the general term for the acceptable standards specified in Section 3 of Chapter 1 and other standards agreed by CCS.

1.2.2 Abbreviations

1.2.2.1 Unless provided otherwise, for the purpose of the Guidelines:
(1) CCS — China Classification Society;
(2) GB — China National Standard;
(3) SY — China Petroleum and Natural Gas Industry Standard;
(4) AISC — American Institute of Steel Construction;
(5) ANSI — American National Standards Institute;
(6) API — American Petroleum Institute;
(7) ASME — American Society of Mechanical Engineers;
(8) ISO — International Organization for Standardization;
(9) NACE — National Association of Corrosion Engineers.

Section 3 Acceptable Standards

1.3.1 General requirements

1.3.1.1 The standards listed in this Section including their provisions are accepted by CCS. Unless specifically agreed, all the applicable requirements in such standards are to be applied. In any instance of conflict between the acceptable standards and the Guidelines, the requirements in the Guidelines are to prevail.

1.3.1.2 Standards other than the acceptable standards listed in this Section may also be used provided that they have equivalent or higher safety level compared with the Guidelines and are approved in advance by CCS.

1.3.1.3 Any deviations, exceptions and modifications to design standards are to be clearly stated in design documents and agreed upon by the owner and CCS.

1.3.1.4 The latest versions of standards valid on the date on which the contract for construction is signed between the owner and the manufacturer are to be applied, unless otherwise specified in the contract.

1.3.2 Acceptable standards

1.3.2.1 The internationally recognized, national and industrial standards which are acceptable to the Guidelines are as follows:

(1) Derrick

API Spec 4F Drilling and Well Servicing Structures

API RP 4G Use and Procedures for Inspection, Maintenance, and Repair of Drilling and Well Servicing Structures

SY/T 5025 Specification for Drilling and Well Repairing Structure and Substructure

(2) Valve and wellhead equipment

API Spec 6A/ISO 10423 Wellhead and Christmas Tree Equipment

SY/T 5127 Specification for Wellhead and Christmas Tree

(3) Drilling equipment

API Spec 7 Rotary Drill Stem Elements

API RP 7G Drill Stem Design and Operating Limits

API Spec 7K Drilling and Well Servicing Equipment

API RP 7L Procedures for Inspection, Maintenance, Repair and Remanufacture of Drilling Equipment

GB/T 17744 Specification for Drilling Equipment

SY/T 6367 Procedures for Inspection, Maintenance, Repair and Remanufacture of Drilling Equipment

SY/T 6407 Specification for Rotary Drill Stem Elements

(4) Hoisting equipment

API Spec 8A Drilling and Production Hoisting Equipment

API RP 8B/ISO 13534 Inspection, Maintenance, Repair and Remanufacture of Hoisting Equipment

API Spec 8C/ISO 13535 Drilling and Production Hoisting Equipment (PSL1 and PSL2)

SY/T 5112 Drilling and Production Hoisting Equipment

GB/T 19190 Drilling and Production Hoisting Equipment

SY/T 5208 Major Hoisting Equipment for Petroleum Well Repair

(5) Wire rope

API Spec 9A/ISO 10425 Wire Rope

API RP 9B Application, Care and Use of Wire Rope for Oil Field Service

SY/T 5170 Specification for Wire Rope

(6) Offshore safety and pollution prevention

API Spec 14A/ISO 10432 Subsurface Safety Valve Equipment

API RP 14B Design, Installation, Repair and Operation of Subsurface Safety Valve Systems

API RP 14C Analysis, Design, Installation and Testing of Basic Surface Safety Systems on Offshore Production Platforms

API Spec 14D Wellhead Surface Safety Valves and Underwater Safety Valves for Offshore Service

API RP 14E Design and Installation of Offshore Production Platform Piping Systems

API RP 14F Design and Installation of Electrical Systems for Fixed and Floating Offshore Petroleum Facilities for Unclassified and Class 1, Division 1 and Division 2 Locations
API RP 14G Fire Prevention and Control on Open-type Offshore Production Platforms
API RP 14J Design and Hazards Analysis for Offshore Production Facilities
SY/T 10024 Design, Installation, Repair and Operation of Subsurface Safety Valve Systems
SY/T 10033 Recommended Practice for Analysis, Design, Installation and Testing of Basic Surface Safety Systems on Offshore Production Platforms
SY/T 10006 Specification for Wellhead Surface Safety Valves and Underwater Safety Valves for Offshore Service
SY/T 10042 Recommended Practice for Design and Installation of Offshore Production Platform Piping Systems
SY/T 10010 Recommended Practice for Design and Installation of Offshore Production Platform Electrical Systems
SY/T 10034 Recommended Practice for Fire Prevention and Control on Open-type Offshore Production Platforms

(7) Drilling well control system
API Spec 16A/ISO13533 Drill-through Equipment
API Spec 16C Choke and Kill Systems
API Spec 16D Control Systems for Drilling Well Control Equipment
API RP 16E Design of Control Systems for Drilling Well Control Equipment
API Spec 16F Marine Drilling Riser Equipment
API RP 16Q Design, Selection, Operation and Maintenance of Marine Drilling Riser Systems
API Spec 16R Marine Drilling Riser Couplings
API Bul 16J Comparison of Marine Drilling Riser Analysis
SY/T 5964 Specification for Combination of Drilling Well Control Equipment
SY/T 5053.1 Blowout Preventer and Control Unit Blowout Preventer
SY/T 5053.2 Blowout Preventer and Control Unit Control Unit
SY/T 5323 Kill Manifold and Choke Manifold

(8) Subsea production system
API RP 17B Flexible Pipe
API Spec 17D Subsea Wellhead and Christmas Tree Equipment

(9) Pressure vessel/fired unit/heat exchanger
ASME Section I Power Boilers
ASME Section IV Heating Boilers
ASME Section VIII, Div 1, 2 Rules for Construction of Pressure Vessels
API Std 530 Calculation of Heater Tube Thickness in Petroleum Refineries
API Std 661 Air Cooled Heat Exchangers for General Refinery Service

(10) Pipeline
ANSI/ASME B31.3 Chemical Plant and Petroleum Refinery Piping

(11) Miscellaneous
NACE MR0175/ISO15156 Materials for Use in H2S-Containing Environments in Oil and Gas Production
AISC Manual of Steel Construction – Allowable Stress Design
API RP 53 Blowout Prevention Equipment Systems for Drilling Operations
API RP 64 Diverter Systems Equipment and Operations
API RP 500 Classification of Location for Electrical Installations at Petroleum Facilities Classified as Class I, Division 1 and Division 2

API RP 520	Sizing, Selection and Installation of Pressure-Relieving Systems in Refineries
API RP 521	Guide for Pressure Relieving and Depressuring Systems
SY/T 10041	Recommended Practice for Classification of Location for Electrical Installations at Petroleum Facilities Classified as Class I, Division 1 and Division 2
SY/T 10044	Recommended Practice for Sizing, Selection and Installation of Pressure-Relieving Systems in Refineries
SY/T 10043	Guide for Pressure Relieving and Depressuring Systems

Chapter 2 SURVEY AND CERTIFICATION

Section 1 Survey and Certification of Drilling Equipment

2.1.1 General requirements

2.1.1.1 This Chapter specifies the requirements for survey, certification and certificates of equipment and parts of drilling plants described in 1.1.2.2. For the purpose of obtaining survey certificates issued by CCS, the equipment manufacturers are to submit in accordance with this Chapter an application to CCS for equipment survey and certification, including description of equipment purpose, design basis and specifications, design standards and other requirements.

2.1.1.2 Pursuant to this Section, design documents are to be submitted for the drilling system, equipment and parts, of which the design is required to be examined in accordance with the requirements of Section 2, Chapter 3 of the Guidelines.

2.1.1.3 If the manufacturer has a valid product design approval certificate issued by CCS, his products may be partially or wholly exempted from the design examination requirement.

2.1.1.4 The equipment and parts related to safety in drilling plants are classified with the categories A, B and C in accordance with the survey and certification requirements. Category A and category B equipment are to have both CCS product certificate and the manufacturer's product certificate, category C equipment is only to have the manufacturer's product certificate:

(1) For equipment category A, the equipment is required to undergo design examination, survey during construction by Surveyors and completion inspection and tests (function, pressure, load tests) and its manufacture records are to be examined;

(2) For equipment category B, the equipment is required to undergo design examination, completion inspection and tests (function, pressure, load tests) and its manufacture records are to be examined;

(3) For equipment category C, the equipment is related to safety and its manufacturer's product certificate is accepted CCS.

2.1.1.5 In general, the manufacturers' product certificate is at least to include the following information:

(1) Equipment instructions/information book;

(2) Equipment operation limits;

(3) The manufacturer's document that the equipment is designed, produced, constructed and tested in accordance with the recognized methods, regulations and standards.

2.1.2 Categorization of surveys and certificates

2.1.2.1 The categorization of surveys and certificates of equipment are to comply with Table 2.1.2.1. CA means the product certificate of CCS and W means factory qualification certification.

2.1.2.2 The categorization of surveys and certificates of other pipes, piping elements, flanges and valves are to comply with Table 2.1.2.2.

2.1.2.3 The categorization of surveys and certificates of other pressure vessels, separators and heat exchangers are to comply with Table 2.1.2.3.

2.1.2.4 The survey and certification of the equipment marked with * in Tables 2.1.2.1, 2.1.2.2 and 2.1.2.3 may also be referred to the requirements in PART ONE of CCS Rules for Classification of Sea-Going Steel Ships.

Categorization of Equipment Survey and Certification Table 2.1.2.1

Equipment		Survey type			Certificate type	
		A	B	C	CA	W
BOP equipment	Hydraulic connector for wellhead		×		×	×
	Ram preventer		×		×	×
	Annular preventer		×		×	×
	Accumulators for subsea stack		×		×	×
	Subsea fail-safe valves in choke and kill lines		×		×	×
	Clamp		×		×	×
	Test stump		×		×	×
BOP control equipment	Accumulators in control system*		×		×	×
	Welded pipes and manifolds*		×		×	×
	Unwelded hydraulic piping*			×		×
	Flexible control hose*			×		×
	Hydraulic hose reel			×		×
	Control pods			×		×
	Acoustic BOP control equipment		×		×	×
	Hydraulic power unit (pump and manifold)*		×		×	×
	Control panels*			×		×
Choke and kill equipment	Choke manifold	×			×	×
	All piping to and from choke manifold		×		×	×
	Piping for choke, kill and booster lines		×		×	×
	Flexible hoses for choke, kill and booster lines		×		×	×
	Valves in choke, kill and booster lines		×		×	×
	Unions and swivel joints		×		×	×
	Emergency circulation pump – pressure side		×		×	×
Diverter unit	Diverter house with annular valve		×			×
	Diverter piping		×			×
	Valves in diverter piping		×			×
	Control panels *			×		×

Equipment		Survey type			Certificate type	
		A	B	C	CA	W
Derrick and hoisting equipment in derrick	Derrick	×			×	×
	Sheaves for crown block and traveling block		×		×	×
	Crown including support beam		×		×	×
	Guide track and dolly		×		×	×
	Traveling block		×		×	×
	Drilling hook		×		×	×
	Swivel		×		×	×
	Links			×		×
	Elevators			×		×
	Drilling line and sand line			×		×
	Dead line anchor		×		×	×
	Drawworks including foundation		×		×	×
	Air winches		×		×	×
	Crane in derrick*		×		×	×
	Casing stabbing arrangement or board		×		×	×
Rotary equipment	Rotary table, including skid adaptor and driving unit		×		×	×
	Kelly			×		×
	Master bushing			×		×
	Kelly bushing			×		×
	Top drive		×		×	×
Pipe handling	Racking arms with lifting head		×		×	×
	Manipulator arm		×		×	
	Pipe handling crane		×		×	
	Horizontal to vertical equipment		×		×	
	Finger board			×		×
	Catwalk			×		×
	Mousehole			×		×
Miscellaneous equipment for drilling	Power tongs for pipe handling			×		×
	Kelly spinner			×		×
	Power slips			×		×
	Single joint elevator			×		×
	Hydraulic power unit, including pumps and manifolds*			×		×
	Burner		×		×	×
	Flare boom (combustion arm)	×			×	×

Equipment		Survey type			Certificate type	
		A	B	C	CA	W
Marine riser and control system	Marine riser connector		×		×	×
	Ball joint and flexible joint		×		×	×
	Riser sections including joints		×		×	×
	Support ring for riser tensioning		×		×	×
	Telescopic joint		×		×	×
	Accumulators*		×		×	×
	Control panel			×		×
Tensioning system	Riser tensioner		×		×	×
	Guide lines and podline tensioners		×		×	×
	Hydro-pneumatic accumulators		×		×	×
	Pressure vessels (air cylinders)		×		×	×
	Piping		×		×	×
	Air compressors			×		×
	Air dryers			×		×
	Wire ropes for tensioning equipment			×		×
	Sheaves for riser tension line			×		×
	Sheaves for guideline and podline			×		×
	Telescopic arms for tension lines		×		×	×
	Control panel			×		×
Drill string heave compensation system	Compensator		×		×	×
	Hydro-pneumatic accumulator		×		×	×
	Pressure vessels (air cylinders)*		×		×	×
	Piping including flexible hoses*		×		×	×
	Air compressors*			×		×
	Air dryers*			×		×
	Wire ropes*			×		×
	Sheaves*			×		×
	Control panel*			×		×

Equipment		Survey type			Certificate type	
		A	B	C	CA	W
Drilling fluid Circulation, transfer and cementing	Drilling fluid pump including pressure side		×		×	×
	Piping for mixing of drilling fluid and suction line to drilling fluid pump			×		×
	Centrifugal pump for mixing drilling fluid			×		×
	Pulsation dampers (air bags)*		×		×	×
	Piping for drilling fluid in the well		×		×	×
	Rotary hose with end connection		×		×	×
	Standpipe manifold		×		×	×
	Kelly cocks		×		×	×
	Non-return valve in drilling string (inside blowout preventer)		×		×	×
	Mixing pumps		×		×	×
	Safety valves		×		×	×
	Circulation head (high pressure)			×		×
	Mud return pipe			×		×
	Trip tank			×		×
	Shale shaker			×		×
	Drilling fluid tank			×		×
	Drilling fluid supply tank			×		×
	Desander, desilter			×		×
	Degasser including piping to burners or to vents)		×		×	×
	Chemical mixers			×		×
	Agitators for drilling fluid			×		×
	Drilling fluid gas separator		×		×	×
	Piping for mixing of cement and suction line to cement pump			×		×
	Cement pump including pressure side		×		×	×
	Cement manifold		×		×	×
	Pulsation dampers		×		×	×
	Piping for cementing pump discharge		×		×	×
	Safety valves		×		×	×
Bulk storage	Pressurized storage tanks		×		×	×
	Piping and valves for pressurized bulk transport		×		×	×
Electrical equipment	Variable frequency drive (VFD), silicon rectifier of control (SRC) and motor control center (MCC)		×		×	×
	Transformer		×		×	×
	Motor with power ⩾ 50 kW		×		×	×
Blowout preventer crane/carriage/guide frame, etc.			×		×	×

Categorization of Surveys and Certificates of Other Pipes, Piping Elements, Flanges and Valves **Table 2.1.2.2**

Description	Condition	Survey type		Certificate type	
		B	C	CA	W
Piping assembly (spools)	Thickness of wall ≥ 25.4 mm	×		×	×
	Design temperature ≥ 400 ℃	×		×	×
	All the short pipes in longitudinally welded pipes and all spools in categories A and B equipment	×		×	×
	Piping other than those mentioned above and piping for category C systems		×		×
Flanges and couplings	Standard flanges and pipe couplings		×		×
	Non-standard flanges and pipe couplings used in types A and B piping systems	×		×	×
	Flanges and pipe couplings other than those mentioned above, and the flanges and couplings used in type C piping systems		×		×
Valve	Valve body of welded construction with ANSI rating > 600 lbs	×		×	×
	Valve designed and manufactured in accordance with recognized standards		×		×
Components of high strength material	Yielding strength > 345 MPa or tensile strength > 515MPa	×		×	×

Categorization of Surveys and Certificates of Other Pressure Vessels, Separators and Heat Exchangers **Table 2.1.2.3**

Descriptions	Condition	Survey type		Certificate type	
		B	C	CA	W
Pressure vessels for	Poisonous liquids	×		×	×
	Liquids with flash point below 100℃	×		×	×
	Liquids with temperature above 220℃	×		×	×
	Compressed gases, where pressure × volume (P × V) is above 1.5, where pressure (P) is in MPa and volume (V) is in m^3	×		×	×
Other pressure vessels not included above			×		×

Section 2 Surveys at Manufacture and During Installation

2.2.1 General requirements

2.2.1.1 This Section is applicable to surveys of drilling system equipment and components at the plant of the manufacturer and surveys of their installation, assembling and test process for verifying compliance of the surveyed system or equipment with the requirements of the Guidelines and applicable standards.

2.2.2 Surveys at manufacture and during assembly

2.2.2.1 Surveys at manufacture includes surveys during manufacture and inspections and tests before delivery. The survey at manufacture is applicable to appraisal survey, certification survey, statutory certification survey and classification survey.

2.2.2.2 Pursuant to the requirements of the Guidelines and the contract, drilling equipment and components are subject to surveys at manufacture and/or delivery inspections in accordance with applicable standards, and approved plans and related comments.

2.2.2.3 Surveys at manufacture and during assembly include, but are not limited to surveys of the following items:

(1) Confirming that the process used to manufacture, fabricate drilling system components has and maintains an effective quality control plan, covering design, procurement, manufacturing and testing, and meeting the applicable standards of equipment;

(2) Welders' qualifications are to be confirmed or verified by the Surveyor;

(3) Welding procedure specifications and corresponding weld procedure qualification records are to be reviewed by the Surveyor;

(4) Verifying material certificates or documentation;

(5) Checking fit-up prior to major weldments;

(6) Checking final weldments;

(7) Witnessing nondestructive examination tests of welds and reviewing records of nondestructive examinations;

(8) Reviewing records of post-weld heat treatment, in particular for piping subjected to pressurized sour service and subject to requirements of NACE MR0175/ISO 15156;

(9) Verifying that dimensions are the same as shown on approved drawing;

(10) Verifying compliance of dimensional tolerances and alignment of mating surfaces with the relevant standards and technical requirements;

(11) Witnessing pressure or proof-load test of equipment components and as a unit, as required in the fabrication procedures;

(12) Witnessing final testing and functional testing of subassemblies and completed units, as required in the fabrication procedures;

(13) Verifying that all pressurized systems, motor controllers, SCR banks, consoles and instrumentation and control panels are in compliance with approved drawings;

(14) Carrying out other inspections agreed upon between all parties in advance.

2.2.3 Surveys during installation

The following surveys are to be carried out by CCS Surveyors on drilling systems/equipment during installation and testing:

(1) Examining installation drawings and test plan/programme of drilling system/ equipment;

(2) Piping systems are to be visually examined, nondestructively examined and pressure tested in accordance with the Guidelines and applicable standards;

(3) All pressure relief arrangements and safety valves are to be tested;

(4) Choke and kill systems are to be pressure-tested at rated working pressure and also subjected to a low-pressure test at 2.07MPa (300 psi) and performance tests;
(5) Drilling pump operation test is to be carried out to verify compliance with requirements contained in the test plan/programme;
(6) Drawworks, blocks and associated equipment are to be performance-tested;
(7) All lifting appliances are to be load-tested;
(8) The mobile framework of drilling derrick is to be tested and the locking device is to be checked;
(9) The installation of each component, framework/system is to be checked and the measurement records are to be checked;
(10) All drilling systems and equipment are to be checked for proper operation and alarm and safety functions are to be tested;
(11) Control system and shutdowns are to be tested;
(12) All wiring and electrical connections are to be checked for continuity and proper workmanship.

Section 3 Surveys for Maintenance of Validity of Certificate

2.3.1 General requirements

2.3.1.1 This Section contains survey requirements for maintenance of validity of certificate (classification or certification) of drilling plant.
2.3.1.2 The surveys to maintain validity of certificate after construction of drilling plants include annual survey, special survey, alteration and damage repair survey.
2.3.1.3 The survey plan and programme of special survey and continuous survey are to be submitted to CCS for examination before survey and kept on board the drilling unit for use. All repair and maintenance records/maintenance manuals are to be kept on board the drilling unit for review by the Surveyor.

2.3.2 Survey onshore and issuance of release notes

2.3.2.1 If during operation the components certified by CCS need to be returned ashore for maintenance, repair or modification, the owner is to promptly notify this to CCS and Surveyors will attend to the facility/plant for all required function, load and pressure testing. Tests are to be carried out in accordance with the Guidelines and applicable standards.
2.3.2.2 Upon satisfactory tests and visual examination, a “release note” is to be issued by the Surveyor, subject to satisfactory installation of the component on the drilling plant and examination of the component in the next regular survey. The “release note” is to be kept on board the drilling unit for check.

2.3.3 Annual survey

2.3.3.1 The drilling plants of all drilling units are subject to annual survey. Annual survey is to be carried out three months before or after the anniversary of date of completion of manufacture, commissioning of a drilling plant or the date of completion of special survey, as applicable.
2.3.3.2 In annual survey, the Surveyor is to carry out the following , as applicable, to verify effectiveness of various systems and equipment:
(1) Review of maintenance manual and relevant logs/records to confirm that a suitable maintenance plan has been followed, required periodic tests have been carried out, and that any repairs, reconditioning and renewals of well control equipment, BOP controls, riser system, pressure vessels, electric system/equipment and hoisting system or lifting devices were carried out according to the Guidelines and applicable standards;

(2) Review of "release notes" issued by CCS since the initial survey or last annual survey, and examination of the components/equipment to the extent deemed necessary by the Surveyor;
(3) Examination whether the exposed surfaces of the derrick, hoisting systems and lifting devices, flare booms, stabbing boards, racking platforms and drilling equipment foundations are in good condition. The inspection of the derrick and related structural members includes the following:

① the general condition of the structure, especially bent, missing or damaged parts and lost corrosion protection coatings;
② tightening of bolts;
③ condition of wire ropes and fittings;

(4) Examination of all fixed parts and the structure of base-mounted winches and other lifting devices. Magnetic particle inspection may be carried out as deemed necessary by the Surveyor to determine whether any crack exists;
(5) General external examination of each system and equipment as practical as possible for damage, corrosion, fracture and other abnormalities;
(6) Anti-corrosion coating, insulation, shrouds and guards around moving parts are to be found in place and in good condition;
(7) Derrick walkways and ladders, drilling floor and drilling system machinery spaces to be surveyed with particular attention to fire and explosion hazards and confirmation that emergency escape routes are not blocked;
(8) External examination of pressure vessels and their appurtenances, including safety devices, foundations, controls, relieving gear, piping, flexible hoses, insulation and gauges;
(9) Examination of emergency shutdown devices;
(10) Examination of all electrical and instrumentation systems, including protective devices and cable support;
(11) Examination of drilling fluid and cementing system;
(12) Examination of BOP test log and maintenance records;
(13) Examination of equipment lube oil condition and oil replacement records;
(14) Examination of explosion prevention integrity of anti-explosion electrical appliances;
(15) Examination of integrity of fire prevention structure.
The drilling plants of all drilling units are subject to annual survey. Annual survey is to be carried out three months before or after the anniversary of date of completion of manufacture, commissioning of a drilling plant or the date of completion of special survey, as applicable.

2.3.4 Special survey (or renewal survey)

2.3.4.1 The drilling plants of all drilling units are subject to special survey, which is to be carried out at five-year intervals after completion of manufacture, commissioning of a drilling plant or completion of special survey, as applicable.
2.3.4.2 The special survey may be commenced at the annual survey prior to its expiry date and be progressed during the succeeding year with a view to completion by its expiry date. When the special survey is commenced before the annual survey prior to its expiry date, the entire survey is to be completed within 15 months from the date of commencement of the special survey if such work is to be credited to the special survey.
2.3.4.3 Where the owner is not able to arrange the special survey by its expiry date in exceptional circumstances, CCS may grant an extension not exceeding 3 months upon the owner's request, provided that a written application is received before the expiry date. In such a case, the date of next special survey for class is to start from the expiry date of the previous special survey before the extension was granted.

2.3.4.4 For surveys completed more than 3 months before the expiry date of the special survey, the date of next special survey for class is to start from the survey completion date. For surveys completed within 3 months before the expiry date of the special survey, the date of next special survey for class is to start from the expiry date of the special survey. For surveys completed after the expiry date of the special survey, the date of next special survey for class is also to start from the expiry date of the special survey.

2.3.4.5 The special survey is to include all items of an annual survey and in addition, the following are to be carried out:

(1) Internal examination and/or thickness gauging of pressure vessels and pressure-retaining components, testing of relief valves and pressure piping systems, as considered necessary by the Surveyor;

(2) Hydrostatic testing of pressure vessels and other pressure-retaining components to their MAWP;

(3) Hydrostatic testing of drilling system piping systems and flexible hoses to their MAWP;

(4) Examination and check of insulation resistance of motors;

(5) Examination of rotating drilling machinery to verify normal operation;

(6) The blowout preventer is to be subjected to a complete performance test and pressure tested to its MAWP;

(7) Examination of mud and cement pump fluid ends;

(8) Function testing of derrick gear, drilling hoisting systems and derrick floor lifting devices;

(9) Close-up examination of the condition of welded joints on the derrick and associated structures, including thickness gaugings and/or nondestructive testing of any suspect areas noted by the Surveyor.

2.3.5 Continuous survey

2.3.5.1 The continuous survey is to be carried out in accordance with the requirements in Chapter 4, PART ONE of CCS Rules for Classification and Construction of Mobile Offshore Units.

2.3.6 Surveys for modifications, damage and repairs

2.3.6.1 For any modification or conversion of the drilling plant that is related to the notation “DRILL” and the validity of certificate of a drilling unit, the relevant plans are to be submitted to CCS for approval. Such modification or conversion and associated parts are in general to comply with the requirements of the Guidelines or at least the originally applicable requirements.

2.3.6.2 Any damage to the drilling plant, that is related to the notation “DRILL” and the validity of certificate of a drilling unit, is to be promptly notified to CCS for damage survey. The repair details are to be submitted for examination and survey and test are to be carried out to the satisfaction of the Surveyor.

Chapter 3 DRILLING SYSTEMS AND EQUIPMENT

Section 1 Design Principles

3.1.1 General requirements

3.1.1.1 This Section contains the basic principles for design and arrangement of drilling systems and equipment.

3.1.1.2 The requirements of this Section apply to all drilling systems and equipment, which have the potential to adversely affect safety or integrity of drilling units and/or drilling plants.

3.1.1.3 Drilling systems and equipment are to be designed, manufactured, installed and tested in compliance with the design principles of this Section, other requirements of the Guidelines and acceptable standards.

3.1.1.4 A written statement is to be provided to CCS by the manufacturer declaring the equipment and parts to be surveyed and certified by CCS are in compliance with the standards applied.

3.1.2 Overall safety principles

3.1.2.1 Drilling systems and equipment are to be designed to minimize risk of hazards to humans, property, and environment by application of the following principles:

(1) No single maloperation or failure is to result in life threatening situations for the involved personnel, or significant damage to property or the environment;

(2) All equipment is to be provided with indicating instruments which will provide the necessary information for safe operation, control and emergency action;

(3) Systems and equipment are to be protected against excessive loads, pressure, temperature and speed;

(4) Where practicable，unnecessary hazards are to be avoided or prevented through safe design such that further protection measures are not required;

(5) Where hazards may occur, measures to reduce hazard possibilities or to mitigate hazard conditions are to be available;

(6) A safety system is to include two independent levels of protection to prevent or minimize the adverse effects of a single fault or failure in equipment, associated piping system and normal process controls. In order to reduce the probability for common cause failures, the two levels of protection are to be provided by functionally different types of safety devices;

(7) The safety system, control system and alarm system are to be designed such that the most probable failures result in the safest possible new condition (fail to safety);

(8) The safety system is to operate to mitigate fault conditions which may develop too fast to be counteracted by local manual intervention;

(9) Other safety systems, such as emergency shutdown, fire-proof and explosion-proof systems are to comply with CCS Rules for Construction and Classification of Mobile Offshore Units;

(10) Systems and equipment are to be designed for operation throughout a specific design life, which is recommended to be not less than 20 years.

3.1.3 Arrangement

3.1.3.1 Equipment and areas with high risk potential are to be segregated from those with a low risk potential.

3.1.3.2 Drilling systems, including all equipment and parts, are to be so arranged that during drilling operation the cables, cable trays, intake and exhaust ducting/pipes, control and shutdown systems and safety systems are protected from damage.

3.1.3.3 Location and design of critical equipment and facilities is to include due consideration of potential for dropped objects, especially in connection with materials and equipment handling.
3.1.3.4 Decks and work areas are to include efficient drainage for spillage of water, oil and drilling fluid. Hazardous drains from drill floor, substructure and well test area are to be collected and routed to a dedicated slop tank system, and are to be segregated from drains from non-hazardous areas.
3.1.3.5 The driller is to have a clear view of all activities at the drill floor and within the derrick during operation directly or by use of reliable auxiliary visual equipment.
3.1.3.6 Arrangement of equipment and devices in hazardous areas is to be in compliance with the requirements of CCS Rules for Construction and Classification of Mobile Offshore Units.
3.1.3.7 The equipment located in hazardous areas is to be protected such that the highest surface temperature will not exceed 80% of autoignition temperature of explosive gases/air mixtures. Where the autoignition temperature is not specified or unknown, the highest surface temperature of equipment is not to exceed 200℃.
3.1.3.8 All equipment intended to be operated, inspected and maintained on board are to be arranged for safe and easy access.
3.1.3.9 Escape routes are to comply with the followings:
(1) The drill floor is to be arranged with at least two direct and unobstructed exits to a safe place;
(2) The derrick is to be arranged with emergency escape means.
3.1.3.10 Arrangement of safety systems is to be in compliance with the relevant requirements in Section 11 of this Chapter.

3.1.4 Load

3.1.4.1 Each part of the drilling plant is to be designed for the maximum foreseeable load conditions. All internal and external loads acting on the drilling plant, which may adversely affect the functionality, strength, safety and reliability of the drilling plant are to be considered. Except for earthquake loads, the most unfavorable combination of loads that may act simultaneously is to be taken into account.
3.1.4.2 Loads acting on the parts of a drilling plant normally include:
(1) Environmental loads: loads mainly resulting from natural environmental conditions, e.g. wind, wave, current, ice and earthquake;
(2) Operational loads：loads other than environmental loads and the deadweight of the components during operation;
(3) Deadweight of the components.
3.1.4.3 Unless otherwise specified, the drilling plant is to be evaluated for applicable loading combinations for the following conditions (e.g., combination of hook load, wind load, motion of unit and stand loads are normally given for derrick structure):
(1) Operation;
(2) Waiting on weather;
(3) Survival;
(4) Transit.
3.1.4.4 Environmental loads
(1) The environmental criteria and motion characteristics used for the design of the unit are to be used.
(2) Where applicable, the followings aspects are to be taken into consideration when establishing the environmental loads:
① motion of the unit;
② wind loads;
③ loads from possible accumulation of snow and ice (if applicable);
④ earthquakes (fixed installations only);

(3) Unless otherwise specified, the greatest of the following value combinations of roll, pitch and heave is to be considered for loads due to motion of floating units:

① Maximum heave and maximum pitch;

② Maximum heave and maximum roll;

③ Maximum heave combined with pitch and roll that occur simultaneously.

(4) Loads due to unit motion are to be taken into consideration for primary load-bearing structures, e.g. derrick/flare boom structures and substructures, and pipe handling equipment/BOP handling cranes, and for fixtures of large equipment, as applicable.

(5) Wind loads are to be calculated according to acceptance criteria and/or CCS Rules for Construction and Classification of Mobile Offshore Units.

(6) Loads from possible accumulation of snow and ice are to be taken into consideration for drilling plants intended to be operated in cold areas. Design values of these loads are to be specified by the owner/designer

(7) Effect of earthquake loads are to be considered for drilling plants installed on fixed units. Earthquake loads are to be calculated according to API RP 2a or CCS Rules for Construction and Classification of Fixed Offshore Units.

Section 2 Plans and Documents

3.2.1 Examination of plans and documents

3.2.1.1 Prior to commencement of manufacture, plans and documents specified in this Section are to be submitted in triplicate by the applicant to CCS for examination. CCS may require additional plans and documents, if necessary.

3.2.1.2 All fabrication and welding procedures and testing programs are to be submitted to CCS for examination.

3.2.1.3 Principal revision or supplements to the approved plans and documents, if any, are to be submitted by the applicant to CCS for examination.

3.2.1.4 Sizes and relevant data necessary for examination are to be indicated in the submitted plans and documents.

3.2.1.5 Plans and documents for CCS approved products need not be submitted.

3.2.2 Plans and documents for structures

3.2.2.1 The following plans and documents are to be submitted to CCS for approval, with dimensions, material types and grades, structural arrangement, details, welding and/or other means of connection being shown on the structural plans:

(1) Structural plans and strength calculations of derrick and substructure;

(2) Structural plans and strength calculations of flare boom and substructure (where applicable);

(3) Structural plans and strength calculations of equipment modules/skids (where applicable);

(4) Plans of ladders and guardrails;

(5) Plans of lifting appliance base and support;

(6) Fabrication specifications, including fabrication procedures, welding procedures, and nondestructive examination and testing;

(7) Corrosion prevention control.

3.2.2.2 The following plans and documents are to be submitted to CCS for information:

(1) General arrangement plan and descriptions of the drilling plant;

(2) Descriptions of derrick and/or flare booms, including ratings of derrick and/or flare booms, design temperatures, limitations of use, and applicable codes/standards.

3.2.3 Plans and documents for drilling systems

3.2.3.1 The following plans and documents are to be submitted for to CCS for approval:

(1) Arrangement plans of the following systems:

① Bulk storage, drilling fluid circulation and transfer systems;

② Heave compensation and tensioning systems (where applicable);

③ Hoisting, rotating and pipe handling/BOP handling systems;

④ Marine riser system;

⑤ Well control system;

⑥ Well test system.

(2) Specifications of drilling equipment;

(3) Design details of the drilling equipment/parts subject to CCS examination as specified in Section 1 of Chapter 2, showing material, size, type, rating, design pressure, design temperature, applicable codes/standards, and necessary calculations according to rules if not additionally attached;

(4) Pressure vessel design drawings, including dimensional plans, design calculations, material specifications, fabrication procedures, and weld details for all pressure vessels, supports and internal components;

(5) Piping and instrumentation drawings for the systems mentioned in the above (1), showing material, size, type, design pressure and design temperature of instruments, piping, valves and fittings, and calculations according to rules if not additionally attached;

(6) System testing program;

(7) Operation and maintenance manual for drilling plant.

3.2.3.2 The following plans and documents are to be submitted to CCS for information:

(1) Schematic plans of drilling process.

3.2.4 Plans and documents for electrical equipment

3.2.4.1 The following plans and documents are to be submitted to CCS for approval:

(1) Plans showing electrical systems of the drilling plant;

(2) Calculations of loads of dedicated main power supply and emergency power supply for the drilling plant;

(3) Calculations of short-circuit currents of the dedicated power system of the drilling plant;

(4) Schematics and arrangement drawings of switchboard;

(5) Parameters of rectifier systems, generators, motors and motor controllers used for drilling functions, including complete rating, insulation class, rated ambient temperature, temperature rise, enclosure type, details of construction, details of cooling system, electrical characteristics and standards to be applied in manufacturing;

(6) Batteries used for emergency blowout preventer control service, including installation, arrangement and details of batteries, where provided, to include charging apparatus, ventilation and corrosion protection;

(7) Calculation and analysis of harmonics of the drilling plant power system.

3.2.4.2 The following plans and documents are to be submitted to CCS for information:

(1) Electrical specification;

(2) Plans showing divisions of hazardous areas.

3.2.5 Plans and documents for control systems

3.2.5.1 The following plans and documents are to be submitted to CCS for approval:

(1) Arrangement plans showing location of units controlled, instrumentation and control devices (showing set points for control system components);

(2) Hazards analysis for control systems;

(3) Calculations for control systems demonstrating the system's ability to react adequately to anticipated occurrences, including transients;

(4) Arrangements and details of control consoles, including front views, installation arrangements together with schematic plans and logic description for all power, control and monitoring systems, including their functions;
(5) Kind and size of all electrical cables and wiring associated with the control systems, including voltage rating, service voltage and current, together with overload and short-circuit protection;
(6) Schematic plans and logic description of hydraulic and pneumatic control systems together with all interconnections, piping sizes and materials, including working pressure and relief-valve settings;
(7) Description of all alarm and emergency tripping arrangements and functional sketches or description of all special valves, actuators, sensors and relays.
3.2.5.2 The following plans and documents are to be submitted to CCS for information:
(1) Specifications for control and instrumentation equipment;
(2) Operation and maintenance manuals for control systems.

Section 3 Structures

3.3.1 General requirements

3.3.1.1 This Section applies to derricks/masts, drill floors, flare booms and other primary load-bearing structures.
3.3.1.2 Structural design is to be in accordance with applicable acceptable standards and this Section and the intended purpose, and to ensure sufficient strength and fatigue characteristics (where necessary) in all specified design conditions.
3.3.1.3 Structure materials are to comply with Section 1of Chapter 4.
3.3.1.4 Loads and load combinations imposed on the structure are to comply with relevant requirements of Section 1 of this chapter.
3.3.1.5 Unless otherwise specified, permissible stresses are to be in accordance with applicable accepted standards such as AISC Manual of Steel Construction, or CCS Rules for Construction and Classification of Mobile Offshore Units.

3.3.2 Derrick and substructure

3.3.2.1 Design and fabrication of the derrick and its substructure is to comply with the requirements of API Spec 4F. Additionally, the following factors are to be taken into consideration (where applicable):
(1) Loads due to possible accumulation of snow and ice and wind loads occurred accordingly;
(2) Fatigue calculation;
(3) Vortex shedding evaluation;
(4) Sufficient local strength and rigidity of the derrick structure where main equipment, such as pipe handling equipment and heave compensators, are installed;
(5) Pre-stress of fasteners.
3.3.2.2 Maximum permissible height of a continuous ladder inside derrick is 9 m. Where the climbing height exceeds 9 m, a rest platform is to be arranged at a suitable position. Passages within the derrick are to be secured with a railing not less than 1.0 m high and with a toe board of at least 100 mm in height.
3.3.2.3 Equipment and components to be lubricated are to be provided with safe and easy access.
3.3.2.4 Equipment and components installed on the derrick are be secured to prevent falling down.

3.3.3 Drill floor

3.3.3.1 The drill floor structure is to be designed to withstand the loads imposed by the hook load, work winches, setback area(s), rotary loads and all installed equipment, and environmental loads. For floating units, loads due to tensioners are also to be taken into consideration.

3.3.3.2 The drill floor structure where main equipment, such as rotary devices, dead line anchors and work winches are installed, is to have sufficient local strength and rigidity.

3.3.3.3 The drill floor is in relevant areas to withstand the impact load from a falling $9\frac{1}{2}$" drill collar stand from a height of 1.5 m, and the structural stress is not to exceed material yield strength.

3.3.3.4 The main working area of the drill floor is to be skidding and weather protected

3.3.3.5 The setback area is to be covered with a material which prevents tool joint damage.

3.3.4 Flare booms

3.3.4.1 Operation and storage of flare booms (where applicable) are to be designed according to recognized standards.

3.3.4.2 The following applicable loads are to be considered in the structural design of flare booms:

(1) Weight of structure, pipes, attachments, passages, rails and all equipment

(2) Wind loads;

(3) Heat loads and pulse loads due to burning;

(4) Vortex shedding evaluation;

(5) Motion of the unit.

Section 4 Bulk Storage and Transfer, Drilling Fluid (Mud) Circulation and Cementing Systems

3.4.1 Bulk storage and transfer

3.4.1.1 General requirements

(1) The bulk storage and transfer system consists mainly of bulk storage tanks, air system and transfer piping;

(2) A sketch showing the transfer system is to be posted at the console for reference during emergency cementing operation. If the sketch is an electronic one, it is to be provided with an emergency source of power.

3.4.1.2 Protection from overpressure

(1) All bulk storage tanks are to be equipped with safety valves or rupture discs to prevent damage due to overpressure. If a bulk storage tank is installed in an enclosed space, it is to be fitted with a relief line routed to an open and safe area;

(2) Enclosed bulk storage areas are to be sufficiently ventilated to avoid a buildup of pressure in the event of a break or leak in the air supply system;

(3) Piping transferring bulks through air are to be fitted with safety valves with pressure settings not exceeding the maximum allowable working pressure of bulk storage tanks.

3.4.1.3 Requirement for drying

Measures are to be taken so that air used for transferring cement or bulk drilling fluids can be dried to dew point. This dew point is to be at least 7℃ below the ambient temperature. All air piping is to be purged by dry air before transferring operation.

3.4.2 Drilling fluid circulation

3.4.2.1 General requirements

(1) A drilling fluid circulation system consists mainly of:

① high pressure mud pumps, pulsation dampeners (air bag), discharge manifolds and lines;

② shakers, desanders, desilters, degassers, mixers, chemical mixers, centrifuges, and drilling fluid tanks (pits);

③ control and monitoring devices.

(2) If oil-based drilling fluid is used, particular attention is to be given to adequate ventilation in the spaces where oil vapour may possibly accumulate.

3.4.2.2 High pressure mud pumps

High pressure mud pumps are to be fitted with pulsation dampeners and safety relief valves set at not more than the maximum allowable working pressure of the systems. Mud relief lines form safety valves are to be self-draining.

3.4.2.3 Degassers and mud and gas separators

Degassers and mud and gas separators are to be vented to a safe location.

3.4.2.4 Drilling fluid mixing equipment

The capacity of drilling fluid mixing equipment (including passive drilling fluid tanks) is to meet the requirements of intended drilling program.

3.4.2.5 Drilling fluid tanks

The total volume of drilling fluid tanks is to satisfy the requirements of intended drilling program. In addition, a visual and audible alarm is to be installed for indicating abnormal conditions regarding drilling fluid tank volume.

3.4.2.6 Emergency circulation

(1) Emergency circulation is an essential function of drilling fluid circulation;

(2) Provision of drilling fluid mixing and circulation equipment and arrangement of piping is to satisfy the drilling fluid emergency circulation demand during drilling operation. When the cementing pump is used as means of emergency circulation, 3.4.3 of this Section is to be complied with.

3.4.2.7 Monitoring of drilling parameters

The following parameters are to be monitored at the drilling console, as applicable:

(1) Mud pump discharge pressure and rate;

(2) Volume of drilling fluid (mud) entering and leaving the borehole;

(3) Temperature of drilling fluid;

(4) Gas content in the drilling fluid;

(5) Difference in volume between the drilling fluid discharged and returned to the unit.

3.4.3 Cementing

3.4.3.1 A cementing system mainly comprises cementing pumps, pulsation dampeners and safety valves, centrifugal pumps for mixing cement, and relevant piping.

3.4.3.2 When the cementing pump is used as means of emergency circulation, facilities for transferring mud to the cementing system are to be provided, and the pump for transferring mud is to be capable of being supplied by an emergency power.

Section 5 Heave Compensation and Tensioning Systems

3.5.1 General requirements

3.5.1.1 This Section is applicable to drilling plants on floating offshore units.

3.5.1.2 Air control panels and accumulators are to be fitted with safety valves, and the air relief lines from safety valves are to be self-draining.

3.5.1.3 Compressed air may only be used with non-combustible hydraulic fluids.

3.5.1.4 Conditions (e.g. position of cylinder pistons, fluid level of leakage tank and leakage level) of the system are to be monitored at the drilling console, and alarms are to be initiated for abnormal conditions.

3.5.2 Heave compensation of drill string

3.5.2.1 The heave compensation equipment is to be designed to eliminate heave motion of the drill string on a floating unit for the purpose of stabilizing drilling well pressure, steadily landing blowout preventer stack and smoothly landing casing.

3.5.2.2 The heave compensation system equipment consists mainly of air compressors, air dryers, air cylinders, pneumatic/hydraulic accumulators, hydraulic cylinders and telescopic arms, control consoles/panels, sheaves and wire ropes.

3.5.2.3 Hydraulic cylinders are to be designed both for internal pressure loads, and for loads resulting from their function as structural members.

3.5.2.4 Restricted flow in both directions of compensators is to be arranged so as to safeguard against high velocity of pressurized fluid due to e.g. wire rupture, hose rupture etc.

3.5.2.5 The heave compensation system is to be designed to allow for certain loss of fluid during normal operation.

3.5.2.6 For fully active compensation equipment, single component failure is not to result in overall failure of the equipment. The power supply to system is to be ensured both in normal operation and emergency operation.

3.5.2.7 For active and passive combined compensation equipment, the failure of the active part is not to result in overall failure of the equipment.

3.5.3 Tensioning of marine drilling risers

3.5.3.1 The function of the riser tensioning system is to provide vertical force to riser top so as to control its stresses and displacements and maintain a basically constant tension to the riser during vertical and horizontal movements of the unit.

3.5.3.2 The equipment of a riser tensioning system mainly includes air compressors, air dryers, control consoles/panels, air vessels, pneumatic/hydraulic accumulators, hydraulic cylinders and telescopic arms, tensioner sheaves and wire ropes.

3.5.3.3 The setting of minimum tension of the system is to guarantee the stability of the riser. The maximum set tension is not to exceed 90% of the dynamic tension limit (DTL) of the tensioner. DTL refers to the ratio of the product of the maximum allowable pressure of tensioner cylinder and its effective hydraulic area to the number of ropes on piston rod sheaves.

3.5.3.4 The tensioning system is to be designed such that in case of failure or repairing of one tensioner, the remaining tensioners are capable of providing the required minimum tension to the riser.

3.5.3.5 The idle sheaves in the tensioning system are to be arranged such as to minimize the angle between tensioning ropes and telescopic pipe axis of the riser so as to maximize vertical component of tension to prolong rope service life.

3.5.3.6 Flow restriction means are to be fitted on pipelines of the tensioning system so that in case of tensioner rope rupture or other failures, fluid flow into the tensioner cylinder will be stopped or greatly reduced.

3.5.3.7 For units fitted with dynamic positioning equipment in deepwater operation, the tensioning system is to be provided with means to prevent recoil of riser in emergency disconnecting the riser so as to avoid damage to the riser, unit and personnel.

3.5.4 Tensioning of guide rope and control pod guide rope

3.5.4.1 Tensioning means are to be provided for guide ropes that serve dismantling and installation of subsea equipment and subsea blowout preventer control pod guide ropes, in compliance with the applicable requirements of 3.5.3 in this Section.

Section 6 Hoisting, Rotating and Pipe Handling/Blowout Preventer Handling Systems

3.6.1 Hoisting and rotary systems

3.6.1.1 General requirements

(1) The major components of hoisting and rotary systems include drawwork and winches, crown block, traveling block, dead line anchor, swivel, top drive, hook, slinger, elevator, kelly and rotary table.

(2) The maximum allowable working load is to be determined by taking account of the working load of the weakest part in interrelated systems.

(3) The equipment installed above the drill floor is to be properly fastened and secured to prevent falling down.

(4) Sheaves, hooks, shackles, hoisting ropes and permanent fittings are to be marked with safe working load (SWL).

(5) Personnel lifting devices are to comply with the requirements in 3.6.4 of this Section.

3.6.1.2 Drawworks

(1) The major functions of drawworks are making a tripp, lifting heavy goods, operating as shift gear or intermediate transmission mechanism of the rotary table.

(2) The drawwork is to have a braking capacity complying with the following requirements:

① Calculation of braking capacity (e.g. selection of friction coefficient) is to take into consideration the worst conditions of mechanical parts.

② Brakes relying on mechanical frictional brakes are to be properly shielded against possible dirt which may affect the performance of the brakes.

③ The capacity of brakes relying on mechanical friction is to comply with the following minimum requirements:

(a) For systems where loads are not lowered by powered descent: 200% SWL;

(b) For systems where loads are not lowered by powered descent: 110% of the sum of static braking moment and the maximum obtainable static moment of the motor, when both moments are exerted in the same direction (static braking moment refers to the moment resulting from lifting SWL with maximum layers of rope on the drum).

④ The cooling water of electromagnetic brakes is to be provided with flow and temperature control, and alarm is to be initiated in case of any limit being exceeded.

⑤ The mechanical coupling between the electromagnetic brake and drawwork drum is to be provided with a device to prevent unintentional disengagement.

(3) The drum is the core part of drawworks. Simple cylindrical drums are to be designed such that the hoop stress σ_h in the barrel will not exceed 85% of the material yield stress. The hoop stress is calculated as follows:

$$\sigma_h = \frac{CS}{pt_{av}}$$

where: S —— tension of rope under spooling, in N;

p —— distance from center to center between ropes within the same layer, in mm;

t_{av}—— average wall thickness of drum barrel, in mm;

C —— Coefficient, 0.85 for first layer of rope, 1 for second layer of rope, 1.3 for third layer of rope and 1.75 for fourth layer and above.

For other drum designs with e.g. internal stiffeners, other recognized calculation methods are to be applied.

(4) Flanges are to be provided at both ends of the drum. The lateral pressure acting on the flanges is assumed to be linearly increasing from zero at the top layer of rope to a maximum value:

$$p_f = \frac{2t_{av}\sigma_h}{3D}$$

where: D —— outer diameter of the barrel, in mm;
σ_h —— hoop stress of rope on the top layer, in N.
Where justified by tests, a smaller pressure may be used.

3.6.1.3 Crown blocks, traveling blocks and wire ropes

The crown block, traveling block and wire rope are three parts which connect the supporting derrick structure with drawworks to hoist and lower drill string. The three parts are to be designed for sufficient bearing capability.

3.6.1.4 Hooks

The hook used to hang rotary swivel is to have sufficient strength, the body of the hook is to be capable of rotating flexibly and hook is to be provided with a safe-lock device.

3.6.1.5 Rotary swivel

When hanging drill stem, the rotary swivel is to keep normal operation and provide a high-pressure sealed channel for drilling fluid entry into drill stem.

3.6.1.6 Rotary table

The rotary table is to be designed to have sufficient capability to rotate drill stem and support drill stem by installed slips.

3.6.1.7 Top drive

In addition to functions of swivel, the top drive (also named as powered rotary swivel) is to have functions of driving and providing torsional moment to drill stem.

3.6.1.8 Elevator links, elevators and deadline anchors

Elevator links, elevators and deadline anchors are to have sufficient bearing capability.

3.6.1.9 Control and monitoring of hoisting and rotary systems

(1) Means are to be provided to prevent the main hoisting equipment (traveling block or top drive) from being run into the crown block;

(2) If an anti-collision system is fitted and when possible collision is detected, the hoisting operation is to be stopped automatically;

(3) The automatic hoisting operation is in case of any system failure to initiate alarm and automatically return to fail-safe mode;

(4) In case of failure of the brake activation system (including operator error), the hoisting operation is to be stopped automatically;

(5) The hoisting system is to be equipped with an easily identifiable and accessible emergency stop device, which is to be independent of the control system and has functional capabilities to both stop and safely lower the load in the event of main brake failure;

(6) The drilling console is to be provided with necessary monitoring device to detect abnormal conditions that may lead to critical failures. Alarms are to be initiated for abnormal conditions;

(7) The following parameters are to be indicated at the drilling console:

① vertical position of hoisting device;
② weight of drill string;
③ drilling depth and mechanical drilling speed;
④ revolving speed and torsional moment.

3.6.2 Pipe handling system

3.6.2.1 General requirements

(1) Main functions of the pipe handling system are horizontal and vertical operations of pipes, consisting mainly of tongs, grippers and lifting magnets.
(2) The holding function of grippers and magnets is essential and there should be reliable measures to prevent unintentional loss of the holding function.
(3) Unless otherwise justified, it is to be possible to complete emergency manoeuvring within 10 minutes of the start of the emergency.
(4) The minimum breaking strength of all fittings and connections is to be at least the same as that of the cable, wire rope or stiff arm to which they are attached. Knots are not to be used to fasten cable or wire rope lines.

3.6.2.2 Tongs

(1) All tongs are to be securely fastened to the derrick or a back-up post and anchored by a wire rope or stiff arm having a minimum breaking strength greater than that of the pulling cable or chain.
(2) Tongs are to be arranged with safety lines. The lines working on the side opposite the safety line are to have a minimum breaking strength greater than the force of the makeup torque.
(3) The breaking strength of all fittings and connections is to be no less than the minimum breaking strength of the connected cables, wire ropes and rigid arms.
(4) The pressure system of power tongs is to be equipped with a safety relief valve.
(5) Failure of the torsional sensor is not to lead to a critical situation.

3.6.2.3 Grippers

(1) Grippers where frictional forces are required to prevent the load from dropping are to be designed to hold two times SWL by frictional forces in the worst operational direction. Frictional coefficients are to be selected taking into account realistic operational surface conditions (e.g. greasy pipe). The holding power is to be verified through testing.
(2) Grippers are to be protected from potential destructive loads that could occur due to vertical loads caused by operating the pipe handling systems downwards.
(3) The failure of power is not to lead to loss of gripper function.
(4) For hydraulically operated grippers, gripper function is to be maintained in the event of hose rupture.

3.6.2.4 Lifting magnets

(1) Lifting magnets are to be capable of holding three times SWL at normal operating conditions.
(2) The lifting magnet is to be provided with means for proper contact with the pipe lifted.
(3) Where standby power is necessary, alarm is to be given in case of failure of standby power.

3.6.2.5 Horizontal handling of pipes

(1) Horizontal handling of pipes refers to transportation of pipes in deck area, for instance transportation of pipes between storage area and drilling deck.
(2) The structural design of horizontal pipe handling equipment is to take into consideration all loads including the load resulting from unit movement.
(3) During pipe handling operation, measures are to be provided to restrict access to operating area, e.g. visible and audible warnings.

3.6.2.6 Vertical handling of pipes

(1) The main vertical pipe handling equipment includes racking board (secondary platform), stand lift arrangement, stand guide arrangement and make-up or break-out arrangement.
(2) Suitable devices are to be provided to secure drill pipes, drill collars, tubing and casing possibly placed in the derrick.
(3) Storage racks are to be designed or other devices installed to prevent drill collars, pipes and other tubular material from being accidentally released from the rack.
(4) The drill floor area is to be regarded as manned during remote pipe handling operations, with particular attention being paid to the potential for accidents and injuries resulting from single failure or error.
(5) Measures are to be provided to prevent unintentional collision in automatic operation.

(6) In case of system failure, the operation of the computer-based pipe handling system is to be automatically halted in its present location or brought to a safe location, as appropriate.

3.6.3 Handling of blowout preventer

3.6.3.1 The design of blowout preventer carrier or skid and its securing device is to be in accordance with the maximum loads in operational and survival conditions.

3.6.3.2 Consideration should be given to the effects of wave slamming and sea current forces on the guideline system as the subsea blowout preventer is deployed.

3.6.3.3 The requirements of 3.6.2.1 (3) in this Section are also applicable to handling of blowout preventers.

3.6.4 Personnel lifting devices

3.6.4.1 General requirements

(1) These requirements are applicable to lifting devices intended for lifting of personnel, and having a height of fall above 3 m;

(2) The safety factor for all load-bearing parts in the personnel lifting system is to be two times that for the same parts of material lifting devices;

(3) All relevant design loads are to be taken into consideration for all operational and non-operational modes. The maximum environmental loads during which the equipment is designed to operate are to be clearly stated;

(4) The movement of control equipment is to be smooth, continuous and repeatable. The winch is to be provided with a speed limiting device for safe transport of personnel. The maximum acceleration of normal and emergency braking is not to injure or harm personnel being transported;

(5) Operation control panels are to be situated at convenient locations. The control handle or equivalent (e.g. button) is to return automatically to stop position when not being operated. Control panels are to include devices for normal operation and emergency stop and be provided with means against inadvertent operation;

(6) Load limiting devices are to be fitted to prevent loads above SWL from being lifted;

(7) The breaking strength of ropes is at least to be ten times SWL;

(8) The hydraulically operated systems are to ensure safety during all operating conditions, including power loss and emergency operation;

(9) Single failure and single error is not to lead to accidents or injuries;

(10) Means of safe egress are to be provided in case of equipment failure, or other hazardous events;

(11) The control position is to be located such that the operator has an unobstructed view of the working range of the equipment. If this can not be accomplished, persons being lifted are at all times to have ready access to an emergency stop device;

(12) The operation outside safe operating limits is to be automatically stopped;

(13) Controlled lowering of the lifting device is to be possible in the event of power failure or other unintended stop. Frictional couplings or clutch is not to be used for emergency operation;

(14) Provision for emergency hoisting is to be present where this may be required for safe escape during an emergency;

(15) Both emergency lowering and hoisting are to be completed within 10 minutes of the start of the emergency. The lowering and hoisting speed should not exceed 1 m/s;

(16) The total weight between winch and sheave arrangement is not to exceed the total weight hoisted by ropes on the other side of the sheave arrangement. This may be accomplished by means of counterweights. Such counterweights are to be arranged to avoid interference with other components, or potential for personnel injury;

(17) Winches are to be designed for power-driven operation up and down, i.e. no free fall with brakes.

3.6.4.2 Sheave arrangement

(1) The sheave arrangement is to be fitted with protection ensuring that derailing of wire rope does not occur;
(2) The diameter ratio between sheave and rope is to be no less than 18:1.

3.6.4.3 Drum

(1) Means are to be fitted to prevent derailing of wire rope and to ensure satisfactory spooling of wire rope;
(2) The diameter ratio between drum and rope is to be no less than 18:1;
(3) At least 3 turns of wire rope are to remain on the drum at the lowest possible operating position of lifting device.

3.6.4.4 Brakes

(1) Two separate, independently operated braking systems are to be fitted, of which one is considered as parking brake and the other as operational brake (e.g. brake to stop motor). Each brake is to be capable of stopping and holding the load upon activation;
(2) Each brake is to automatically engage upon emergency stop, power loss or other energy failure. In normal operation, the parking brake may be manually operated.
(3) The brakes should preferably be fitted directly on the drum. If this is not feasible, all components transmitting brake forces are to be dimensioned as the brake itself.
(4) Each brake is to be able to hold a static load of 1.8 times SWL;
(5) The operational brake is to be engaged with the control devices in neutral position;
(6) Means are to be provided to avoid unintentional release.

Section 7 Marine Riser System

3.7.1 General requirements

3.7.1.1 This Section is applicable to riser systems on floating offshore units.

3.7.1.2 The main functions of the marine riser system are to provide a channel for fluid flow between the floating drilling unit and the wellhead, support for kill, choke and other pipelines, guide for entry of drilling tools into well and service for deployment and recovery of blowout preventers.

3.7.1.3 Main components of the marine riser system include tensioner system, diverter system, telescopic joints (including tensioner ring), coupling, riser joints, flexible/ball joints, lower marine riser package (LMRP), kill and choke and auxiliary lines, buoyancy devices, riser running equipment and special equipment.

3.7.2 Functional requirements for components

3.7.2.1 Tensioner system

Functions of tension equipment are given in Section 5 of this Chapter.

3.7.2.2 Diverter system

Functions of diverter system are given in Section 8 of this Chapter.

3.7.2.3 Telescopic joints

The basic function of a telescopic joint is to compensate for relative displacement between floating unit and riser and transmit tension forces to the riser through tensioner ring installed on the outer barrel.

3.7.2.4 Couplings

Coupling provides a means of quickly connecting and disconnecting riser joints and in addition may provide support for choke, kill and auxiliary line and load reaction for buoyancy devices, and provides support to transmit the weight of suspended riser string to the riser handling spider while running or retrieving the riser.

3.7.2.5 Riser joints

Riser string is composed of interconnected riser joints having a coupling welded on each end. The riser string is the main component of the riser system and executes functions specified in 3.7.1.2 of this Section.

3.7.2.6 Flexible/ball joints

The use of flexible/ball joints allows angular misalignment between riser and blowout preventer and between riser and floating unit so as to reduce bending moment on the riser.

3.7.2.7 Lower marine riser package

(1) The lower marine riser package mainly include riser adapter, flexible/ball joints, subsea control pod, riser connector, and one, two or no annular preventer.

(2) Main functions of the lower marine riser package are to provide a release interface between blowout preventer and riser and in addition, to provide hydraulic control of blowout preventers by control pods and provide kill and choke channels to blowout preventer stack by jumper hose.

3.7.2.8 Pipelines on riser string

The pipelines fixed on the riser string mainly include kill and choke pipelines, air pipelines to provide air to buoyancy cans, hydraulic pipelines to provide hydraulic fluid for control of blowout preventers, and mud boost pipelines to pump drilling fluid into the riser just above the blowout preventer stack to increase annular circulating velocities.

3.7.2.9 Buoyancy devices

Buoyancy devices may be attached to riser joint so as to reduce tension on riser top.

3.7.2.10 Riser running equipment

The riser running equipment mainly includes handling tools for hoisting and lowering risers and blowout preventer stack, riser spider supporting for the riser and blowout preventer stack, and guide lines for directing the riser and associated subsea equipment to proper locations.

3.7.2.11 Specialty equipment

Specialty equipment mainly includes 760 mm (30 inchs) latch used to connect wellhead housing and hang-off system used to hang off the disconnected riser.

3.7.3 Design and operation limits

3.7.3.1 The design of riser strings is to take into consideration the inner and outer pressure and the loads imposed by external environment (wave and current); the design and installation of lower marine riser packages, blowout preventer stack and wellhead are to take into consideration the shear, bending and tension loads transmitted by the riser string; the positioning analysis of floating units is preferably to take into consideration loads transmitted to the unit by risers.

Loads on all parts of the system are to be assessed to ensure that the maximum stress is within the allowable scope and that the fatigue life is acceptable.

3.7.3.2 In riser design, the following three operation modes are to be considered:

(1) drilling mode;

(2) connected nondrilling mode;

(3) disconnected mode.

3.7.3.3 In the above operation modes, the limits of the following design parameters are to be specified:

(1) angles of upper and lower flexible/ball joints (mean value and maximum value);

(2) allowable stress criteria;

(3) tension (dynamic tension limit, minimum setting tension and maximum setting tension).

3.7.3.4 The limit of each parameter in every operation mode is to be clearly recorded in the operation manual.

3.7.4 Monitoring

3.7.4.1 Riser angle indicators, wellhead position indicators, tensioner pressure gauges and video cameras are to be provided to monitor the riser system.

3.7.5 Disconnectin

3.7.5.1 Apart from normal disconnecting, risers are to be provided with emergency disconnecting equipment for quick release in uncontrollable unit displacement so as to avoid damage to unit and risers. The control requirements for emergency disconnecting are given in Section 8 of this Chapter.

3.7.6 Operation manual

3.7.6.1 The unit is to be provided with riser system operation manual, which is at least to include the following:

(1) Drawings of riser system components provided by the manufacturer, indicating critical parameters such as size and weight;
(2) Rated load of critical components of riser system as specified by the manufacturer;
(3) Rated internal and collapse pressure rating of riser and integral lines;
(4) Procedure of running and retrieving of riser system;
(5) Procedure of setting maximum and minimum tension;
(6) Operation limits and emergency procedures;
(7) Examination and maintenance procedures for each component;
(8) Criteria and procedures for cutting and slipping tensioner lines;
(9) An accurate example of operation logbook;
(10) List of recommended spare parts.

Section 8 Well Control System

3.8.1 General requirements

3.8.1.1 Well control systems are composed mainly of blowout prevention system, kill and choke system, diverter system and control and monitoring system.

3.8.1.2 Well control systems are designed mainly to confine well in the wellbore, provide means to add fluid to the wellbore, and allow controlled volumes to be safely withdrawn from the wellbore. In addition, the riser of a floating unit is to be able to be quickly disengaged from subsea blowout preventer stack.

3.8.1.3 All the system components are to be designed as fire-proof type.

3.8.1.4 The provisions of 3.8.6 in this Section are applicable to all hydraulic and pneumatic systems in drilling plants.

3.8.2 Blowout prevention

3.8.2.1 Blowout preventer

(1) The main function of the blowout preventer is to seal drilling well in case of excessive pressure in well bore or abnormal spillage of drilling fluid.

(2) Blowout preventers are categorized as annular (universal) blowout preventers and ram blowout preventers; rams are categorized as full sealing (shear) and half sealing (pipe) rams; ram blowout preventers are categorized as single, double and triple rams blowout preventers. Blowout preventers are divided into six standard grades in terms of maximum working pressure or ten standard series in terms of through diameters.

(3) Blowout preventer stack is generally used in drilling operation. A blowout preventer stack is generally composed of the following one, two or more blowout preventers, generally with drilling spools fitted to surface blowout preventer stack:

① an universal blowout preventer;
② single ram blowout preventer with mechanical locking device;

③ double ram blowout preventer with mechanical locking device.

(4) The pressure grade and through diameter of a drilling spool are to be no less than those of the blowout preventer connected thereto.

(5) The blowout preventer stack is to be provided with kill and choke lines, which may be directly installed on side outlet of blowout preventer or drilling spool.

(6) The shear ram blowout preventer is to be able to shear the thickest section of the heaviest drill stem specified for use with the blowout preventer.

(7) The pipe ram blowout preventer is to be designed for any hang-off loads to which it may be subjected.

(8) The ram blowout preventer is to be provided with a locking device to ensure long-term seal.

(9) Adequate amount of spare parts for blowout preventers is to be provided.

3.8.2.2 Valves of drill stem

(1) The main function of valves in the drill stem is to prevent back flow in the drill stem.

(2) The drill stem is to be equipped with two kelly cock valves, one of which installed below swivel and the other at the bottom of Kelly. One of the valves is to be capable of being remotely controlled. The lower kelly cock valve is to be designed such that it can be run through surface blowout preventer stack.

Where top drive is used in drilling, hydraulic remote control valves are to be installed below top drive.

The operation handle (button) of remotely controlled valves are to be easily accessible, clearly marked and provided with means against inadvertent operation.

(3) The design pressure of kelly cock valves is to be no less than the rated pressure of blowout preventers.

(4) A manual valve in open position for the drill stem is to be available for immediate use at all times.

(5) A spanner or other tools are, if required for manual valves, are to be kept in a readily accessible place.

(6) An open or close drill stem safety valve is to be located in open position on the drill floor where it is available for immediate use. The valve is to be capable of withstanding the same well surface pressures as the blowout preventers in use, and is to fit the pipe in use at the time and it is not to be possible to mount this safety valve in a wrong direction.

3.8.3 Choke and kill

3.8.3.1 The main function of choke manifolds is to discharge pressure in well bore at controllable rate or fully stop flow of fluid; the main function of kill lines is to pump drilling fluid into well or circular space when blowout preventers are closed during well control operation.

3.8.3.2 Each choke and kill pipeline from the blowout preventer stack is to be equipped with two stop valves installed on the blowout preventer stack. Where the blowout preventer stack is installed on the seabed, these two stop valves are to be arranged for hydraulic remote control; for surface blowout preventer stack, only one of these two valves may be arranged for hydraulic remote control.

3.8.3.3 The high pressure side of choke manifolds and kill lines are to be rated to at least the same working pressure as the rated working pressure of the blowout preventer stack. The pressure rating of fittings and valve is to match that of pipes to which they are connected.

3.8.3.4 The maximum and minimum design temperatures of choke and kill manifolds are 121℃ and -29℃ respectively, and any design temperature beyond the limits is to be stated.

3.8.3.5 The choke and kill manifolds are to have the function to pressurize drilling fluids to rated pressure of the blowout preventer stack by using mud pumps, cementing pumps or other pumps.

3.8.3.6 The choke manifolds and kill lines are to be arranged to enable pumping through one line whilst there is simultaneous flow return over the chokes through the opposite line.

3.8.3.7 The kill and choke manifolds are to be provided with valves as follows:
(1) One valve for each of the outlet and inlet lines, such that lines to and from the manifold can be isolated. Where high pressure or low pressure zones meet in the manifold system, 2 valves arranged in series are to be used. Manifolds for 34.5 MPa or higher pressures are to be equipped with 2 valves before each of the chokes. The working pressure of the valves is to be rated not less than that of the choke manifold.
(2) At least 3 chokes for the choke manifold, of which one is to allow for remote control, and one for manual adjustment. It is to be possible to isolate and change each choke while the manifold is in use.
3.8.3.8 It is to be possible to route the returns from the choke manifold through an permanently installed mud and gas separator. It is also to be possible to route the returns through a fixed piping arrangement leading directly overboard (overboard lines). The pressure rating of the overboard lines is not to be less than that of the buffer chambers of the choke manifold.
3.8.3.9 Vent lines from the mud degassing or gas separator are to extend 4 m above the crown block.

3.8.4 Diverters

3.8.4.1 The function of a diverter system is to divert the hazardous well flow (shallow gas) overboard by semi- or full-sealing of well bore and opening valves on diverter vent lines prior to setting the casing string on which the blowout preventers and choke manifolds will be installed during top-hole drilling.
3.8.4.2 A diverter with a securing element for closing around the drilling equipment in the hole is to be provided.
3.8.4.3 The diverter is to be equipped with two 254 mm or larger lines that are to be piped overboard in opposite directions.
3.8.4.4 The diverter valve is to be of full opening type and its caliber is to be the same as that of the pipe.
3.8.4.5 The design of pipelines is to take into consideration possible erosion during operation. The bends of pipelines are to be minimized to ensure internal smoothness.

3.8.5 Control and monitoring of well control system

3.8.5.1 The well control system is to be provided with at least two control panels, one of which is to be operated at the driller's stand. These control panels are to be directly connected to main equipment of the control system, and not in series. Each control panel is to include but not limited to the following control devices:
(1) Closing and opening of blowout preventers;
(2) Closing and opening of kill and choke valves of blowout preventers;
(3) Operation of diverters;
(4) Normal and emergency disconnection of riser connectors on floating units.
3.8.5.2 The second control panel is to be located at a suitable distance from the driller's stand and arranged for easy access, including when the control panel at the driller's stand is not functioning or is out of reach.
The operation of the diverter may be controlled at one location and no second control panel is required.
3.8.5.3 The control panels are to give clear indication of blowout preventer status (i.e. open or closed), indicate available pressure for the various functions and operations, give visible and audible alarm signals for low pressure of accumulators, loss of power supply and low levels in control fluid storage tanks.
3.8.5.4 The control console (panel) is to be provided with means against inadvertent operation. Additionally, for floating units, the activation devices for riser disconnection and shear ram(s) are to have additional protection against inadvertent operation.

3.8.5.5 For hydraulic systems, the main unit of the control system, including the pilot valves, are to be situated in a shielded position easily accessible from the outside without requiring entry via the drill floor or the cellar deck.
3.8.5.6 For electrical or computer-based systems, two mutually independent systems are to be installed.
3.8.5.7 The control system of blowout preventers is to be designed such that the time from start of driving each preventer to completion of closing it is as follows:
(1) Not more than 30 s for surface ram blowout preventers and surface annular blowout preventers with through diameter less than 500 mm, and not more than 45 s for surface annualr blowout preventers with through diameter not less than 500 mm;
(2) Not more than 45 s for subsea ram blowout preventers, and not more than 60 s for subsea annular blowout preventers.
3.8.5.8 Two independent hydraulic pipelines are to be led from the main hydraulic equipment to control subsea blowout preventers, and each set of pipelines is to be provided in different control pods.
3.8.5.9 When the system is started or reset, normal operation is to be resumed automatically.
3.8.5.10 In case of failure of pump unit, the capacity (volume and pressure) of accumulators is to meet the requirements for blowout preventer stack control and the specific design is to comply with the provisions of API SPEC 16D.
3.8.5.11 Clear indications of drill pipe pressure and choke manifold pressure are to be available on all kill and choke control stands. Choke valve position and drilling fluid pump rate are in addition to be available at the remote control stand.
3.8.5.12 The diverter control system is to be equipped with an interlock to ensure that the valve in the diverter pipe is opened before the diverter closes around the drilling equipment.
3.8.5.13 The response time of the diverter control system is to comply with the following requirements:
(1) 30 s for packing elements with nominal bore not more than 508 mm;
(2) 45 s for packing elements with nominal bore more than 508 mm.
3.8.5.14 The emergency disconnector of riser and subsea blowout preventer stack are to be independent from their main disconnectors. In addition to operation at normal position, the emergency disconnector is to be capable of being operated at another position accessible in the event of an emergency.
3.8.5.15 The emergency disconnector is to be provided with a special subsea accumulator, which is to, in case of pump failure, sequentially close pipe blowout preventers and shear blowout preventers, and open riser connectors.

3.8.6 Hydraulic and pneumatic systems

3.8.6.1 Hydraulic systems
(1) The performance of hydraulic fluid is to satisfy the temperature requirements for operation environment and cause no chemical corrosion of system components. Its flash point is to be not less than 150℃.
(2) The system is to be provided with means to prevent pressure pulse. The fluid flow is to be maintained in laminar flow condition.
(3) The detachable connector is to be protected against fluid leakage that will cause injury to personnel or spillage to hot surfaces.
(4) Where necessary, the system is to be provided with means for filtration and for deflation of entrapped gases.
(5) Systems required to be in continuous operation or systems for which critical maloperation may be caused by dirty fluid are to be provided with two parallel filter systems, and alarm is to be initiated in case of filter blockade.

(6) Accumulators locally installed as standby power of source for essential systems are to be protected against unintentional isolations or mechanical damages that will interfere with required correct operation.
(7) The piping and equipment required to remain in service in case of fire are to be fire-resistant.
(8) Hydraulic return lines are to be designed for maximum return flow in adverse conditions. Special attention is to be paid to blockages in filters or vent pipes as well as blockages due to mechanical damage or inadvertent valve operation.
(9) The air pipes on circulation tanks and expansion tanks are to be directed to a safe place.
(10) Prior to use, piping is to be flushed and cleaned.

3.8.6.2 Pneumatic systems

(1) The components, which have a stricter requirement for air quality than instruments, are not to be used for pneumatic systems. Extremely small openings are to be avoided in pneumatic passages.
(2) The main pipes are to be inclined relative to the horizontal with drainage at the lowest point so as to prevent liquid accumulation in pipes.
(3) The instrument air is to be free from oil, moisture, contamination and condensation under relevant pressure and humidity.
(4) Where a system serves more than one function (e.g. two control loops), it is to be provided with two sets of reduction valves and filters.
(5) Accumulators locally installed as standby air source of essential systems are to be protected against unintentional isolations or mechanical damages that will interfere with required correct operation.
(6) Piping is to be flushed and dried prior to use.

Section 9 Well Testing System

3.9.1 General requirements

3.9.1.1 The main equipment of a well testing system includes burners, testing separator, heat exchanger, testing manifolds and piping.

3.9.1.2 The safety-related parameters in testing system, e.g. pressure, level and temperature are to be monitored.

3.9.1.3 Emergency shut-down valves are to be provided between well and testing equipment, but may be omitted where the master control valve provided on the well has emergency shut-off function. The emergency shut-down valves are to be capable of being controlled both locally and in control room.

3.9.1.4 All pressure bearing equipment and piping are to be capable of being manually discharged from a safe position.

3.9.1.5 The discharge of oily water in testing system is to comply with the provisions of the Administration of the State having jurisdiction over drilling area.

3.9.2 Testing separator

3.9.2.1 Two safety valves are to be provided on testing separator, each valve being sized to the maximum release volume in expected single well testing.

3.9.3 Heat exchanger

3.9.3.1 Safety valves are to be provided on heated end and heating end of heat exchanger.

3.9.4 Flare burner

3.9.4.1 Flare burner is to be fitted at a safe distance from the unit, which is to be validated by heat intensity calculations.

3.9.4.2 Means are to be provided for cooling flare burner.

3.9.4.3 In case where crude oil is burned and atomization is used, the atomization supply lines are to be provided with non-return valves or other recognized means to prevent return of hydrocarbon to non-hazardous piping system.

3.9.4.4 The design of burning system is to ensure full combustion of crude oil.
3.9.4.5 Automatic ignition system is to be provided to ensure ignition of flare burner in testing.

3.9.5 Manifolds and pipelines

3.9.5.1 Safety valves are to be provided between choke manifolds and heat exchanger and may be omitted where the design pressure of choke manifolds and heat exchanger is higher than well closing pressure.
3.9.5.2 The inner diameter of flare line or downstream line of choke valves is to be not less than that of the greatest pipeline in the choke manifold.
3.9.5.3 The flexible hoses from swivel and kelly are not to be used as part of testing lines.
3.9.5.4 Two complete flare lines or other means are to be provided for testing, which are respectively arranged on both sides of the drilling plant.
3.9.5.5 Two valves are to be installed in series in bypass lines of pressure relief arrangement (e.g. choker).
3.9.5.6 Where the pressure grade in piping is changed, means are to be provided to prevent overpressure of the lower rated pipe lengths and if practicable, two isolating valves are to be installed.

Section 10 Piping

3.10.1 General provisions
3.10.1.1 Piping mainly includes pipes, fittings, valves, flanges, expansion connectors, flexible hoses and hose connectors for the purpose of transfer and control of fluid flow.
3.10.1.2 Categorized by functions, the piping of a drilling system mainly includes:
(1) High pressure drilling fluid and cementing piping;
(2) Choke and kill piping;
(3) Well testing piping;
(4) Diverter piping;
(5) Control piping of blowout preventers and other equipment;
(6) Bulk mud and cement piping.
3.10.1.3 Piping is to be designed to withstand the maximum stress that could arise from the most severe combination of temperature and pressure.
3.10.1.4 The design of piping is to take into account the following but not limited to the following relevant factors and combinations of these factors:
(1) Corrosion, erosion;
(2) Vibration, hydraulic hammer;
(3) Pressure pulsations;
(4) Excessively low temperature;
(5) External impact influence.
3.10.1.5 The downstream piping of safety valves is preferably to be sized one diameter nominal size larger than upstream piping. The sizing of other open-ended piping is also take into account expected pressure gradients during operation.

3.10.2 Wall thickness

3.10.2.1 For the pipes under internal pressure, the minimum wall thickness δ is to be not less than that obtained by the following formula:

$$\delta = \delta_0 + b + h + c \quad \text{mm}$$

where: δ —— minimum calculated thickness, in mm;

δ_0 —— basic calculated thickness, in mm, see provisions of 3.10.2.2 of this Section;
b —— additional bending allowance, in mm, see provisions of 3.10.2.3 of this Section;
h —— thread allowance, in mm, see provisions of 3.10.2.4 of this Section;
c —— corrosion allowance, in mm, see provisions of 3.10.2.5 of this Section.

3.10.2.2 Formula for basic calculation of wall thickness

Where D/δ is not less than 6, the basic wall thickness δ_0 is to be calculated as follows:

$$\delta_0 = \frac{pD}{2[\sigma]e + p} \quad \text{mm}$$

where: p —— design pressure, in Mpa;
D —— outer diameter of pipe, in mm;
$[\sigma]$——permissible stress of pipe material, in N/mm^2, see provisions of 3.10.2.6 of this Section;
e —— effective welding coefficient, taken as 1 for seamless steel pipes, electric resistance welded pipes and high frequency welded steel pipes, e to be otherwise considered for pipes made by other methods.

Where D/δ is less than 6, δ_0 is to be calculated in accordance with the combined stress method specified in 3.10.2.8 of this Section.

3.10.2.3 The additional bending allowance b is to be not less than that obtained by the following formula:

$$b = 0.4\frac{D}{R}\delta_0 \quad \text{mm}$$

where: R —— mean radius of the bend, in mm, R generally taken not less than $3D$;
D —— outer diameter of pipe, in mm;
δ_0 —— basic calculated wall thickness, mm.

3.10.2.4 The thread allowance is at least to be equal to thread depth. For machined surfaces or grooves where the tolerance is not specified, the tolerance is to be 0.5 mm in addition to the specified depth of cut.

3.10.2.5 Corrosion allowance

(1) The corrosion allowance of steel pipes is to be selected in accordance with Table 3.10.2.5.

(2) For pipes passing through tanks, an additional corrosion allowance for external corrosion is to be added, depending on the external medium; where pipes are effectively protected against corrosion, corrosion allowance may be reduced up to50%; where stainless steel is used, the corrosion allowance may be reduced to zero.

(3) For drilling fluid (including kill and choke) or cementing piping system, the corrosion allowance is to include erosion allowance and for other piping systems exposed to erosion, the erosion allowance is to be taken into account.

(4) For pipes of brass, copper, copper-tin alloys and copper-nickel alloys with nickel content less than 10%, the corrosion allowance is to be 0.8 mm; for pipes of copper-nickel alloys with nickel content not less than 10%, the corrosion allowance is to be 0.5 mm; where the media has no corrosive effect on pipe material, the corrosion allowance may be zero; a greater corrosion allowance is to be adopted where pipe material is subject to heavy corrosion and/or erosion.

Steel Pipe Corrosion Allowance *C* mm **Table 3.10.2.5**

Piping service	*C*	Piping service	*C*
Compressed air	1.0	Lubricating oil	0.3
Hydraulic oil	0.3	Fuel oil	1.0
LPG	0.3	Crude oil	2.0
Well test or hydrocarbon	0.5	Fresh water	0.8
Drilling fluid or cementing	3	Seawater	3.0

3.10.2.6 Permissible stresses

(1) The permissible stress $[\sigma]$ of steel pipes is to be taken as the minimum value calculated by the following formula:

$$[\sigma] = \frac{R_m}{2.7} \quad \text{N/mm}^2$$

$$[\sigma] = \frac{R_{eH}^T}{1.6} \quad \text{N/mm}^2$$

$$[\sigma] = \frac{R_{m10000}^T}{1.6} \quad \text{N/mm}^2$$

$$[\sigma] = R_{p1\%10000}^T \quad \text{N/mm}^2$$

where: R_m —— specified tensile strength of material at ambient temperature, in N/mm^2;

R_{eH}^T—— specified yield strength or 0.2% proof strength ($R_{P0.2}$) of material at design temperature, in N/mm^2;

R_{m10000}^T —— average stress of material to produce rupture in 100,000 h at design temperature, in N/mm2;

$R_{p1\%10000}^T$ —— average stress of material to produce creep in 100,000 h at design temperature, in N/mm^2.

R_m, R_{eH}^T and R_{m10000}^T are to comply with the relevant provisions of CCS Rules for Materials and Welding, and $R_{p1\%10000}^T$ is to be determined according to relevant standards.

(2) The permissible stresses of copper and copper alloy pipes are to be selected from Table 3.10.2.6.

Permissible Stresses of Copper and Copper Alloy Pipes Table 3.10.2.6

Pipe material	Testing conditions	Min. tensile strength N/mm^2	Permissible stress N/mm^2										
			Design temperature℃										
			50	75	100	125	150	175	200	225	250	275	300
Copper	Annealing	215	41	41	40	40	34	27.5	18.5	—	—	—	—
Alum. brass	Annealing	325	78	78	78	78	78	51	24.5	—	—	—	—
CuNi5Fe1Mn CuNi10Fe1Mn	Annealing	275	68	68	67	65.5	64	62	59	56	52	48	44
CuNi30	Annealing	365	81	79	77	75	73	71	69	67	65.5	64	62

Note: ① If the metal temperature is between the values listed in the table, the permissible stress may be determined by linear interpolation;

② The permissible stresses of materials not included in this Table are to be agreed by CCS.

3.10.2.7 The negative manufacturing tolerance has not been taken into account for the minimum wall thickness δ described in 3.10.2.1 of this Section and where there is any negative tolerance allowable in manufacture, the nominal thickness δ_m of pipes is to be not less than that determined by the following formula:

$$\delta_m = \frac{\delta}{1 - \frac{a}{100}} \quad \text{mm}$$

where: a —— percentage of negative manufacturing tolerance on nominal thickness.

3.10.2.8 The formula of equivalent combined stress is specified as follows:

$$\sigma_e = 0.707\sqrt{(\sigma_\theta - \sigma_l)^2 + (\sigma_l - \sigma_r)^2 + (\sigma_r - \sigma_\theta)^2}$$

where: σ_e —— equivalent combined stress;

σ_θ —— circumferential or hoop stress;

σ_l —— axial stress;

σ_r —— radial stress.

The equivalent combined stress at any point of the pipe is to be not more than 60% of the minimum yield strength of the material. The minimum yield strength of any material is to be taken as the lesser of:

(1) specified yield strength or 0.2% proof strength;

(2) 0.8 times specified tensile strength.

3.10.3 Piping connections

3.10.3.1 The number of detachable piping connections is to be limited to the minimum required for maintenance and inspection.

3.10.3.2 All connections including end piping parts are to be manufactured in accordance with applicable standards. Connections not covered by the relevant standards are to be demonstrated as suitable for their intended use.

3.10.3.3 Joints of pipes with outer diameter of 51 mm and above are normally to be made by butt-welding, flanged, or screwed union where the threads are not part of the sealing. Joints for smaller sizes, and which are not intended for corrosive fluids, may be welded or screwed and seal welded. Application of other mechanical connectors is to be justified on a case by case basis.

3.10.3.4 If the piping system is rated at 20.7 MPa or above, ordinary threaded connections are not to be used for mud system, choke and kill system, cement system or well test system, or joints in other piping systems subject to bending or vibrational loads.

3.10.3.5 Weld neck flanges are to be forged to a shape as close to the final shape as possible.

3.10.3.6 Couplings with stud ends may only be used where suitable, and where used, are to have tapered threads.

3.10.3.7 The branch lines welded onto trunk lines are preferably to be reinforced with weldolets shaped for smooth transition between branch and trunk lines. Calculations of branch reinforcement are required where weldolets of unrecognised type are used in the branch connection.

3.10.3.8 Piping in which expansion joints or bellows are fitted is to be properly installed and adequately adjusted. Protection against mechanical damage is to be provided where necessary.

3.10.4 Valves

3.10.4.1 The grades of pressure and temperature of valves are to be not less than those of pipelines; the calibers of valves are to be compatible with those of pipes; the types of valves are to be suitable for their intended use.

3.10.4.2 Valves are to be designed and manufactured in accordance with recognized standards.

3.10.4.3 Valves are to be accessible and easily operated.

3.10.4.4 Valves are to be provided with on/off position indicators.
3.10.4.5 Threaded bonnets are not to be used for valves with nominal size over 50 mm.
3.10.4.6 The closing of valves is to be so timed that no detrimental stress of piping will occur due to water hammering.

3.10.5 Support of piping

3.10.5.1 Piping is to be mounted and reasonably supported such that:
(1) the weight of piping is not supported by connected objects;
(2) heavy valves and fittings do not cause large additional stress in adjacent pipes;
(3) axial forces generated in piping are offset;
(4) detrimental vibration of piping is eliminated.

3.10.6 Flexible hoses

3.10.6.1 General requirements
(1) The locations of flexible hoses are to be clearly shown in design documents;
(2) Flexible hoses which are suitable for the intended use may be installed in locations where hard piping is unsuitable;
(3) Flexible hoses are to be installed as accessible for inspection, and the minimum bending radius is to comply with the instructions of the manufacturer.
(4) Means are to be provided to isolate potential uncontrolled harzadous outflow from flexible hoses.
(5) The flexible hoses carrying combustible fluids or used in hazardous areas are to be fire-resistant.
(6) Flexible hoses are to be used according to the design conditions specified by the designer, e.g. pressure, temperature and effective use period.
(7) Flexible hoses are to be effectively secured to prevent detrimental bending and vibration.
(8) Design and manufacturing of flexible hoses are to comply with the applicable standards accepted by CCS.
3.10.6.2 The minimum burst pressure of rotary hoses is to be at least 2.5 times the working pressure; assembled flexible hoses are to be hydraulically tested to twice the working pressure for at least 1 min.
3.10.6.3 The minimum burst pressure of flexible choke and kill hoses is to be at least 2.25 times the rated working pressure and where the working pressure is lower than 69 MPa, the minimum burst pressure is to be increased to three times the rated working pressure; assembled flexible hoses are to be hydraulically tested to twice the rated working pressure and where the working pressure is higher than 34.5 MPa, the testing pressure may be reduced to 1.5 times the rated working pressure, for at least 1 h.
3.10.6.4 The flexible choke and kill hoses used in subsea are to be capable of collapse resistance under external pressure so as to prevent functional failure of hoses.

Section 11 Electrical Equipment and Control Systems

3.11.1 General requirements

3.11.1.1 The provisions of this Section are applicable to the following systems and components of drilling plants:
(1) The essential systems and essential functions of important systems as defined in Chapter 1;
(2) The protective safety functions as defined in Chapter 1;
(3) Production shutdown and blowdown systems for well test system;
(4) Emergency shutdown system (ESD);

(5) Fire and gas detection and alarm system;
(6) Other safety-related systems or components.

3.11.1.2 Unless otherwise provided in this Section, the electrical systems and components are to comply with the relevant requirements for electrical systems and equipment in CCS Rules for Construction and Classification of Mobile Offshore Units or CCS Rules for Construction and Classification of Fixed Offshore Units.

3.11.2 Electrical equipment

3.11.2.1 The main and emergency sources of power for the drilling plant may be those for the unit. Alternatively, separate main and emergency sources of power may be arranged for the drilling plant and their capacities are to be sufficient for the drilling plant.

3.11.2.2 The following equipment are to be supplied from two power sources connected respectively to different sections of the main switchboard, or by the main switchboard as one source and by the emergency switchboard as another source:

(1) Blowout preventer motor;
(2) Mud-filling pump;
(3) Rotary table or top drive.

3.11.2.3 The power supply and control of drilling equipment and systems are also to comply with the requirements of Sections 4 to 9 of Chapter 3 of the Guidelines.

3.11.3 Configuration of control systems

3.11.3.1 General requirements

(1) As far as possible, the systems are to be arranged so that no single failure or maloperation will result in life threatening situations for the involved personnel, or significant damage to property and/or the environment.

(2) Layout design of control and display devices is to include due consideration of the user interface, and with attention to the significance of human factors during an emergency situation. Graphical information systems are to contain all relevant functions for safe operation, are to be easy to understand and operate, and are to enable system overview.

(3) For essential and important systems and other safety systems, deviations between a command action and expected result of the command action are to initiate an alarm.

(4) When two or more safety actions are released by one failure condition (e.g. start of standby pump and stop of engine at low lubricating oil pressure), these actions are to be activated at different levels. The least drastic action is to be activated first.

3.11.3.2 Field instrumentation

(1) The field instrumentation belonging to separate essential process segments is to be mutually independent.

(2) When the field instrumentation of a process segment is common for several systems, and any of these systems is essential, failure in any of these systems is not to affect this field instrumentation and vice versa.

(3) Where manual emergency operation of an essential process segment may be required, the necessary field instrumentation is to be independent of other parts of any system.

(4) Electronic components, which replace traditional mechanical components, are to have the same reliability as the mechanical component being replaced.

(5) The fail-safe principles are to be applied to design of all safety systems and for this reason, input circuits to and output circuits from safety systems are to be configured as follows:

If all output circuits from a safety system are normally energized (normally closed), all input circuits to the same system are normally to be energised (normally closed).

If one or more output circuits from a safety system are normally de-energised (normally open), all input circuits to the same system are normally to be de-energised (normally open).

3.11.3.3 Power supply

(1) Systems that are critical to the safety of personnel and the installation are to be powered from uninterruptible power supplies (UPS).

(2) The UPS are to be monitored with alarm for failure from a manned control room, normally including loss of input power and internal failure of UPS.

3.11.4 Response to failures

3.11.4.1 Failure detection

(1) The systems are to have self-check facilities to detect the most probable failures that can cause erroneous or reduced system performance, or which could affect the integrity and safety of the equipment/unit.

(2) The self-check facilities are to cover, as a minimum, the following failure types:

① power failures;

② sensor and actuator failures;

③ loop failures (at least broken connections and short circuit) for normally de-energised circuits in safety systems;

④ and additionally for computer systems: communication errors, computer hardware failures, software execution failures and software logic failures.

(3) Detection of failures in systems other than non-important systems is to initiate an alarm.

3.11.4.2 Failure-safe

The most probable failures (e.g. loss of power or cable/wire failures) are to result in the least critical of any possible new conditions. This is to include consideration of the safety of the systems themselves, as well as the safety of the unit.

3.11.5 General requirements for system design

3.11.5.1 The safe operation and maintenance of systems are to comply with the following requirements:

(1) Start-up and restarting are to be possible without specialized system knowledge. The system is to be restored and resume operation automatically on power-up and restoration after loss of power.

(2) Testing of essential systems and alarm systems should be possible during normal operation. The system is not to unintentionally remain in test mode.

3.11.5.2 The power distribution and control systems are to comply with the following requirements:

(1) Independent and/or redundant systems are to have separate supplies from the distribution system, and are to have separate circuit protection.

(2) If connected to the same distribution switchboard, redundant systems are to be supplied from two power sources with independent supply to the distribution switchboard. The second source may be a battery.

(3) Systems that may be exposed to excessive conducted electromagnetic interference and harmonic interference through the electrical power supplies are to have provision for adequately filtered power.

3.11.6 General requirements for computer-based systems

3.11.6.1 Where a computer-based system is part of essential function(s), a secondary means of operation is to be provided by either a non-computerized system or an independent computer-based system of appropriate diversity.

3.11.6.2 The system response and capacity are to comply with the following requirements:
(1) Systems used for process equipment control are to provide response times compatible with the time constants of the related process equipment.
(2) The sampling frequency is to be adjustable so as to be suitable for the safe operation of drilling plant. The sampling frequency for monitoring of essential parameters is to be adjustable from 5 s to 10 s. The response times listed in Table 3.11.6.2(2) is applicable for typical offshore process equipment.

Typical Response Time **Table 3.11.6.2(2)**

Equipment	Response time (s)
Data sampling for automatic control (fast-changing parameters)	0.1
Data sampling for indications of analogue remote controls (fast-changing parameters)	0.1
Other indications	1
Alarms	2
Display of fully updated screen views	2
Display of fully updated screen views including start of new application	5

(3) System start-up and system restoration following power failures are to take place with sufficient speed to comply with the maximum unavailable time for the systems. On start-up and restoration, the system is to revert to a pre-defined state providing an appropriate level of safety.
(4) The system capacity is to be sufficient to provide adequate response time for all functions, including consideration of the maximum load and maximum number of simultaneous tasks under normal and abnormal process equipment conditions.
3.11.6.3 For computer systems where cooling or forced ventilation is necessary to keep the temperature at an acceptable level, alarm for high temperature or maloperation of the temperature control function is to be provided.
3.11.6.4 Integrated systems supporting one or more essential or important functions, which for safety reasons cannot be interrupted, are to be arranged to enable individual units to be tested, repaired, and restarted without interference with the continuing operation of the remaining parts of the system.
3.11.6.5 Essential systems are to have diagnostic facilities to support finding and repairs of failures.
3.11.6.6 Access to and configuration functions of computer systems are to be protected so as to avoid unauthorized modifications of the system performance. Unauthorised access to essential and important systems from a location outside the unit is not to be possible.

3.11.7 Design of system elements

3.11.7.1 General requirements
(1) A system consists of one or several system elements, each serving a specific function.
(2) System elements are categorized as follows:
① automatic control;
② remote control;
③ safety;
④ alarm;
⑤ planning and reporting;
⑥ Calculation, simulation and decision support.

3.11.7.2 Automatic control

(1) Automatic control is to keep process equipment variables within the limits specified for the equipment under control during normal working conditions.

(2) The automatic control is to be stable over the entire control range. The margin of stability is to be sufficient to ensure that variations in the parameters of the controlled process equipment that may be expected under normal conditions, will not cause instability. The automatic control system element is to be able to accomplish the function it is to serve

3.11.7.3 Remote control

(1) At the remote command location, the user is to receive continuous feedback information on the effects of initiated commands.

(2) One command location is to be designated as the main command location. The main command location is to be independent of other command locations.

(3) When control is possible from several locations, only one command location is to be in control at a time.

(4) Active control is not to be transferred before acknowledgement from the receiving command location unless the relevant command locations are sufficiently close to enable direct visual and audible contact. Transfer of control is to give audible pre-warning. The main command location is to be able to take control at any time.

(5) Significant change of process equipment parameters is not to occur during transfer of control from one location to another.

(6) Each alternative command location is to be provided with clear, local indication to show when that location is in control.

(7) Control system elements are to include safety interlocks against any user errors that could result in major damages or loss of essential or important functions.

(8) There is not to be conflict between operation of safety interlocks in different parts of the systems. Basic safety interlocks should be hardwired and are to be active during both remote and local operation. Hardwired safety interlocks (e.g. non-closure of protective cover of a winch inhibits the starting-up of the winch) should not be overridden.

3.11.7.4 Safety

(1) The automatic safety actions are to give alarm at appropriate predefined workstations.

(2) The safety system elements are to be capable of stopping the equipment under control. The stopped equipment is not to automatically restart.

(3) When a safety system element is made inoperative by a manual inhibit or override, this is to be clearly indicated at appropriate predefined workstations.

(4) When the safety system element is activated, it is to be possible to trace the cause of safety system activation by means of central or local indicators.

3.11.7.5 Alarm

(1) Alarms are to be visual and audible, and are to indicate abnormal conditions only. Additional visual and audible alarms are to be installed in areas where the audible signal may not be heard due to background noise. Several suitably placed low volume audible alarm units should be used rather than a single unit for the whole area. A combination of audible signals and rotating light signals is preferably to be used.

(2) Visual alarms are to be easily distinguishable from other indications by use of colour and special representation.

(3) Audible alarms are to be readily distinguishable from signals indicating normal conditions, telephone signals, different alarm systems and noise.

(4) The audible and visible characteristics of alarm signals are to comply with the requirements of IMO Resolution A.830(19), Code on Alarms and Indicators, 1995.

(5) Responsibility for alarms is not to be transferable before being acknowledged at the receiving location. Transfer of responsibility is to give audible pre-warning. Each alternative location is to have clear, local indication of when that location is in charge.
(6) Presentation and acknowledgement of alarms are to be possible only at the workstation(s) specifically provided for response to the alarm.
(7) Alarms at workstations are normally to be manually acknowledged in two steps:
① to silence audible signal, leaving the visual signal (e.g. rotating light signals) on the workstation unchanged. After acknowledgement, the audible signal is to operate for any new failure.
② To acknowledge the visual alarm. Alarms, including the detection of transient faults, are to be maintained until acknowledgement of the visual indication. The visual indications of individual alarms are to remain until no abnormal condition is being detected. Acknowledged alarms are to be clearly distinguishable from unacknowledged alarms.
(8) Acknowledgement of visual signals is to be separate for each signal, or may be common for a limited group of signals. Acknowledgement is to be possible only when the user has visual information regarding the alarm condition.
(9) Permanent blocking of alarm units is not to be possible. Where justified, manual blocking of separate alarms may be acceptable provided that the blocked alarm is clearly indicated as such.
(10) Sufficient information is to be provided to ensure optimal alarm handling. Alarm text is to be easily understood.
(11) The more probable or frequent failures within the alarm system, such as broken connections to measuring elements, are to initiate alarm.
(12) Interlocking of alarms is to be arranged so that most probable failures in the interlocking system, e.g. broken connection in external wiring, do not prevent alarms.
(13) The ability to lock alarm and safety functions in a certain operating mode is to be automatically disabled in other modes.
(14) It is to be possible to delay alarms in order to prevent spurious alarms during normal transient conditions.

3.11.7.6 Pre-warning

Pre-warnings are to be acknowledged. Pre-warnings are to be distinguishable from alarms.

3.11.7.7 Indication

Sufficient indications to enable safe operation of essential and important functions are to be installed at all control locations from which these function are to be operated. It is recommended that indicating and recording instruments be centralized and arranged to facilitate watch-keeping.

3.11.7.8 Calculation, simulation and decision support

The output from calculation, simulation and decision support modules is not to suppress basic information which is necessary for safe operation of essential and important functions. The output from calculation, simulation and decision support modules is to be presented as additional information.

3.11.8 Software of computer-based systems

3.11.8.1 Software requirements

(1) The operation system of processor systems to support running of application software is to have the following functions:
① running several modules under allocated priorities;
② detecting execution failures of individual modules;
③ discrimination of faulty modules to ensure maintained operation at least of modules of same or higher priority.

(2) The individual application software modules of an operating system as specified in (1) are not to perform operations related to more than one function. These modules are to be allocated priorities in accordance with the relative priority between the functions they serve.
(3) When hardware belonging to input, output, communication links, and user interface is configured to minimise the consequences of failures, the related software is to be separated in different computer tasks so as to secure the same degree of separation.
(4) Where calculation, simulation or decision support elements are used to serve essential functions, and basic functionality can be maintained without these elements, the application software is to be designed to facilitate such simplified operation.
(5) System set-up, process equipment configuration, and setting of process equipment parameters which is performed onboard the unit is to take place without modification of program code or recompilation. Where such actions cannot be avoided, all changes are to be thoroughly verified.
(6) The version(s) of the software in use is(are) to be readily identifiable.

3.11.8.2 Software manufacturing

(1) Manufacturing of software for complicated system(s) is to include all relevant actions to reduce the probability of errors in the program code to an acceptable level.
(2) The relevant actions are at least to include those to:

① ensure that the programming of applications is based on complete and valid specifications;
② ensure that purchased software has an acceptable track record and is subject to adequate testing;
③ impose full control of software releases and versions during manufacturing, installation onboard and during the operational phase;
④ ensure that program modules are subject to syntax and function testing as part of the manufacturing process;
⑤ minimise the probability of execution failures. The typical execution failures are deadlocks, infinite loops, division by zero, inadvertent overwriting of memory areas, erroneous input data.

(3) The actions taken to comply with 3.11.8.2（1） are to be documented, and the execution of these actions is to be retraceable. The documentation is to include a brief description of all tests applied to the system (hardware and software), with a description of tests that are intended to be made by sub-vendors, tests to be carried out at the manufacturer, and tests to remain until installation onboard.

3.11.9 User interface of computer-based systems

3.11.9.1 General requirements

(1) The status of the controls and information displayed is to be clearly indicated.
(2) Alarms are to be time tagged.
(3) The time tagging for all alarms is to be consistent in the whole system.
(4) Full redundancy is to be provided for visual display units receiving and displaying alarm presentations of essential screen-based systems, and the required redundancy may be provided by a printer or other equivalent means.
(5) User input devices are to be designed and arranged so as to avoid inadvertent operation. Dedicated function keyboards are to be provided for essential and important systems.
(6) Symbols and associated information shown in a mimic diagram are to have a logical relationship.
(7) Means are to be provided to ensure that only correct use of numbers and letters, and only values within reasonable limits, will be accepted when data is entered manually into the system.
(8) If the user provides the system with insufficient input, the system is to request the continuation of the dialogue by means of clarifying questions. Under no circumstances is the system to end the dialogue incomplete without request to user.

3.11.9.2 Illumination

The illumination of all visual display units and user input devices is to be adjustable to a appropriate level suitable for all applicable light conditions. However, illumination reduction which inhibits readability of information belonging to essential and important functions is not to be possible.

3.11.10 Data communication links of computer-based systems

3.11.10.1 General requirements

(1) Failure in a node is not to result in any adverse effect on the remaining part of the data communication link and vice versa.

(2) Data communication links are to be automatically initialized on "power on". Following a power interruption, the links are to regain normal operation without manual intervention.

(3) The capacity of the data communication link is to be sufficient to prevent overload at any time.

(4) The data communication link is to be self-checking, detecting failures on the link itself, and also data communication failures on nodes connected to the link. Detected failures are to initiate an alarm on dedicated workstations.

(5) For essential and important functions, measures are to be provided to prevent acceptance of corrupted data at the receiving node.

(6) Where two and more essential functions use the same data communication link, this link is to be redundant.

(7) Redundant data communication links are to be routed with as much separation as practical.

3.11.10.2 Local area networks

(1) Means are to be provided to monitor the usage and status of the network.

(2) It is to be possible to remove or insert nodes without interrupting normal network operation.

(3) Facilities are to be provided to ensure that a messages relating to essential or important functions are received within a predefined time.

3.11.10.3 Redundant local area networks

(1) The requirements of 3.11.10.2 are all applicable to redundant local area networks.

(2) Switching between networks is to be automatic within 30 s when serving functions requiring high accuracy of switching time. In other cases, switching may be manual provided that the switching is simple and unambiguous.

3.11.10.4 Instrument nets

Instrument nets are to meet the requirements for local area networks.

3.11.10.5 Interconnection of networks

The interconnected networks are to be mutually independent. The means of interconnection are routers, bridges and gateways.

3.11.11 General requirements for component design and installation

3.11.11.1 Environmental strains

(1) Instrumentation equipment is to be suitable for marine use, and designed to operate under environmental conditions as described in 3.11.12. A lower value may be acceptable provided that the actual environmental conditions will not exceed the proposed values given in 3.11.12 and that all contracting parties agree to the revised values.

(2) Data sheets are to be sufficiently detailed to ensure proper application of the instrumentation equipment.

(3) Performance and environmental testing may be required to determine the suitability of the equipment.

3.11.11.2 Materials

Explosive materials, and materials which may develop toxic gases, are not to be used. Covers, termination boards, printed circuit cards, constructive elements, and other parts that may contribute to spreading fire are to be of flame-retardant material. Materials with a high resistance to corrosion and ageing should be used. Metallic contact between different materials should not cause electrolytic corrosion in a marine atmosphere. As base material for printed circuit cards, glass-reinforced epoxy resin or equivalent should be used.

3.11.11.3 Design and installation of components

(1) The design and installation of components are to facilitate operation, adjustment, repair and renewal. As far as practicable, screw connections are to be secured.

(2) Electric cables and components are to be effectively separated from all equipment which, in case of leakage, could cause damage to the electrical equipment. Pipes and equipment conveying oil, water or other fluids, or steam under pressure are to be provided with drainage and located in a separate section from desks, consoles, and switchboards which contain electrical equipment.

(3) Means are to be provided to prevent moisture (condensation) from accumulating inside equipment, including when the plant is shut down.

(4) Differential pressure elements are to be able to sustain a pressure differential at least equal to the highest process equipment pressure.

(5) The installation of temperature sensors is to enable easy dismantling for functional testing.

(6) The clamps used to secure capillary tubes are to be made of a material softer than that of the tubing.

(7) The isolation valves in essential instrument sensor pipes and speed control valves in actuator control tubing are to be designed to avoid inadvertent operation.

(8) Fused isolating transformers are to be fitted between the main power supply and other units or systems.

(9) The on/off switching of the power supply is not to cause excessive voltage or other strains that may damage internal or external components.

(10) Key components of computer-based systems necessary for maintaining essential and important functions are to demonstrate that functionality and reliability are not compromised during performance at elevated temperatures which could result from a failure in the ventilation system or power supply.

(11) Circuits are to be designed to prevent damage of the unit or adjacent elements by internal or external failures. No damage should occur when the signal transmission lines between measuring elements and other units are short-circuited, grounded or broken. Such failures are to be fail-safe.

(12) The equipment is preferably to function without forced cooling. Where such cooling is necessary, precautions are to be taken to prevent the equipment from being damaged in case of failure of the cooling unit.

(13) Components are to effectively secured so as to prevent mechanical stressing of wires and soldered joints through vibration and mechanical shock.

3.11.11.4 Protection by enclosures

Enclosures for equipment are to be made of steel or other flame-retardant material capable of providing EMC protection and are to comply with the minimum requirements in Table 3.11.11.4.

Minimum Requirements of Equipment Enclosures Table 3.11.11.4

Class	Location	Degree of Protection
A	Control rooms, accommodation, bridge	IP22
B	Machinery space	IP44
C	Open deck, masts, below floor plate in machinery space	IP56
D	Submerged application	IP68

3.11.11.5 Power supply

(1) When using low voltage battery supply, the charging equipment, batteries and cables are to keep the voltage at equipment terminals within +25 %to −20 % of the nominal voltage during charging and discharging.

(2) Reverse current to the battery through the charging device is to be prevented.
(3) Systems including a standby battery which is connected for continuous charging are not to be disturbed in any way by disconnection of the battery.
(4) Terminal lists are to be clearly marked. Varying system voltages are to be distinguished.

3.11.11.6 Optical fiber equipment

(1) Power budget calculations are to be conducted to:
— determine the length between input/output units;
— select components to obtain a safe and reliable transmission system;
— demonstrate that adequate power reserve has been provided.
(2) After installation, optical time domain reflectometry measurements for each fibre are be used to correct and re-evaluate the power budget calculations.
(3) In principle, the construction of optical fiber devices is to comply with the relevant specifications in IEC publications.
(4) The safety of personnel and operations is to be considered in the installation procedures. Warning signs and labels giving information to operators are to be placed where hazard exists. Care must be taken to prevent fibres from penetrating eyes or skin.
(5) For fibre optic systems using standard single- and multimode fibres, a power level below 10 mW is considered as intrinsically safe in hazardous areas.

3.11.11.7 Maintenance and checking

Maintenance, repair and performance testing of systems and components are, as far as practicable, to be possible without affecting the operation of other systems or components.

3.11.11.8 Marking

All units and test points are to be clearly and permanently marked. Sensors, controllers and actuators should be marked so that they can be easily and clearly identified on arrangement plans and in instrument lists.

3.11.12 Environmental conditions

3.11.12.1 The electrical equipment and control systems of drilling plants are to work well under the environmental conditions prescribed in CCS Guidelines for Type Approval Test of Electric and Electronic Products.

3.11.12.2 In certain applications, other environmental parameters that may influence normal work of equipment are to be taken into account, e.g.:

(1) Fire;
(2) Explosive atmosphere;
(3) Temperature;
(4) Wind, rain, snow, ice and dust;
(5) Noise;
(6) Mechanical impact or bump force equivalent to 20 g of 10 ms duration;
(7) Liquid splashing or dropping;
(8) Corrosive atmosphere.

Chapter 4 MATERIALS, MANUFACTURE AND TESTING

Section 1 Materials

4.1.1 General requirements

4.1.1.1 The materials of structures and equipment are to be suitable for their intended purposes and have sufficient strength, plasticity, notch toughness and proper corrosion resistance. In addition, the materials to be welded are to have good weldability properties.

4.1.1.2 The materials are generally to comply with recognized standards. Material in compliance with other special technical specifications may also be accepted, subject to prior approval by CCS.

4.1.1.3 The materials are to be produced in accordance with their specifications. The specifications are to include but not restricted to the following parameters and limits:

(1) Chemical composition;

(2) Properties;

(3) Qualification test;

(4) Possessing (including smelting, possessing and heat treatment methods. Where applicable, the instructions of possessing methods are to include forging ratio);

(5) Repair welding.

4.1.1.4 Impact toughness

(1) The values required for the impact roughness of materials are generally to be determined according to the lowest design temperature, thickness and structural member category, based on recognized standards. In addition, factors like fabrication method, restraint extent, stress concentration and loading rate are to be taken into account, if applicable.

(2) For materials of thickness less than 10 mm, the largest possible subsize impact test specimens are to be prepared. The conversion of impact energy between such specimens and standard ones is shown in Table 4.1.1.4(2). For materials with nominal thickness up to 6mm, the impact test is generally not required.

Conversion Factor **Table 4.1.1.4(2)**

Specimen size (mm)	Conversion factor
10×10①	1
10×7.5	5/6
10×5	2/3

Note: ① Specimens of this size are standard specimens.

4.1.1.5 The test and inspection of materials are generally to comply with the relevant requirements in PART ONE of CCS Rules for Materials and Welding.

4.1.1.6 Both internal and external steel surfaces exposed to seawater/salt air environment are to be provided with appropriate corrosion prevention means, and this may achieved by coating protection and/or cathodic protection system. The applied corrosion prevention system is to be suitable to the locations of structures/equipment and their intended use. In addition, appropriate corrosion margins are to be considered for some structures and equipment as appropriate.

4.1.2 Structural steel

4.1.2.1 The structural steel of drilling plants is generally to comply with the relevant requirements of API RP2A or CCS Rules for Construction and Classification of Mobile Offshore Units.

4.1.2.2 The derrick and flare boom structures and the supporting structure of drilling plants are generally divided into primary components and secondary components. The main load-bearing components and components bearing high tensile or shear stress may be defined as primary components, e.g. derrick legs and chords including end connection, skid beam and substructure connection bolts, etc. and other components are secondary components.

4.1.2.3 For the purpose of preventing lamellar tearing, where the plates in way of main connection bear significant tensile stress in through-thickness direction, such plates are to be made of Z-direction steel and the reduction of area in through-thickness direction is to be not less than 25%.

4.1.3 Equipment material

4.1.3.1 The chemical composition, mechanical properties and delivery condition of materials of equipment components and parts and all other material requirements are to fully comply with the requirements of recognized standards.

4.1.3.2 Where no requirements for impact toughness of materials is specified in the applicable recognized standards , it is recommended that the impact toughness of materials of primary load-bearing components and pressure-retaining components of drilling equipment comply with the following requirements:

(1) The impact test temperature is the lowest design temperature of material.

(2) Materials for piping and pressure-retaining components are to have an average (longitudinal) Charpy V-notch impact energy of minimum 27 J for the following high pressure piping systems:

① choke and kill system;

② high pressure drilling fluid system;

③ well test system;

④ cementing system.

(3) The average values of (longitudinal) Charpy V notch impact energy for materials of other main load-bearing components and pressure-retaining components are to be not less than those given in Table 4.1.3.2.(3).

Charpy V notch impact Energy **Table 4.1.3.2.(3)**

Material yield strength R_{eH} (MPa)	Impact energy (J)
$R_{eH} \leqslant 270$	27
$270 < R_{eH} < 420$	$0.1R_{eH}$
$R_{eH} \geqslant 420$	42

4.1.3.3 Materials exposed to hydrogen sulfide-containing fluids are to comply with the requirements of NACE MR0175. Any welding or other fabrication affecting hardness of such materials is to be performed in accordance with qualified procedure specifications so as to ensure that material surface hardness after welding or prossessing will not exceed the maximum hardness value specified in NACE MR0175.

4.1.3.4 Electric resistance welded pipes are not to be used for working pressure above 3.2 MPa, or design temperatures above 300 °C.

4.1.4 Bolt material

4.1.4.1 The impact toughness and corrosion resistance of bolt and nut material are to be consistent with those of the components or parts to which they are connected, and are to comply with recognized standards.

4.1.5 Sealing materials

4.1.5.1 The material used for sealing is to be suitable for the intended service and capable of bearing the specified working pressure and temperature.

4.1.5.2 The elastomeric sealing material used in critical components is to be tested to ensure suitability for fluids that they will be exposed to during service, and age-sensitive materials are to have a defined storage life and be identified in storage as to month and year of manufacture.

4.1.6 Steel wires

4.1.6.1 The steel wires used in drilling plants or equipment installation are to comply with API Spec 9A or equivalent standards.

4.1.7 Certificate of conformity

4.1.7.1 The materials of all primary load-bearing components and pressure-retaining components are to have a material certificate.

4.1.7.2 The material certificate is to include but not limited to the following:

(1) Purchaser's name and order number;
(2) Address to which material is despatched;
(3) Specification and description of material;
(4) Cast number and results of chemical composition analysis;
(5) Mechanical test results;
(6) Condition of supply;
(7) For forgings and castings:
    ① Details of heat treatment;
    ② Method and results of non-destructive examination;
    ③ Test pressure, if any;
    ④ Forging ratio, applicable to forgings only;
    ⑤ Evaluation of the defects found from macrostructure examination, if any and applicable to forgings only.

Section 2 Manufacture and Testing

4.2.1 General requirements

4.2.1.1 This Section covers manufacture and testing of equipment, structures and systems of drilling plants.

4.2.1.2 The equipment, structures and systems of drilling plants are to be manufactured, installed and tested in accordance with the applicable standards and the requirements of this Section.

4.2.1.3 The equipment/product manufacturers are to have necessary qualified production and testing facilities, a perfect quality inspection team, and competent personnel following a strict quality assurance system in production.

4.2.1.4 Marking

All equipment is to be marked with identification, at least an individual delivery serial number related to fabrication and certification. The identification may be marked by low stress stamping, forging, painting or a fixed label, as appropriate, and is to be clearly readable. The size and specification of the identification are to comply with GB/T13306.

4.2.1.5 Documents

The manufacturer is to provide and keep the following documents for each piece of equipment, as applicable:

(1) Design documents;
(2) Design verification documents;
(3) Technical specifications;
(4) Approval records, e.g.:
    ① approval records of welding procedures;
    ② approval records of welder qualifications;
    ③ approval records of NDT personnel qualifications;
    ④ calibration records of measuring and testing equipment;
(5) The examination and testing records are to include but not limited to:
    ① material testing report, covering chemical composition and mechanical properties (tension, impact and hardness);
    ② NDT report;
    ③ records of manufacturing process;
    ④ performance test records, including load, pressure and function test records;
    ⑤ records of any noncompliance, rectification and repair;
    ⑥ records of special workmanship;
(6) Product quality certificate number and delivery serial number.

The manufacturer is to maintain all relevant documents for at least ten years, during which these documents are to be complete and available at any time.

4.2.2 Processing

4.2.2.1 The manufacturer is to carry out cold and hot processing in accordance with the workmanship documents prepared by him.

4.2.2.2 After cold forming, the mechanical properties of steel, especially the impact toughness, are to maintain the required values, or otherwise heat treatment after cold forming is required for its mechanical properties to satisfy the required values. For materials with required impact toughness, where the plastic deformation after cold forming exceeds 3% with no hot treatment to eliminate hardness resulting from cold forming, strain aging test is to be carried out.

4.2.2.3 After hot forming, the mechanical properties of material is to maintain the required values or otherwise hot treatment is to be performed such that the required values are reached.

4.2.3 Welding

4.2.3.1 Welders are to attend qualification tests and hold qualification certificates in accordance with the requirements in Chapter 4, PART THREE of CCS Rules for Materials and Welding or applicable design standards. Only the welders holding the Qualification Certificate of Welder issued or accepted by CCS are permitted to engage in welding operation appropriate to their qualified range of work.

4.2.3.2 Welding operation is to be carried out in accordance with a welding procedure specification prepared to the applicable standards or Chapter 4, PART THREE of CCS Rules for Materials and Welding and approved by CCS. The welding procedure specification is to specify all basic and (if necessary) additional parameters related to the required applicable standards.

For unapproved procedures, including novel ones and material, the manufacturer is to develop detailed welding procedure specifications and submit them to CCS for approval. Such welding procedures can be adopted only upon satisfactory approval testing.

4.2.3.3 The welding procedure approval test is to be carried out in the presence of the Surveyor. After completion of testing, the test results are to be recorded in the approval test report and to be submitted, together with the welding procedure specification to CCS for approval.

If a CCS approved welding procedure has not been adopted for construction of the similar structures or components within six years from the date of approval, it is to be re-approved before reuse.

4.2.3.4 The type and size of welding joints are to comply with the requirements of approved welding procedure specifications and approved plans and documents.
4.2.3.5 The hot treatment of components and parts after welding is to comply with the applicable approved welding procedure specifications.
4.2.3.6 Welding repair
(1) The manufacturer is to prepare a detailed repair welding procedure specification to evaluate, remove, examine and repair welding defects of structures and components.
(2) It is to ensure that repaired welds are completely fused to parent metal with smooth transition to the adjacent area.
(3) After the repair of a weld joint requiring post-weld heat treatment, a new heat treatment is to be carried out.
(4) The repaired welds are subject to visual inspection, and surface and internal NDT in accordance with the welding procedure specification.
(5) Position and sizes of defects repaired, repair method, and quality examination after repair are to be recorded and filed by the manufacture for reference.

4.2.4 Inspection
4.2.4.1 The manufacturer is to prepare a detailed and complete inspection plan for all main load-bearing components and pressure-retaining parts including equipment and structures, which is to be approved by CCS Surveyor.
4.2.4.2 Surface and internal quality inspection of welds is to be carried out according to the NDT specification which is to be prepared in compliance with applicable standards and approved by CCS Surveyor, covering testing methods, extent and welding quality acceptance criteria.
4.2.4.3 The personnel engaged in NDT of welds are to undergo qualification evaluation and hold qualification certificates in accordance with recognized standards. Only the testing personnel holding the Qualification Certificate of NDT Personnel issued or accepted by CCS are permitted to engage in NDT of welds appropriate to their qualified range of work.
4.2.4.4 Where the applicable standards do not contain the requirements for NDT scope, the method, number and areas of testing may be determined by reference to the following recommendations:
(1) For welds of pressure–retaining parts and pipes, refer to 7.5.4.1 of PART THREE of CCS Rules for Materials and Welding;
(2) For welds of structural components, refer to 6.3.2.2 of PART THREE of CCS Rules for Materials and Welding;
4.2.4.5 The NDT of welded steel structures with material yield strength more than 400 Mpa is generally to be performed 48 h after welding. Where heat treatment is required for welded parts, NDT is to be performed after heat treatment.
4.2.4.6 The NDT of welds is to be performed without paint coating.
4.2.4.7 Where unacceptable weld quality is revealed by NDT, the extent of NDT is to be increased in accordance with the applicable standards. Where the applicable standards do not contain any requirement for this, the extent of NDT is to be increased at least along both ends of the defective weld.
4.2.4.8 NDT is to be performed for the welds repaired and the inspection reports before and after repair are to be submitted to CCS for reference.
4.2.4.9 All performed NDT and results are to be recorded and filed for reference.

4.2.5 Testing
4.2.5.1 The manufacturer is to prepare a detailed and complete test programme for all main load-bearing components and pressure-retaining parts, which is to be approved by CCS Surveyor.

4.2.5.2 Pressure test

(1) Pressure-retaining parts, pipelines and fitting are subject to pressure test in accordance with the applicable standards.

(2) Where the applicable standards do not contain clear requirements for testing pressure and holding time, the testing pressure is to be at least 1.5 times the design pressure; the holding time for stabilized pressure is to be not less than 15 min. A shorter holding time may be considered for very small components.

(3) Testing pressure, holding time and testing results are to be recorded and filed for reference.

4.2.5.3 Functional test

(1) All systems including associated control, monitoring and safety systems are subject to functional test under working conditions in accordance with the test programme.

(2) All performed function tests and results are to be recorded and filed for reference.

4.2.5.4 Load test

(1) All lifting appliances are subject to load test in accordance with the testing programme before initial operation.

(2) The testing load and holding time are to comply with the applicable standards or CCS Rules for Lifting Appliances of Ships and Offshore Installations.

(3) All performed load tests and results are to be recorded and filed for reference.