OFFSHORE STANDARD
DNV-OS-E101

DRILLING PLANT

OCTOBER 2006

Since issued in print (October 2006), this booklet has been amended, latest in April 2008.
See the reference to "Amendments and Corrections" on the next page.

DET NORSKE VERITAS

FOREWORD

DET NORSKE VERITAS (DNV) is an autonomous and independent foundation with the objectives of safeguarding life, property and the environment, at sea and onshore. DNV undertakes classification, certification, and other verification and consultancy services relating to quality of ships, offshore units and installations, and onshore industries worldwide, and carries out research in relation to these functions.

DNV Offshore Codes consist of a three level hierarchy of documents:

— *Offshore Service Specifications.* Provide principles and procedures of DNV classification, certification, verification and consultancy services.
— *Offshore Standards.* Provide technical provisions and acceptance criteria for general use by the offshore industry as well as the technical basis for DNV offshore services.
— *Recommended Practices.* Provide proven technology and sound engineering practice as well as guidance for the higher level Offshore Service Specifications and Offshore Standards.

DNV Offshore Codes are offered within the following areas:

A) Qualification, Quality and Safety Methodology
B) Materials Technology
C) Structures
D) Systems
E) Special Facilities
F) Pipelines and Risers
G) Asset Operation
H) Marine Operations
J) Wind Turbines
O) Subsea Systems

Amendments and Corrections

This document is valid until superseded by a new revision. Minor amendments and corrections will be published in a separate document normally updated twice per year (April and October).

For a complete listing of the changes, see the "Amendments and Corrections" document located at: http://webshop.dnv.com/global/, under category "Offshore Codes".

The electronic web-versions of the DNV Offshore Codes will be regularly updated to include these amendments and corrections.

Comments may be sent by e-mail to *rules@dnv.com*
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Main Changes

The highlights are as follows:

— Workover and well intervention equipment is included.
— The requirements for Charpy energy impact values for bolting has been changed.
— BOP accumulator capacity requirements have been clarified.
— The requirements for lifting lugs for maintenance lifting has been modified.
— The requirements for emergency power has been clarified.

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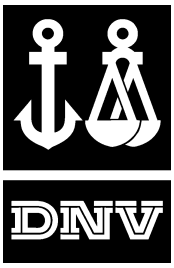

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DNV-OS-E101

DRILLING PLANT

CHAPTER 1

INTRODUCTION

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DET NORSKE VERITAS

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SECTION 1
INTRODUCTION

A. General

A 100 Introduction

101 This offshore standard contains criteria, technical requirements and guidance on design, construction and commissioning of drilling facilities and associated equipment

102 The standard is applicable to drilling facilities located on floating offshore units and on fixed offshore installations of various types.

103 The standard has been written for general world-wide application. Governmental regulations may include requirements in excess of the provisions of this standard depending on the type, location and intended service of the offshore unit or installation.

104 This standard is provided as a facilities standard, and is supplementary to other discipline specific standards for structures, electrical, materials, components etc. as indicated in Table A1.

Table A1 DNV Offshore Standards (DNV-OS) and other DNV references

Reference	*Title*
DNV-OS-A101	Safety Principles and Arrangement
DNV-OS-B101	Metallic Materials
DNV-OS-C101	Design of Offshore Steel Structures, General (LRFD method)
DNV-OS-C102	Structural Design of Offshore Ships
DNV-OS-C103	Structural Design of Column Stabilised Units (LRFD method)
DNV-OS-C104	Structural Design of Self Elevating Units (LRFD method)
DNV-OS-C105	Structural Design of TLPs (LRFD method)
DNV-OS-C106	Structural Design of Deep Draught Floating Units
DNV-OS-C401	Fabrication and Testing of Offshore Structures
DNV-OS-D301	Fire Protection
DNV-OS-E201	Hydrocarbon Production Plant. (Only applicable for well testing)
DNV-OS-F201	Dynamic Risers
DNV "Lifting appliances"	Rules for Certification of Lifting Appliances
DNV-RP-A203	Qualification Procedures for New Technology
Standard for Certification No 2.4*	Environmental Test Specification for Instrumentation and Automation Equipment
Standard for Certification No. 2.7.3*	Portable Offshore Units
Standard for Certification No 2.9*	Approval Programme No. 201 - Approval of Hydraulic Cylinders
Classification Note 6.1	Fire Test Methods for Plastic Pipes, Joints and Fittings
Classification Note 30.5	Environmental Conditions and Environmental Loads
Classification Note 45.1	Electromagnetic Compatibility
* Previously called Certification Notes.	

A 200 Objectives

201 The objectives of this standard are to:

— provide an internationally acceptable standard of safety for drilling facilities by defining minimum requirements for the design, materials, construction, testing and commissioning of such facilities

— serve as a reference document in contractual matters between purchaser and contractor

— serve as a guideline for designers, purchasers and contractors

— specify procedures and requirements for drilling facilities subject to DNV certification and classification.

A 300 Organisation of this standard

301 This standard is divided into three main chapters:

Chapter 1: General information, scope, definitions and references.
Chapter 2: Technical provisions for drilling facilities for general application.
Chapter 3: Specific procedures and requirements applicable for certification and classification of drilling facilities in accordance with this standard.

A 400 Scope and application

401 This standard is applicable for design and construction of drilling facilities for use on all types of fixed and floating offshore installations.

402 The standard should be applied from concept design through to final construction, including major modifications.

403 Requirements presented are minimum requirements to be satisfied, but should take account of available technological and technical improvements at the time of application. Prescriptive requirements are not intended to inhibit application of practicable improvements.

404 The requirements of this standard shall be supplemented where installation specific design or assessment shows that higher standards are more appropriate.

A 500 Deviation from the requirements

501 Without prejudice to 403, deviations from the requirements of this standard may only be substituted where shown to provide an equivalent or higher level of integrity or safety than under this standard. Any deviation or exemption from this standard shall be agreed and documented between all contracting parties.

B. Definitions

B 100 Verbal forms

101 *Shall:* Indicates requirements strictly to be followed in order to conform to this standard and from which no deviation is permitted.

102 *Should:* Indicates that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required. Other possibilities may be applied subject to agreement.

103 *May:* Verbal form used to indicate a course of action permissible within the limits of the standard.

104 *Agreement* or *by agreement:* Unless otherwise indicated,

agreed in writing between manufacturer or contractor and purchaser.

B 200 Definitions

201 *Alarm:* Warning of abnormal condition and is a visual and/or audible signal, where the audible part normally calls the attention of personnel, and the visual part serves to identify the abnormal condition.

Guidance note:

Both audible and visual part alone may serve both functions during special operating conditions.

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202 *Basic software:* Software necessary for the hardware to support the application software.

Guidance note:

Basic software normally includes the operating system and additional general software necessary to support the general application software and project application software.

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203 *Computer:* Any programmable electronic system, including main-frame, mini-computer or micro-computer.

Computer based system serving an essential or important function: The function can be in operation without support from the computer system, i.e. the computer is not part of the function.

Computer based system as part of an essential or important function: The function can not be in operation without support from the computer system, i.e. the computer is part of the function.

204 *Computer task:* A multiprocessing environment, one or more sequences of instructions treated by a control program as an element of work to be accomplished by a computer.

205 *Contract* or *Contracting parties*: Formal written agreement or parties who need to adhere to the formal written agreement.

206 *Data communication links:* Point to point links, instrument net and local area networks, normally used for inter computer communication on board vessels.

A data communication link includes all software and hardware necessary to support the data communication.

Guidance note:

For local area networks, this includes network controllers, network transducers, the cables and the network software on all nodes.

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207 *Defined accidental events:* Events that could cause death or serious personal injury to personnel on board the installation, and that are controlled in order to meet risk acceptance criteria. This includes events that could result in significant damage to the structure of the installation, loss of stability, or the need to evacuate the installation. Defined accidental events form one basis for defining dimensioning accidental loads.

208 *Design pressure:* The maximum allowable working or operating pressure of a system used for design. The set point of PSVs can not exceed this pressure.

209 *Drilling facilities:* Areas containing systems and equipment required for drilling operations.

210 *Drilling plant:* Equipment and systems necessary for safe drilling operations, but limited to the systems covered by this standard.

211 *Equipment:* All mechanical and structural components of which the drilling systems covered by this standard consist.

212 *Equipment under control (EUC):* The mechanical equipment (machinery, pumps, valves, etc.) or environment (smoke, fire, waves, etc.) monitored and/or controlled by an instrumentation and automation system.

213 *Essential system:* Generally defined as a system which supports equipment which needs to be in continuous operation for maintaining the unit's manoeuvrability. The definition is extended for systems associated with the drilling plant to 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.

214 *Fail safe:* Implies that a component or system goes to, or remains in, the mode which is deemed to be safest on failures in the system.

215 *Failure:* In the context of this standard, an event causing one or both of the following effects:

— deterioration of functionality to such an extent that safety is significantly affected
— loss of component or system function.

216 *Field instrumentation:* All instrumentation that forms an integral part of a process segment to maintain a function.

The field instrumentation includes:

— sensors, actuators, local control loops and related local processing as required to maintain local control and monitoring of the process segment
— user interface for manual operation (when required).

Other equipment items do not, whether they are implemented locally or remotely, belong to the field of instrumentation. This applies to data communication and facilities for data acquisition and pre-processing of information utilised by remote systems.

217 *General application software:* Computer software performing general tasks related to a process equipment being controlled or monitored, rather than to the functioning of the computer itself.

218 *Hazardous area:* Space in which a flammable atmosphere may be expected at such frequency that special precautions are required. Refer to reference codes for a complete definition including zones etc.

219 *Independent systems:* Implies that there are no functional relationships between the systems and they can not be subject to common mode failures.

220 *Indications:* The visual presentation of process equipment values or system status to a user.

221 *Installation* or *drilling installation*: is a general term for floating and fixed structures, including facilities, which are intended for exploration, drilling, production, processing or storage of hydrocarbons or other related activities or fluids. The term includes installations intended for accommodation of personnel engaged in these activities.

222 *Instrument net:* Data communication within the field instrumentation connecting instruments in a network.

223 *Integrated system:* A combination of computer based systems which are interconnected in order to allow common access to sensor information and/or command or control.

224 *Interlock system:* A set of devises or keys that ensure that operations (e.g. opening and closing of valves) are carried out in the right sequence.

225 *Important system:* Generally defined as a system supporting equipment which need not necessarily be in continuous operation for maintaining the unit's manoeuvrability, but which is necessary to maintain the unit's main functions. The definition is extended for systems associated with the drilling plant to cover systems, which ensures reliable operation and

which maintains plant operation within operational limitations.

226 *Local area network:* Data communication between the field instrumentation and the other parts of a system, and between different systems.

227 *Maximum Allowable Working Pressure (MAWP):* The maximum operating pressure of a system used for design.

228 *Maximum unavailable time:* The maximum duration of time the function is allowed to be unavailable, i.e. the maximum permissible time lag involved in restoring lost function upon failure.

229 *Minimum Design Temperature, MDT:* Minimum design operating or ambient start-up temperature. The lowest predictable metal temperature occurring during normal operations including start-up and shut-down situations shall be used. (If no thermal insulation is fitted, then ambient temperature shall be used if this is lower than the temperature of the content).

230 *Node:* Process segment or a part of the system connected as part of the data communication link.

231 *Non-important system:* Defined as a system, which is neither essential nor important.

232 *Non-redundant structure:* See 248.

233 *Operating conditions:* Conditions wherein a unit is on location for purposes of drilling or other similar operations and combined environmental and operational loading are within the appropriate design limits established for such operations. The unit may be either afloat or supported on the sea bed as applicable.

234 *Point to point link:* Data communication between two dedicated nodes.

235 *Pre-warning:* Indication of a process equipment or system state that needs attention.

236 *Primary structure:* Structural elements that are essential to the overall integrity of the structure.

237 *Process:* The result of the action done by the EUC, see 212.

238 *Process segment:* A collection of mechanical equipment with its related field instrumentation, e.g. a machinery or a piping system. Process segments belonging to essential systems are referred to as essential.

239 *Project application software:* Computer software performing tasks related to the actual process equipment for a specific project.

240 *Reference thickness:* Material thickness. For weld regions the reference thickness is defined as the thickness of the plate determining the weld throat thickness.

241 *Rupture (or bursting) disc:* A device designed to rupture or burst and relieve pressure at a defined pressure and rate. The device will not close after being activated.

242 *Safe Working Load (SWL):* The maximum allowable mass to be lifted.

243 *Safety factor:* The relationship between maximum allowable stress level and a defined material property, normally specified minimum yield strength.

244 *Safety shutdown:* A safety action that will be initiated upon failure and shall result in shutdown of the process equipment or part of the process equipment in question.

245 *Safety system:* Electronic or electrical or mechanical system installed to execute protective measures based on a pre-defined logic to bring an undesirable event under control based on manual or automatic execution or to monitor critical parameters and initiate alarms.

246 *Secondary structure:* All structures that are not defined as primary, special or non-redundant.

247 *Software module:* Assembly of code and data with a defined set of input and output, intended to accomplish a function and where verification of intended operation is possible through documentation and tests.

248 *Special area* or *Non-redundant structure:* Areas of primary structural elements with critical stress concentrations or members which are non-redundant.

249 *System:* Includes all components necessary for monitoring, control and safety, including sensors and actuators. As used in this standard, system is a short term used for instrumentation and automation system.

A system includes all resources required to support one specific function, including:

— the field instrumentation of one or more process segments
— all necessary resources needed to maintain the function including system monitoring and adequate self-check, all user interfaces.

250 *Survival condition:* Condition during which a unit may be subjected to the most severe environmental loading for which the unit is designed. Drilling or similar operations may have been discontinued due to the severity of the environmental loading. The unit may be either afloat or supported on the sea bed as applicable.

251 *Transit condition:* All unit movements from one geographical location to another.

252 *Uninterruptible Power Supply (UPS):* Device supplying output power in some limited time period after loss of input power with no interruption of the output power.

253 *Unit:* Entity of hardware, software, or both.

254 *User:* A human being that will use a system or device, e.g. captain, navigator, engineer, radio operator, stock-keeper, etc.

255 *User Input Device (UID):* Device from which a user may issue an input including handles, buttons, switches, keyboard, joystick, pointing device, voice sensor and other control actuators.

256 *Utility systems:* Systems providing the installation with supporting functions. Typical systems are cooling water, hot oil for heating, chemical systems for injection, instrument air and power generation system.

257 *Visual Display Unit (VDU):* Area where information is displayed including indicator lamps or panels, instruments, mimic diagrams, Light Emitting Diode (LED) display, Cathode Ray Tube (CRT), and Liquid Crystal Display (LCD).

258 *Working load (suspended load):* The mass of the load lifted plus the mass of the accessories (e.g. sheave blocks, hooks, slings etc.)

259 *Workstation:* Position at which one or several functions constituting a particular activity are carried out.

B 300 Abbreviations

301 Abbreviations as shown in Table B1 apply to this standard.

Table B1 Abbreviations

Reference	*Title*
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
API	American Petroleum Institute
APV	Air pressure vessel
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing of Materials
BOP	Blow Out Preventer

Table B1 Abbreviations (Continued)	
Reference	*Title*
BS	British Standard (issued by British Standard Institution
CIBS	Classification information breakdown structure
CMC	Certification of materials and components
CSA	Canadian Standards Association
DIN	Deutsche Institut für Normung e.v
DNV	Det Norske Veritas
DVR	Design Verification Report
EN	European de Normalisation
ESD	Emergency Shutdown
EUC	Equipment Under Control
EWT	Extended Well Testing
FEM	Federation Europeenne de la Manutetion
F&G	Fire and Gas
HPHT	High pressure high temperature
HPU	Hydraulic power unit
HVAC	Heating, ventilation and air conditioning
IEC	International Electrotechnical Commission
IRN	Inspection release note
IP	Institute of Petroleum
ISO	International Organisation for Standardisation
LMRP	Lower Marine Riser Package
MODU	Mobile Offshore Drilling Unit
NACE	National Association of Corrosion Engineers
NDT	Non-destructive testing
NDE	Normally de-energised
NE	Normally energised
NS	Norwegian Standard (issued by Norwegian Standards Association)
NFPA	National Fire Protection Association
OS	Offshore Standard
OSS	Offshore Service Specification
PC	Product certificate
PCV	Pressure Control Valve
PROM	Programmable Read Only Memory

Table B1 Abbreviations (Continued)	
Reference	*Title*
PSV	Pressure Safety (or Relief) Valve
RP	Recommended Practice
SG	Specific gravity
SWL	Safe working load
TBK	Den norske Trykkbeholderkomite (Norwegian Pressure Vessel Committee)
TEMA	Tubular Exchange Manufacturers Association
TLP	Tension Leg Platform
UID	User Input Device
UPS	Uninterruptible Power Supply
VDU	Visual Display Unit
WT	Well Testing

C. Normative References

C 100 General

101 The requirements of this standard include carefully integrated references to internationally recognised codes and standards, as well as other DNV Offshore Standards. Except where only specific part(s) of a code or standard is referenced in this standard, or where otherwise agreed by all involved parties, all applicable requirements for the equipment system in question arising from the referenced code or standard shall apply.

102 Other *ad hoc* combination of codes or standards should only be made after proper consideration of the compatibility of the documents, and only where safety and sound engineering practice can be justified. Such selective (piecemeal) application of a code or standard shall be verified.

103 The international or national references as well as references to other DNV Offshore Standards frequently referred to in respective sections of this standard are shown in Table C1 and Table A1 respectively. In any instance of conflict between specific requirements of a reference standard and this standard, the requirements of this standard shall apply.

Table C1 International or national references		
System	*Reference No.*	*Title*
BOPs	API Spec 6A	Wellhead and Christmas Tree Equipment
	API Spec 16A	Drill Through Equipment
	API Spec 16D	Control Systems for Drilling Well Control Equipment
	API RP 16E	Design of Control Systems for Drilling Well Control Equipment
	API RP 53	Blowout Prevention Equipment Systems for Drilling Operations
	ISO 10423	Petroleum and natural gas industries - Drilling and production equipment - Specification for valves, wellhead and Christmas tree equipment
Choke and kill systems	API Spec 16C	Choke and Kill Systems
Diverter systems	API RP 64	Diverter Systems Equipment and Operations
Marine risers	API Spec 16R	Marine Drilling Riser Couplings
	API RP 16Q	Design, Selection, Operation and Maintenance of Marine Drilling Riser Systems
	API Bul 16J	Comparison of Marine Drilling Riser Analyses
	DNV-OS-F201	Dynamic Risers

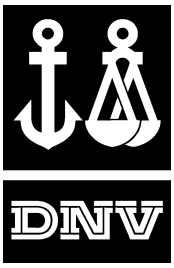
Table C1 International or national references (Continued)

System	*Reference No.*	*Title*
Drilling equipment	API Spec 7K	Drilling Equipment
	API Spec 8C	Drilling and Production Hoisting Equipment (PSL1 and PSL2)
	API Spec 9A	Wire Rope
	API RP 7G/ ISO 10407	Petroleum and natural gas industries - Drilling and production equipment - Drill stem design and operating limits
	API RP 7L	Inspection, Maintenance, Repair, and Remanufacture of Drilling Equipment
	API RP 8B	Inspection, Maintenance, Repair, and Remanufacture of Hoisting Equipment
	API RP 9B	Application, Care and Use of Wire Rope for Oil Field Service
	FEM	Rules for the Design of Hoisting Appliances
Pressure vessels, fired units and heat exchangers	TBK 1-2	Generelle regler for trykkbeholdere (General Rules for Pressure Vessels)
	ASME Boiler and Pressure Vessel Code	Section VIII, Division 1 and 2, Rules for Construction of Pressure Vessels
	ASME Boiler and Pressure Vessel Code	Section IV, Heating Boilers
	ASME Boiler and Pressure Vessel Code	Section I, Power Boilers
	PD 5500	Unfired Fusion Welded Pressure Vessels
	BS 2790	Specification for Design and Manufacture of Shell Boiler of Welded Construction
	BS 5045	Transportable gas containers
	TEMA	Tubular Exchangers Manufacturers Association standards
	API Std 530 / ISO 13704	Calculation of Heater Tube Thickness in Petroleum Refineries
	DNV	See Table A1
Derrick	API Spec 4F	Drilling and Well Servicing Structures
	API RP 4G	Maintenance and Use of Drilling and Well Servicing Structures
Lifting appliances in general, and lifting appliances for BOP and burner boom.	DNV	DNV Rules for Certification of Lifting Appliances
	ILO Form No. CG3	Certificate of test and thorough examination of loose gear
Work over and well intervention equipment	ISO 13628-7	Design and operation of subsea production systems - Part 7 Completion/workover riser systems
Piping	ANSI/ASME B31.3	Chemical Plant and Petroleum Refinery Piping
	API RP 14E	Design and Installation of Offshore Production Platform Piping Systems
	API RP 17B	Flexible Pipe
Corrosion - hydrogen sulphide	NACE MR0175 / ISO 15156	Sulphide Stress Cracking Resistant Metallic Material
Miscellaneous	ANSI B2.1	Pipe Threads, General Purpose (Inch), (Except Dryseal)
	ISO 10418	Petroleum and natural gas industries - Offshore production platforms - Analysis, design, installation and testing of basic surface safety systems
	API RP 14C	Analysis, Design, Installation and Testing of Basic Surface Safety Systems on Offshore Production Platforms
	API RP 14J	Design and Hazards Analysis for Offshore Production Facilities
	API RP 505	Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Zone 0, Zone 1 and Zone 2
	ASTM 193	Alloy steel and stainless steel bolting materials for high temperature service
	EN 10204	Metallic Products - Type of Inspection Documents
	IEC 60092-504	Electrical installations in ships - Part 504: Special features - Control and instrumentation
	IEC 60529	Degrees of protection provided by enclosures (IP Code)
	IEC 60533	Electrical and electronic installations in ships - Electromagnetic compatibility
	IEC 60945	Maritime navigation and radiocommunication equipment and systems - General requirements - Methods of testing and required test results
	IP 15	Area classification code of Petroleum Installations
	ISO 898-1	Mechanical properties of fasteners made of carbon steel and alloy steel - Part 1: Bolts, screws and studs.

104 Other codes and standards may be applied provided that the alternative standard can be clearly shown to provide a comparable or higher safety level than under the requirements of this standard.

105 Any deviations, exceptions, and modifications to the design codes and standards shall be documented and agreed between all contracting parties.

106 The latest issue of the standards (as referred to in Table A1 and Table C1) valid on the date of contract signed between the contracting parties shall be used, unless otherwise specified in the contract.



OFFSHORE STANDARD
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DRILLING PLANT

CHAPTER 2

TECHNICAL PROVISIONS

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SECTION 1
DESIGN PRINCIPLES

A. General

A 100 Objective

101 This section states the basic principles to be considered for design and layout of drilling facilities in order to avoid hazards occurring on the installation.

102 An overall objective for the design of drilling facilities is that no single failure shall result in life threatening situations for the involved personnel, or significant damage to property and the environment.

A 200 Scope and application

201 The requirements of this section apply to all drilling systems and equipment, which have the potential to adversely affect safety or integrity of the offshore installation.

202 The requirements apply specifically to drilling systems and equipment on board offshore installations.

203 The principles stated in this section shall be fulfilled in implementing requirements outlined elsewhere in this offshore standard.

B. Overall Safety Principles

B 100 General principles

101 *Safety systems*, wherever mentioned within this standard, comprises the following systems:

— all *essential systems* and essential functions of *important systems* as explained in Sec.1 and Sec.5
— all other protective safety functions as explained in 102.5
— production plant shutdown and blowdown systems for well test system
— emergency shutdown system (ESD)
— fire and gas detection and alarm system
— any other safety critical systems and components (e.g. position keeping ability versus riser limitations and associated disconnection system for floating installations).

Of the above, details and requirements for ESD, fire and gas systems, and production plant shall be taken from the respective standards referenced in 102.9.

102 *Drilling systems*, including all components, shall be designed to minimise risk of hazards to personnel, property, and environment by application of the following general principles:

.1 No single failure or maloperation shall result in life threatening situations for the involved personnel, or significant damage to property and/or the environment.
.2 All equipment shall be provided with indicating instruments which will provide the necessary information for safe operation, control, and emergency action.
.3 Where practicable, unnecessary hazards should be avoided or prevented through safe design such that further protection measures are not required.
.4 Where hazards may occur, items, plant, or equipment which are important for safety (i.e. require functionality to maintain the safety of the system or installation), shall be available.
.5 Systems and equipment shall be protected against excessive loads, pressure, temperature and speed.
.6 A safety system element shall be provided in order to automatically implement safety actions on occurrence of predefined abnormal process equipment states. This system element shall include all resources required to execute the safety actions.
.7 The safety system element shall be designed such that the most probable failures, e.g. loss of power supply or wire failure, 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 All other safety systems, such as ESD and F&G, shall be according to the respective DNV standards, DNV-OS-A101 and DNV-OS-D301. For production plant, shutdown, and blowdown systems see DNV-OS-E201.
.10 Systems and equipment shall be designed for operation throughout a specific design life. Unless otherwise specified, the design life shall be taken as 20 years.

B 200 Drilling systems and equipment

201 An *essential system* is generally defined as a system which supports equipment which needs to be in continuous operation for maintaining the unit's manoeuvrability.

The definition is extended for systems associated with the drilling plant to cover systems which are needed to be available on demand to prevent development of, or mitigate the effects of an undesirable event and to safeguard the personnel, environment and the installation.

202 An *important system* is generally defined as a system supporting equipment which need not necessarily be in continuous operation for maintaining the unit's manoeuvrability, but which is necessary to maintain the unit's main functions.

The definition is extended for systems associated with the drilling plant to cover systems, which ensures reliable operation and which maintains plant operation within operational limitations.

203 A *non-important system* is defined as a system, which is neither essential nor important.

204 Among the various operational modes (operation, waiting on weather, survival and transit) for a drilling installation, Table B1 is developed further to categorise the following systems and components applicable for the *operation mode*.

Table B1 System or component categorisation

System or Mode	*Drilling*	*Fixed to bottom operations (e.g.: Well testing)*
Well control systems	E	E
Marine riser including tensioning system	I*	E
Heave compensation	I*	E
Hoisting	I*	I
Rotation	I	N
BOP or Pipe handling	I*	N
Bulk storage, drilling fluid circulation and cementing	I*	N
Well testing	N	I
Blowdown system for well testing	N	E

E = Essential, I = Important, N = Non-important

* Only certain functions and component of these important systems are categorised as essential or safety critical. See Sec.5 under the subheading of each of the systems mentioned above for details.

205 Essential systems and essential functions of important systems shall include two independent levels of protection to minimise the adverse effects of a single fault in process equipment, associated piping system, and normal process controls. In order to reduce the probability for common cause failures, the two levels of protection shall be provided by functionally different types of safety devices; ensuring uncompromising reliability at all times.

206 To facilitate understanding of these overall safety principles, prescriptive requirements for systems and components are given in Sec.5. However, if a system or component other than those mentioned in Sec.5 is used and can be defined as essential or important according to 201 and 202, then the system or component shall comply with the safety principles as applicable for essential or important systems or components.

C. Arrangement and Layout

C 100 General arrangement

101 Arrangement and layout of the drilling plant and its systems and equipment shall be arranged as far as possible in agreement with the principles of DNV-OS-A101 in order to ensure safe operation.

102 Equipment and areas with high risk potential shall be segregated from those with a low risk potential, (see DNV-OS-A101 Sec.3).

103 All equipment and parts, which shall be operated, inspected, or maintained on board shall be installed and arranged for safe and easy access.

104 Facilities for safe isolation shall be provided for all parts of the drilling and utility systems, which contain high pressure fluids, flammable or toxic substances, and which require to be accessed for maintenance or other operations while adjacent parts of the system are energised or pressurised.

105 Location and design of critical equipment and facilities shall include due consideration of potential for dropped objects, especially in connection with materials and equipment handling.

106 Equipment with moving parts or hot or cold surfaces, and which could cause injury to personnel on contact, shall be shielded or protected.

Guidance note:

Shielding or insulation should normally be installed on surfaces, which can be reached from work areas, walkways, stairs or ladders if surface temperatures exceed 70°C.

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107 If geographical location of operation is such that ice and snow accumulation may occur, systems or equipment for effective de-icing with necessary availability shall be installed.

108 Decks and work areas shall include efficient drainage for spillage of water, oil, drilling mud, etc., which could occur. Hazardous drains from drill floor, substructure and well test area shall be collected and routed to a dedicated slop tank system, and shall be segregated from drains from non-hazardous areas.

109 The driller shall have a clear view of all activities at the drill floor and within the derrick (or similar) during operation.

Guidance note:

The clear view should be provided directly by a suitable location of the control cabin or indirectly by e.g. use of monitors (cameras).

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C 200 Arrangement of safety systems

201 Safety systems which may be required to operate simultaneously during a defined accidental event shall be controlled from the same physical location to the extent possible. Alternatively, efficient and fool-proof visual and/or audible communication facilities shall be provided to enable safe operation of the drilling plant and installation.

202 Safety systems and relevant controls shall be located, or otherwise protected, so as to remain operational and safely accessible for the necessary time during an uncontrolled well situation or other defined accidental event, (see DNV-OS-A101 Sec.3).

203 In particular, the main control unit of such systems, including the following, shall not be located on the drill floor:

— BOP or diverter control system
— necessary provisions for cutting of drillpipe at any time
— disconnection (subsea BOPs only).

Guidance note:

Necessary provisions for cutting of drillpipe may be super shear ram (cuts tool joint), 2 shear rams or possibility of emergency lowering or hoisting.

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204 Control hoses, cables, and other means necessary for operation of safety systems shall be suitably located or protected so as to ensure availability of such systems for the time required during the defined accidental events.

205 Back-up supplies to systems important for safety shall be provided to enable safety systems to remain available for the time required during the defined accidental events. Electrical equipment required to remain operational in areas affected by a gas release (e.g. well control system) shall be certified for hazardous area zone 2, (see also DNV-OS-A101 Sec.4.)

206 All alarms initiated by the control and monitoring systems and the safety systems shall be released and acknowledged in the driller's cabin, toolpusher's office and the central control room, as appropriate for the safe operation of the drilling plant and the unit. The station in command shall be clearly indicated.

207 When an emerging (stick out) device for overriding a safety action is provided, it shall be arranged such that unintentional operation is prevented. There should be clear indication when the device is operated.

C 300 Escape and access routes

301 The drill floor shall be arranged with at least two direct and unobstructed exits.

302 At least one escape route from the drilling derrick and from driller’s cabin shall lead directly to a safe place without requiring personnel to enter the drill floor area.

303 See DNV-OS-A101, Sec.6 for general requirements for escape and escape routes, as well as specific requirements for stairs, ladders, handrails, etc.

D. Fire and Explosion

D 100 Active and passive fire protection

101 See DNV-OS-D301 for basic fire protection requirements.

D 200 Hazardous areas

201 See DNV-OS-A101. This reference also contains specific requirements for drilling units.

D 300 Ventilation

301 See DNV-OS-A101 Sec.4.

D 400 Fire and gas detection

401 See DNV-OS-D301 Ch.2 Sec.5.

E. Control and Monitoring, System Configuration

E 100 General

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

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

103 For essential and important systems and other safety systems, deviations between a command action and expected result of the command action shall initiate an alarm.

104 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 shall be activated at different levels. The least drastic action shall be activated first.

E 200 Field instrumentation

201 The field instrumentation belonging to separate essential process segments shall be mutually independent.

Guidance note:

System B is independent of system A when single system failures occurring in system A have no effect on the maintained operation of system B. (However, single system failure occurring in system B may/may not affect the operation of system A.)

Two systems are mutually independent when a single system failure occurring in either of the systems has no consequences for the maintained operation of the other system according to the situation described above.

Redundancy may provide the necessary independence. See 400.

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202 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 shall not affect this field instrumentation and vice versa.

203 Where manual emergency operation of an essential process segment may be required, the necessary field instrumentation shall be independent of other parts of any system.

204 Electronic components, which replace traditional mechanical components, shall have the same reliability as the mechanical component being replaced.

205 The fail-safe principles described in 206 and 207 shall be applied to all safety systems, regardless of energy transfer principles.

Guidance note:

Energy transfer principles may be e.g. electrical, hydraulic or pneumatic.

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206 Input circuits to, and output circuits from, safety systems shall be configured as follows:

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

207 As an example, the output circuits from safety systems being able to shut down the systems given in Table B1 shall be configured as per the principles given in Table E1.

Table E1 Safest conditions and corresponding output circuit configuration

System	*Safest condition in case of failure to the shutdown system*		*Output circuit configuration* [2]
	Drilling	*Fixed to bottom operations (e.g. well testing)*	
Well control system	Operational	Operational [1]	NDE / NDE
Emergency mixing and circulation of drilling fluid	Operational [3]	N/A	NDE / -
Main hoisting systems facilitating well disconnection	Operational [4]	Operational [4]	NDE / NDE
Heave compensation during fixed to bottom operations	Operational [5]	Operational [5]	NDE / NDE
Integrated main hoisting and heave compensation systems	Operational [5]	Operational [5]	NDE / NDE
Well testing facilities (blowdown systems)	N/A	Operational	- / NDE
Well testing facilities (excluding/blowdown systems)	N/A	Shutdown	- / NE

Notes:

1) See well control systems as applicable for well testing. (Last two items of this table.)
2) See DNV-OS-A101 Sec. 5 for definitions and general requirements.
3) See Sec.5 G102 for details.
4) See Sec.5 E203 for details.
5) See Sec.5 D102 for details.

NDE = Normally de-energised, NE = Normally energised

E 300 Integrated system

301 User Input Devices (UIDs) for control shall be available only on workstations from where control is permitted.

302 Multifunction of Visual Display Units (VDU) and User Input Devices (UID) shall be redundant and interchangeable. The number of units at control stations shall be sufficient to ensure that all functions can be provided with any one unit out of operation, taking into account any functions which are required to be continuously available.

E 400 Redundancy

401 Redundant systems shall be installed to the extent necessary to maintain the safe operation of the installation. Switch-

over to redundant systems shall be simple, and shall be available in event of failure in the control and/or monitoring systems.

Guidance note:

Redundancy means that any of two or more *mutually independent* systems (see 201) can maintain a function. The two systems may be of different type or have different functionality.

The selection of spare parts, redundancy, or manual operation facilities, in order to ensure continuity of operation upon failure of instrumentation equipment should include due consideration of the manning level.

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402 Automatic switching between two systems shall not be dependent on only one of the systems.

E 500 Power supplies

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

Guidance note:

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

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502 The UPS shall be monitored with alarm for failure from a manned control room.

Guidance note:

The following failures should normally be considered:

- loss of input power
- internal UPS failure.

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503 The emergency power systems and UPS and associated controls, etc. shall be self contained, and located such that they are not vulnerable to events which may affect the main power supply.

F. Design Principles, Response to Failures

F 100 Failure detection

101 The systems shall have facilities to detect the most probable failures that can cause erroneous or reduced system performance ("self-check" facilities), or which could affect the integrity and safety of the equipment or the offshore installation.

102 The self-check facilities shall cover, as a minimum, the following failure types:

— power failures
— sensor and actuator failures
— loop failures (at least broken connections and short circuit) for normally de-energised (normally open) circuits in safety systems.

And additionally for computer based systems:

— communication errors
— computer hardware failures
— software execution failures
— software logic failures.

103 Adequate failure detection may be obtained by combining two mutually independent systems, which together provide the required failure detection properties, e.g. an automatic control system together with an independent alarm system.

104 Detection of failures in systems other than non-important systems shall initiate an alarm.

F 200 Fail-to-safety

201 The most probable failures, e.g. loss of power or cable or wire failures shall result in the least critical of any possible new conditions.

This shall include consideration of the safety of the systems themselves, as well as the safety of the offshore installation. See Table B2 for examples.

G. Design Principles, Maximum Unavailable Time

G 100 General

101 The time needed to bring a system back in operation upon a failure condition shall be adapted to the redundancy requirements imposed on the system served.

102 Typical maximum unavailable times for the different categories are found in Table G1.

Table G1 Maximum unavailable time

System Category	*Time*
Continuous availability (R0)	None
High availability (R1)	30 s
Manual system restoration (R2)	10 minutes
Repairable systems (R3)	3 hours

G 200 Continuous availability (R0)

201 A system serving a function that shall be continuously available shall be designed such that there is no interruption of the function during system normal operation modes or in case of a single system failure.

202 Changeover between redundant systems shall take place automatically and with no disturbance of the continuous operation of the function in case of system failure. User requested changeovers shall be simple, easily initiated, and shall take place with no unavailable time for the function.

203 User interfaces of redundant systems shall allow supervision of both systems from the same position.

204 As a principle, all essential systems and essential functions of important systems should belong to this category unless it is demonstrated that it is possible to suspend these specific operations without compromising the safety of the personnel, equipment or installation (see Table B1).

G 300 High availability (R1)

301 A system serving a function that shall have high availability is to be designed to provide continuous availability in normal operation modes.

302 In case of system failures, changeover between redundant systems shall take place automatically, if such redundancy is required. User requested changeover in normal operation shall be simple, easily initiated, and shall take place within the same maximum time.

303 User interfaces of redundant systems shall be located close to each other and changeover between the systems shall have no significant effect on the user's maintained execution of other tasks.

G 400 Manual system restoration (R2)

401 A system serving a function that requires manual system restoration shall be designed to provide restoration of the function within a maximum time specified for R2, in case of system failures.

Guidance note:

Restoring a function may involve a limited number of simple manual actions.

User interfaces of redundant systems may be designed for manning of normally unattended workstations when required, provided such manning is immediately available.

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G 500 Repairable systems (R3)

501 A system serving a function of category R3 shall be designed to provide restoration of the function within a maximum time specified for R3 in case of system failures.

Guidance note:

Restoring a function may involve a number of manual operations, including minor replacements or repair of equipment.

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H. Design Load Conditions

H 100 General

101 The drilling system and each part of the drilling plant shall be designed to operate safely under the maximum foreseeable load conditions experienced during drilling operations, and to limit the risk of drilling hazards. Subsections H and I give further information for calculation of such loads and loading conditions.

102 All external loads, which may adversely affect the proper functionality, safety, strength and reliability of the drilling plant shall be considered.

H 200 Design pressure and temperature

201 The specified design temperature and pressure conditions for equipment and components shall include adequate margins to cover uncertainties in the prediction of internal and external temperature or pressure conditions.

202 The design pressure shall normally include a margin above the maximum operating pressure.

203 The design conditions shall include start-up, shutdown, and abnormal conditions which are considered as reasonably likely to occur.

204 Where necessary, analysis shall be used to establish operational limitations, which are not readily or reliably available.

Guidance note:

E.g. low temperature in choke and well testing systems, etc.

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H 300 Environmental loads

301 The environmental criteria and motion characteristics used for the design of the unit during applicable operating and non-operating conditions shall be used.

Guidance note:

Normally, the following design conditions should be evaluated:

- operation
- waiting on weather (applicable for floating installations only)
- transit
- survival
- accidental heel.

See DNV-OS-C101 for further guidance.

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302 Design of the system shall include allowance for relative motion between different parts of the system, to the extent necessary to avoid inducing detrimental stresses (e.g. for design of riser systems).

303 Tests to confirm component or system suitability for intended purpose shall be performed and documented, as necessary.

304 Where applicable, the following aspects shall be taken into consideration when establishing the environmental loads:

— motion of the unit (i.e. heave, roll, pitch, sway, surge and yaw)
— wind loads
— air temperatures and humidity
— loads from possible accumulation of snow and ice
— earthquakes (fixed installations only).

305 *Motion*

.1 Unit motion due to wind, current, and wave loads shall be included in the design loads for all major structural components of importance to drilling facilities, e.g. pipe handling equipment, BOP handling cranes, derrick structure, etc.

.2 Unit motion shall also be considered when evaluating fixture of pressure containing equipment having considerable mass, such as air pressure vessels, etc.

.3 The unit motion due to surge, sway and yaw are normally relatively small. This motion may be neglected provided that the greater of the conservative value combinations (305.4) are considered for the actual location, and for all relevant modes (i.e. transit, operational and non-operational modes).

.4 *Value combinations*

— maximum heave and maximum pitch
— maximum heave and maximum roll
— maximum heave and square root of sum of squares maximum roll and maximum pitch, i.e.

$$\text{Heave}_{max} + \sqrt{(\text{Roll}_{max})^2 + (\text{Pitch}_{max})^2}$$

.5 Where more accurate motion analysis forms the basis for design motion loads, such analysis should also take into account the effect of surge, sway and yaw accelerations.

.6 Maximum limiting values for transit and operational mode shall be documented, defined either as horizontal and vertical accelerations respective to g (a_x, a_y and a_z), or as roll, pitch and heave amplitudes and periods, together with distance to roll or pitch centre.

Guidance note:

Where vessel motion characteristic is not available, conservative maximum pitch and roll accelerations of 0.35 g (at drill floor level, should be proportionally adjusted upward at higher levels) should be considered together with maximum heave acceleration of 1.3 g for non-operational mode (survival).

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306 *Wind loads*

.1 Wind loading of exposed equipment and components for all relevant modes shall be included as a design load in the design calculations. Limiting maximum occurring wind speeds during transit and operation shall be clearly defined (specifying reference height above sea level and average time period).

Guidance note:

For details of calculation of wind loads associated with various. wind speeds and geometry, see e.g. *Classification Note No. 30.5.*

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.2 Unless otherwise specified, 100-year storm values for the intended geographical location shall be used for evaluation of survival condition.

Guidance note:

For typical wind speeds ref. DNV-OS-E301 Ch.2 Sec. 1 B300 Wind

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307 *Air temperature*

Unless otherwise specified, systems and equipment shall be designed for operation under ambient air temperature:

— between the minimum design temperature and 35°C
— inside machinery housing or other compartments containing equipment between 5°C and 55°C.

308 *Accumulation of ice and snow*

Where such weather conditions are known to occur, maximum loads from snow and ice accumulation shall be clearly defined for all relevant modes. Where location specific loading is not available, values as specified in DNV-OS-C101 may be used.

309 *Earthquake loads*

See DNV-OS-C101.

H 400 Operational loads

401 *Principal loads*

The principal loads to be considered are:

— loads due to the deadweight of the components. (If the deadweight of equipment varies with operational mode, e.g. dry weight during transit and full weight during operation, this shall be clearly specified)
— loads due to the working load.

Guidance note:

E.g. hook-load, rotary load, riser tensioner load.

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Loads due to pre-stressing (i.e. loads imposed on structural items due to pre-stressing of bolts, wire ropes, etc.).

402 *Vertical loads due to operational motions*

.1 The vertical loads due to operational motions shall be taken into account by multiplying the working load by a dynamic coefficient ψ.
.2 Minimum values of ψ to be used in design calculations for specific equipment are found under respective sections of this standard.
.3 For equipment with no specific value listed in this standard, the magnitude of ψ shall be in accordance with a recognised code or standard, as applicable.
.4 Lower values than stated in 402.2, 402.3 may only be applied where thoroughly demonstrated through testing, i.e. measurements of ψ during operation of the equipment under consideration.

403 *Horizontal loads due to operational motions*

Where applicable, examples of relevant loads to be considered are:

— inertia forces due to horizontal movements
— centrifugal forces
— forces transverse to rail resulting from reeling and skew motion
— buffer loads, etc.
— For further details on calculation of these loads, see *Rules for Certification of Lifting Appliances*.

404 *Well fluid composition and specific weight*

.1 Design shall include due consideration of well fluid composition, with regard to such phenomena as corrosion, stress corrosion cracking, erosion, fouling, etc.
.2 Unless otherwise specified, a specific drilling fluid weight of 2.1 t/m^3 shall be used as design basis for relevant equipment (e.g. mud tanks, riser tensioner etc.).

405 *Accidental loads*

.1 Unless otherwise identified (e.g. from safety assessment or shelf-state requirements), the accidental loads given in 405.2 to 405.4 shall apply.
.2 The drill floor shall be designed to withstand the impact from a falling 9 1/2" drillcollar stand from a height of 1.5 m.
.3 For floating installations, all equipment with potential to impair access or escape on the unit shall be provided to withstand an emergency static condition with the unit inclined at an accidental heel angle. The heel angle shall correspond to a two compartment damage (static), together with the dynamic motion response resulting from survival condition in the damaged position. This also applies to equipment that has a potential of seriously escalating the damage situation.

Guidance note:

If the two compartment damage angle is not known, an angle of 17 ° should be applied. The dynamic motion response should be calculated based on the unit in damaged position. If these unit characteristics are not known, an additional static angle of 10 ° should be used.

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.4 Unless means for emergency lowering of loads are provided, maximum operating weights shall be applied for this maximum inclination. The effect of other environmental loads (e.g. wind loads) need not be considered during this emergency condition.

H 500 Loading combinations

501 Unless otherwise specified, equipment shall be evaluated for applicable loading combinations for the following operating and non-operating conditions:

— operational
— waiting on weather (applicable for floating installations only)
— survival
— transit.

I. Design Calculations

I 100 General

101 For each loading condition, and for each item to be considered, the most unfavourable combination, position, and direction of loads which may act simultaneously shall be used in the analysis.

I 200 Design safety factors

201 Appropriate safety factors shall be applied in determination of an acceptable stress level for the different load conditions.

202 Safety factors shall be in accordance with a relevant recognised code, standard, or recommended practice for each particular component, unless otherwise specified in this standard.

Guidance note:

E.g. *Rules for Certification of Lifting Appliances* for mechanical components, unless covered by applied code or standard.

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203 The yield strength used in calculations shall not exceed 0.85 of the specified minimum tensile strength.

I 300 Modes of failure

301 The mechanical components of the drilling system shall be designed against the following possible modes of failure, including, where relevant:

— excessive yielding
— structural stability
— fatigue fracture.

302 *Excessive yielding*

The stress analysis shall normally be based on the elastic theory. An ultimate strength (plastic) analysis may be used where appropriate.

303 *Structural stability*

The stability analysis shall be carried out according to generally accepted theories.

304 *Fatigue*

.1 Areas of mechanical components that are susceptible to fatigue damage shall be evaluated.

.2 Structures with slender members that are exposed to direct wind loading shall be documented as able to withstand possible wind induced oscillations.

.3 The fatigue analysis shall be based on a period of time equal to the planned life of the drilling plant. Unless otherwise specified, a 20 year design life shall be applied.

.4 The fatigue analysis shall be based on a representative load spectrum for the occurring loads.

Guidance note:

If detailed inertia load spectrum is not available, a Weibull parameter h of 1.1 can be used, together with extreme inertia loads corresponding to the design life of the drilling plant. If this approach is used, the effect of directional spreading of the environmental loads should not be used in the fatigue analysis.

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SECTION 2
MATERIALS AND WELDING

A. General

A 100 Principles

101 Materials selected shall be suitable for the purpose, and shall have adequate properties of strength, notch toughness, and ductility. In addition, materials to be welded shall have good weldability properties.

102 Materials to be used for applications involving H_2S-containing fluids (sour service) shall be selected according to NACE MR0175 and any additional requirements under this standard.

103 The materials shall generally be specified in accordance with recognised standards. Special written specifications may also be accepted where justified on a case by case basis.

104 Standards and specifications shall specify material properties and testing procedures, including NDT, as relevant. Requirements given in this section apply.

B. Specific Requirements

B 100 General

101 For welded C-Mn steels for major pressure containing and load carrying parts the chemical composition is normally to be limited to the following carbon (C)- and carbon equivalent (CE)-values:

$$C \leq 0.22$$

$$CE = C + \frac{Mn}{6} + 0{,}04C \leq 0.45$$

102 When the relevant elements are known, the following carbon equivalent formula shall be used:

$$CE_{(b)} = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Cu + Ni}{15} \leq 0.45$$

Materials not meeting this limitation may be used provided that suitable welding procedures are applied.

Guidance note:

The welding of such materials normally requires more stringent fabrication procedures regarding selection of consumables, preheating, post weld heat treatment and NDT, see Sec.6 C107.

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103 Impact testing is normally required for steel materials with reference thickness above 6 mm if the Minimum Design Temperature (MDT) is below 0°C. Testing shall be carried out at MDT for materials under this category.

104 Materials for structural and mechanical components shall be manufactured from materials having minimum longitudinal impact toughness according to Table B1. If only transverse values are available, 2/3 of the values of Table B1 apply. The requirements shall be met as an average of 3 specimens, and with no individual value to be less than 2/3 of the specified minimum average.

Table B1 Average minimum Charpy V-notch energy absorption

Yield strength (MPa)	*Charpy V-notch energy (J)*
Yield strength ≤ 270	27
270 < Yield strength < 420	10% of yield strength [1]
Yield strength ≥ 420	42

1) Rolled structural steel delivered in normalised condition may be accepted with a minimum Charpy V-notch value of 27 J at –20°C (for a MDT = –20°C) provided that the materials are delivered in accordance with internationally recognised standards such as DIN, BS, ASTM etc. and are suitable for their intended application.

105

1) Materials for piping and pressure retaining components are required to have documented Charpy impact values of minimum 27 J if part of one of the following high pressure piping systems:

   — choke and kill system
   — high pressure mud system
   — well test system
   — cement system.

   Guidance note:

   Recognised piping standards such as ANSI B31.3 is considered not to fully cover the high pressure systems listed above due to special design conditions normally not present in standard process piping, e.g. water hammering effects and choking (Joule Thompson) effects. For such conditions, proper impact properties are considered important.

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2) For drilling and workover risers the Charpy impact value requirement specified in B104 shall apply.

106 Bolt material documented Charpy impact properties shall be consistent with the system where the bolts are applied, see B105 if applied for piping and pressure retaining bolt assemblies and B706, Table B3 if applied for structural and mechanical bolt assemblies.

107 Where standard test specimens cannot be made, subsize specimens may be used with the energy conversion factors as given in Table B2.

Table B2 Average Charpy V-notch energy absorption

Specimen section (mm^2)	*Energy factor*
10 x 10	1
10 x 7.5	5/6
10 x 5	2/3

108 For austenitic stainless steels, impact tests are only required for design temperatures below –105°C.

109 Impact test specimens shall be sampled from a location:

— 2 mm below the surface for thickness ≤50 mm, or
— t/4 for thickness > 50 mm.

110 Materials for "sour service" shall meet the hardness requirements in NACE MR0175. Any welding or other fabrication affecting hardness shall be carried out according to a qualified procedure, in order to ensure that the maximum specified hardness is not exceeded.

111 Plates that transfer significant loads in the thickness direction (Z-direction) shall be guaranteed with through thickness ductility in order to reduce the probability of lamellar tear-

ing. The minimum reduction of area, Zz, shall not be less than 25%.

B 200 Rolled steel

201 The material standard or specification shall define an extent of testing comparable to that described in DNV-OS-B101.

B 300 Steel piping

301 Electric resistance welded pipes shall not be used for working pressure above 32 bar, or design temperatures above 300°C.

302 The material standard or specification shall define an extent of testing comparable to that described in DNV-OS-B101.

B 400 Steel forgings and castings

401 Testing of mechanical properties of forgings and castings shall normally be performed on a trepanned outlet or a prolongation removed from the forging or casting after completion of final heat treatment, or by random selection of forgings or castings from the same heat and heat treatment batch. The test material shall represent the thickest section of the component.

402 Separate test coupons may be accepted where justified. The separate test coupons for determining mechanical properties shall represent the actual component in every respect. The samples shall be from the same heat as this actual component, and shall have received the same forging ratio and heat treatment simultaneously with the material they represent. The test samples shall be of a dimension reflecting the critical wall thickness in the actual component.

403 Test specimens shall be as follows:

a) The mechanical test specimens shall be removed from the test material at a depth of 1/4 thickness (t). When applicable, the specimens shall be located t/4 from the inner surface.

b) Transverse test specimens shall normally be used.

c) Minimum one full set of mechanical tests per lot shall be tested. (One lot consists of components from the same heat and the same heat treatment batch.) If components of different dimensions are in the same lot, it is sufficient to test the largest dimensions only, provided the strength requirement is the same for all dimensions.

404 Flanges, valve bodies, etc., shall normally be forged to shape, or cast. If such components are machined from forged bar stock, rolled bar stock, forged plate, or rolled plate, the material shall be tested in the transverse direction and shall meet the requirements for longitudinal specimens of forged to shape components. If using plate, testing shall also be performed in the short-transverse (through thickness) direction.

405 The material standard or specification has to define an extent of testing comparable to that described in DNV-OS-B101.

B 500 Cast iron

501 Cast iron shall not be used for critical parts with MDT below 0°C unless specifically justified and agreed between all parties.

502 For non-welded sheaves, impact testing of the material is not required. Nodular cast iron used for sheaves shall have a minimum elongation of 10% (L_o = 5 d).

503 Mechanical properties of castings shall be tested in accordance with the requirements given in 401 to 403.

504 The material standard or specification shall define an extent of testing comparable to that described in DNV-OS-B101.

B 600 Other metallic material

601 Aluminium, copper, and other non-ferrous alloys shall have a supply condition, chemical composition, mechanical properties, weldability, and soundness according to material standard provided the requirements of DNV-OS-B101 are fulfilled.

B 700 Bolting material

701 In general bolt assemblies considered to be essential for structural and operational safety shall conform to a recognised standard.

Guidance note:

E.g. ISO 898-1 with regard to property class.

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702 Major pressure retaining or structural bolts, and nuts with minimum yield strength above 490 N/mm^2, shall be manufactured of low alloy or alloyed steel, and shall be supplied in quenched and tempered condition.

Guidance note:

Low alloy or alloy steels are considered to be those steels where one or more of the elements Cr, Mo and Ni comply with a specified minimum content of 0.40% (Cr), 0.15% (Mo) and 0.40% (Ni), respectively.

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703 For general service when the installation is in an atmospheric environment, the specified tensile properties shall not exceed ISO 898-1 property class 10.9.

Guidance note:

Property class 12.9 may only be applied if requirements to flatness of surfaces and pretension according to recognised principles are fulfilled.

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704 For submerged installations the tensile properties shall not exceed property class 8.8 or ASTM A193 B7 or equivalent.

705 For bolted joints, in which the bolts are directly exposed to the sour environment (wetted), lower tensile properties than for 8.8 class may be necessary to comply with NACE MR0175.

706 Documentation of bolting material used in structural and mechanical assemblies considered to be essential for structural and operational safety. The specific impact test requirements apply as referred in Table B3.

The assessment of Charpy documentation requirements shall be based on:

— nature of external loading and the resulting stress level in bolt, as a combination of tension, pressure and shear stress
— whether the bolt is a primary load bearing element, or only considered as part of a connection clamping parts in place
— consequences of failure.

Table B3
Documentation requirements for bolts produced from low alloy or alloyed steel:

Cat.	*Load condition*	*t > 0°C*	*0°C ≥ t ≥ -20°C*	*t < -20°C* [1]
A	No tension from external load. Connection relying on friction	2.2 certificate	2.2 certificate	3.1. certificate
B	Tension from external load is considered secondary and small compared to the bolts capacity. Some redundancy required, e.g. no single point of failure of bolt shall cause risk of failure of the structure.	2.2 certificate	2.2 certificate	3.1. certificate Certificate to show compliance with Charpy values in Table B1.
C	Bolts subject to external load in non-redundant application e.g. slewing ring bolts on cranes.	3.1 certificate	3.1.certificate Charpy impact / fracture mechanic properties to be consistent with the system where it is applied.	3.2 certificate Charpy impact properties to be consistent with the system where it is applied.

All Bolts are as a minimum to be in accordance with ISO 898-1.

Corresponding nuts are to be in accordance with ISO 898-2. No impact testing is required for nuts and washers or other bolting elements mainly exposed to compressive loads.

Certificates to be according to EN 10204, October 2004

1) Bolts intended for use below –20C to be subject to special consideration. In general, bolts intended for temperatures below – 20°C should be of austenitic stainless steel or equivalent. Impact tests of bolts with austenitic stainless steel are normally not required. See B108.

Bolts with diameter less than 16 mm shall not be used for load bearing purposes in structure considered as special and primary.

B 800 Sealing materials

801 The materials used shall be suitable for the intended service, and shall be capable of sustaining the specified operating pressure and temperature of the particular unit or fluid.

802 Elastomeric sealing materials used in critical components should be tested in order to ensure that they are compatible with all fluids that they will be exposed to during service.

C. Corrosion

C 100 General

101 Materials shall be selected as having adequate corrosion resistance or else a corrosion protective system such as coatings, cathodic protection, or chemical treatment of corrosive fluids, may be applied as applicable.

102 The selection of materials and/or corrosion protective systems shall ensure mutual compatibility, taking into account the effect of relevant operational parameters, techniques for inspection, monitoring and maintenance, and the required design life.

103 For certain applications, a corrosion allowance (i.e. extra wall thickness to compensate for metal loss by corrosion) may be applied. This allowance may be applied either alone, or in combination with a corrosion protective coating or chemical treatment.

D. Material Certificates

D 100 General

101 All materials for main load bearing and pressure containing components shall be supplied with documentation stating:

— process of manufacture and heat treatment (metallic materials)
— results for relevant properties obtained through appropriate tests carried out in accordance with recognised standards.

Guidance note:
3.1 according to EN 10204 or equivalent.
For bolting material reference is made to B706.

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SECTION 3
PIPING

A. General

A 100 Application

101 Piping includes:

- pipes
- flexible piping such as expansion elements and flexible hoses
- other parts such as valves and fittings
- piping connections such as welded connections, bolted flanges, clamps, couplings, gaskets etc.
- hangers and support brackets.

B. Piping Design

B 100 General

101 Piping systems used for safe operation of the unit shall normally be separate from piping systems used for drilling and well testing operations. If cross connections for drilling or well testing operations are necessary, non-return valves or other equivalent means for avoiding possible contamination of the safe system by the hazardous medium shall be fitted.

102 For piping not covered by the applied recognised codes or standards, a combined stress calculation as specified in 200 may be used.

103 Relevant factors and combinations of factors shall be taken into account for the design evaluation of possible failure modes such as, but not limited to:

- corrosion/erosion types
- vibration, hydraulic hammer
- pressure pulsations
- abnormal temperature extremes
- impact forces
- leakages.

Guidance note:

Further guidance for general piping design is available in ANSI/ ASME B31.3.

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104 Sizing of piping or tubing downstream of PSV's or other open ended piping system shall take into account expected pressure gradients during operation of the systems.

Guidance note:

One diameter nominal size larger for the downstream piping relative to the upstream piping is recommended.

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B 200 Hard piping design

201 Piping calculations shall ensure that pipes have the necessary strength (i.e. strength thickness) throughout their operational life.

202 Where a combined stress calculation according to Von Mises' theory is applied, the equivalent combined stress at any point of the piping wall shall not exceed 60% of the minimum specified yield strength of the material.

The minimum yield strength (σ_f) of any material shall be taken as the lesser of:

- minimum upper yield strength
- yield strength at 0.2% offset
- 0.8 × minimum tensile strength of the material (σ_b).

The equivalent combined stress as defined by Von Mises is:

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

Where

σ_e = equivalent (Von Mises) combined stress
σ_θ = circumferential or hoop stress
σ_l = longitudinal or axial stress
σ_r = radial stress.

Guidance note:

The calculations σ_θ, σ_l and σ_r may be based on Lame's equations for cylinders.

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203 The minimum design wall thickness (t) of all piping shall include allowances for:

- bending, see 206
- threads, see 207
- corrosion, see 208
- erosion, see 210.

204 The minimum wall thickness of a straight or bent pipe shall not be less than:

$$t = t_0 + \textit{allowances}.$$

205 If pipes are to be bent, the minimum wall thickness before bending shall not be less than:

$$t = t_0 + b$$

Where

t_0 = strength thickness (as calculated from 202, or applied recognised standard)
b = bending allowance.

206 *Bending allowance*

In cases where the allowance for bending, b, is not determined by a more accurate method, or where the bending procedure does not include control of the wall thickness, the allowance shall not be less than:

$$b = \frac{1}{2.5}\,\frac{D}{R}\,t_0$$

where

R = means radius of the bend in mm
$\frac{D}{R}$ = the bending ratio

Where the bending ratio is not available, this ratio will be taken equal to 1:3.

207 *Allowance for threads*

The calculated minimum strength thickness of piping, which shall be threaded, shall be increased by an allowance equal to thread depth, dimension h of ANSI B2.1 or equivalent shall apply. For machined surfaces or grooves where the tolerance is not specified, the tolerance shall be 0.5 mm in addition to the specified depth of cut.

208 *Corrosion allowance*

The corrosion allowance, c, for steel pipes shall be as specified in Table B1, and subject to the following special requirements where applicable:

a) For pipes of copper, brasses, copper-tin alloys and Cu-Ni alloys with Ni-content < 10%, the corrosion allowance shall be 0.8 mm.

b) For pipes of Cu-Ni alloys with Ni-content ≥ 10%, the corrosion allowance shall be 0.5 mm.

c) The corrosion allowance may be reduced down to zero where the medium has negligible corrosive effect on the material employed.

d) A greater corrosion allowance should be considered for pipes where there is a risk of heavy corrosion and/or erosion.

Table B1 Corrosion allowance ‹‹c›› for steel pipes

Piping service	*c (mm)*
Compressed air	1
Hydraulic oil	0.3
Lubricating oil	0.3
Fuel oil	1
Cargo oil	2
LPG	0.3
Fresh water	0.8
Sea water in general	3
Well test or hydrocarbon service	2
Mud or cement including choke and kill lines	3

1) For pipes passing through tanks, an additional allowance for external corrosion shall be considered according to the figures given depending on the external medium.

2) For pipes efficiently protected against corrosion, the corrosion allowance may upon approval be reduced up to 50%.

3) For stainless steels the corrosion allowance may be omitted.

4) See 210 for mud or cement piping.

209 The value of t does not account for any negative manufacturing tolerance, therefore the nominal wall thickness t_1, shall not be less than:

$$t_1 = \frac{t}{1 - \frac{a}{100}}$$

a = percentage negative manufacturing tolerance.

210 *Erosion allowance*

Where piping is likely to be exposed to erosion, an erosion allowance shall be specified to take into account likely service conditions.

Guidance note:

Unless otherwise specified, the allowance of 3 mm above covers erosion also for mud or cement piping.

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B 300 Flexible piping

301 The locations of flexible piping elements shall be clearly shown in the design documentation.

302 Flexible piping parts which are suitable for the intended use may be installed in locations where hard piping is unsuitable.

303 Flexible piping elements shall be installed as accessible for inspection.

304 Means of protection shall be provided for flexible piping used in systems where leakage of medium could result in a hazardous situation.

305 The design burst pressure for flexible hoses shall be according to applied code or standard, and as a minimum 2.5 times the maximum working pressure. The burst pressure shall be verified through prototype testing.

306 The design of flexible hoses critical to the operation of drilling activities shall be based on a relevant recognised code or standard listed in Ch.1 Sec.1 Table C1.

Guidance note:

API Spec. 16C should be applied for e.g. choke and kill hoses.

API RP 17B should be applied for e.g. cement hoses, mud rotary hose, mud booster hose.

Either of the 2 specifications given above should be applied for other critical hoses, as applicable.

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307 Flexible hoses and non-metallic expansion joints for flammable fluids systems have to qualify a fire endurance test according to IMO Res. A.753(18) or equivalent.

The flexible hose has to maintain its integrity and functional properties for the same period as required for the total piping system and components. Ref. also DNV-OS-D101 Ch.2 Sec.2 B500.

B 400 Valves and other piping parts

401 Screwed-on valve bonnets shall not be used for valves with nominal diameter exceeding 50 mm.

402 Screwed-on valve bonnets shall be secured against loosening when the valve is operated.

403 Indicators shall be provided to show open and closed position of valves.

404 Closing time of valves shall be selected such that detrimental stresses due to hydraulic hammering do not occur in piping.

405 Piping parts not covered by recognised standards shall be demonstrated and documented as suitable for their intended use. Drawings shall be supported by stress calculations. Application, type of medium, design pressure, temperature range, materials, and other design parameters shall be indicated. If the piping parts have a complicated configuration that makes theoretical calculations unreliable, certified prototype proof test reports may be applied to demonstrate their suitability for the intended use.

B 500 Piping connections

501 The number of detachable pipe connections shall be limited to those, which are necessary for mounting and dismantling. The piping connections shall be in accordance with the applied code or standard, or shall be otherwise demonstrated as suitable for their intended use.

502 Joints of pipes with outer diameter of 51 mm and above shall normally 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. Tapered threads and double bite or compression joints shall be justified on a case by case basis.

503 If the piping system is rated at 207 bar (3000 psi) or above, ordinary threaded (i.e. NPT) connections shall not 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.

Guidance note:

ASME B31.3 states that threaded joints may only be used for instrumentation, vents, drains, and similar purposes, and shall not be larger than NPS ½". Threaded joints shall not be used where subject to bending or vibrational loads, which is normally the case for mud systems, choke and kill systems, cement systems or well test systems.

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504 Weld neck flanges shall be forged to a shape as close to the final shape as possible.

505 Couplings with stud ends may only be used where suitable, and where used, shall have tapered threads.

506 Calculations of branch reinforcement are required where:

— weldolets of unrecognised type and shape are used in the branch connection, or
— the strength is not provided inherently in the components in the branch connection.

Guidance note:

See ANSI/ASME B31.3, Sec. 304.3 for further details.

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507 Piping in which expansion joints or bellows are fitted shall be adequately adjusted, aligned, and clamped. Protection against mechanical damage shall be provided where necessary.

508 End fittings shall be designed and fabricated according to recognised codes or standards.

C. Supporting Elements

C 100 General

101 The piping system shall be mounted and supported such that:

— weight of piping is not supported by connected machinery
— heavy valves and fittings do not cause large additional stress in adjacent pipes
— axial forces due to internal pressure, change in direction or cross-sectional area and movement of the installation or unit are considered
— detrimental vibrations will not arise in the system.

102 Welded supports shall not be applied to piping exposed to water hammering, vibration and rated 207 bar (3000 psi) or above.

Guidance note:

This will typically include HP-mud systems, choke and kill systems, cement systems and well test systems.

Welded support for such systems may only be applied if the following conditions are agreed upon:

- Doubler plates should be introduced between support and piping, material should meet the requirements of recognised code (e.g. ANSI B31.3) and be of at least the same quality as the support material.
- Doubler plates shall be welded on using the same parameters and conditions as specified in the welding procedure.
- Piping stress or fatigue and flexibility analysis performed according to recognised code (e.g. ANSI B31.3, Ch. IX).

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103 Where this cannot be avoided, doubler plates shall be used, or the support shall be welded to the pipe in a way that introduces the minimum of stresses to the pipe surface from forces acting on the support.

104 Gland type (stuffing box) penetrations shall be applied for pipe penetrations through decks or bulkheads.

SECTION 4
ELECTRICAL, INSTRUMENTATION, CONTROL AND MONITORING SYSTEMS AND COMPONENTS

A. General

A 100 Scope

101 This section gives requirements primarily for the following systems and components:

— all essential systems and essential functions of important systems as explained in Sec.1 and Sec.5
— all other protective safety functions as explained in Sec.1 B102.5
— production shutdown and blowdown systems for well test system
— emergency Shutdown System (ESD)
— fire and gas detection and alarm system
— any other safety critical systems or components (e.g. position keeping ability versus riser limitations and associated disconnection for floating installations).

Systems such as ESD, F&G shall also be according to the respective standards, DNV-OS-A101 and DNV-OS-D301. For production plant shutdown and blowdown systems, see DNV-OS-E201 for complete requirements.

B. Electrical Systems and Components

B 100 Application

101 The requirements regarding electrical systems and components shall be as required by the relevant DNV standard for electrical systems and equipment. The requirements as outlined in the rest of this standard are only applicable to instrumentation, control and monitoring systems and the electrical power supply to these systems and their components.

102 Power supply requirements to the drilling plant shall be in accordance with the principles given in Sec.1 and detailed requirements for drilling systems and components as given in Sec.5.

103 Other internationally recognised codes and standard such as IEEE, IEC or similar may be applied upon prior agreement in each case.

104 For dynamically positioned drilling units the following shall apply:

— the drilling plant shall have the possibility to receive power from redundant and independent power sources
— the load shedding system shall be designed to ensure that the in case of reduced power output from the generators, the drilling plant has enough available power to perform emergency operations as specified in 105.

105 In case of main power failure it shall be possible to secure the well using emergency power. It shall be possible to perform the following functions on emergency power in relevant combinations:

— mix, transfer and circulate drilling fluids (ref. Ch.2. Sec.5 G102)
— recharge BOP control system accumulators
— if the BOP has only one shear ram, not capable of shearing tool joint and sealing the well, it shall be possible to hoist and lower the main hoisting system to be able to shear the work-string (ref. Ch.2 Sec.5 C201 .3)
— adjust riser tension and heave compensation system

C. Instrumentation, Control and Monitoring systems

C 100 Application

101 The requirements below are applicable for systems and components a mentioned in A100.

102 Other internationally recognised codes and standards such as API, IEC may be used provided that the additional requirements of this standard are fulfilled over and above the requirements of any other standard applied.

D. System Design, General Requirements

D 100 System operation and maintenance

101 Start-up and restarting shall be possible without specialised system knowledge. The system shall be restored and resume operation automatically on power-up and restoration after loss of power.

102 Testing of essential systems and alarm systems should be possible during normal operation. The system shall not unintentionally remain in test mode.

Guidance note:

Automatic return to operation mode or alarm should be arranged.

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D 200 Power distribution to control systems

201 Independent and/or redundant systems shall have separate supplies from the distribution system, and shall have separate circuit protection.

202 If connected to the same distribution switchboard, redundant systems shall be supplied from at least two power sources with independent supply to the distribution switchboard.

Guidance note:

The second source may be a battery.

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203 Systems that may be exposed to excessive conducted electromagnetic interference (i.e. beyond their tolerance level, see Table K3) through the electrical power supplies shall have provision for adequately filtered power.

E. Computer Based Systems, General Requirements

E 100 System dependency

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

E 200 Computer usage

201 Computers serving essential and important functions shall be used only for purposes relevant to the operation of the offshore installation.

E 300 System response and capacity

301 Systems used for process equipment control shall provide response times compatible with the time constants of the related process equipment.

302 The sampling frequency shall be based on the frequency of the variable, to enable realistic re-construction of essential or important data which is critical in the decision making and safe operation of the drilling plant and the installation.

Guidance note:

Sampling frequency shall be taken as 5 to 10 times the frequency of the variable used for monitoring of critical parameters.

The following response time is applicable for typical offshore process equipment:

Typical response time	
Equipment item	*Response time (s)*
Data sampling for automatic control purposes (fast changing parameters)	0.1 s
Data sampling, indications for analogue remote controls (fast changing parameters)	0.1 s
Other indications	1 s
Alarm presentations	2 s
Display of fully updated screen views	2 s
Display of fully updated screen views including start of new application	5 s

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303 System start-up and system restoration following power failures shall take place with sufficient speed to comply with the maximum unavailable time for the systems. On start-up and restoration, the system shall revert to a pre-defined state providing an appropriate level of safety.

304 System capacities shall be sufficient to provide adequate response times for all functions, including consideration of the maximum load and maximum number of simultaneous tasks under normal and abnormal process equipment conditions.

E 400 Temperature control

401 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 shall be provided.

E 500 System maintenance

501 Integrated systems supporting one or more essential or important functions which, for safety reasons, cannot be interrupted shall 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.

502 Essential systems shall have diagnostic facilities to support finding and repairs of failures.

E 600 System access

601 Access to system set-up or process equipment configuration functions shall be protected so as to avoid unauthorised modifications of the system performance. For screen based systems, tools shall be available to facilitate easy and unambiguous modification of configuration parameters wherever such modification is permitted during normal operation.

Guidance note:

As a minimum, this applies to:

- calibration data
- alarm limit modification
- manual alarm blocking or inhibiting.

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602 Unauthorised access to essential and important systems from a location outside the offshore installation shall not be possible.

F. System Design, System Elements

F 100 General

101 A system consists of one or several system elements, where each system element serves a specific function.

102 System elements belong to the following categories:

— automatic control
— remote control
— safety
— alarm
— indications
— planning and reporting
— calculation, simulation and decision support.

F 200 Automatic control

201 Automatic control shall keep process equipment variables to within the limits specified for the equipment under control (e.g. the machinery) during normal working conditions.

202 The automatic control shall be stable over the entire control range. The margin of stability shall 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 shall be able to accomplish the function it shall serve.

F 300 Remote control

301 At the remote command location, the user shall receive continuous feedback information on the effects of initiated commands.

302 One command location shall be designated as the main command location. The main command location shall be independent of other command locations.

303 When control is possible from several locations, only one command location shall be in control at a time.

304 Active control shall 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 shall give audible pre-warning. The main command location (as defined for that particular operation) shall be able to take control at any time.

305 Significant change of process equipment parameters shall not occur during transfer of control from one location to another.

306 Each alternative command location shall be provided with clear, local indication to show when that location is in control.

307 Control system elements shall include safety interlocks against any user errors that could result in major damages or loss of essential or important functions.

308 There shall not be conflict between operation of safety interlocks in different parts of the systems. Basic safety interlocks should be hardwired and shall be active during both remote and local operation.

Guidance note:

Hardwired safety interlocks (e.g. non-closure of protective cover of a winch inhibits the starting-up of the winch) should not be overridden by programmable interlocks.

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F 400 Safety

401 Automatic safety actions shall give alarm at appropriate predefined workstations.

402 When the safety system element stops an Equipment Under Control (EUC), the EUC shall not start again automatically.

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

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

F 500 Alarm

501 Alarms shall be visual and audible, and shall indicate abnormal conditions only. Additional visual and audible alarms shall be installed in areas where the audible signal may not be heard due to background noise.

Guidance note:

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 may be of advantage.

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502 Visual alarms shall be easily distinguishable from other indications by use of colour and special representation.

503 Audible alarms shall be readily distinguishable from signals indicating normal conditions, telephone signals, different alarm systems and noise.

504 The audible and visual characteristics of alarm signals defined by IMO Resolution A.830(19), *Code on Alarms and Indicators, 1995*. Paragraph 6 Characteristics, should be used.

505 Responsibility for alarms shall not be transferable before being acknowledged at the receiving location. Transfer of responsibility shall give audible pre-warning. Each alternative location shall have clear, local indication of when that location is in charge.

506 Presentation and acknowledgement of alarms shall only be possible at the workstation(s) specifically provided for response to the alarm.

Guidance note:

Alarm lists may be available on any workstation.

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507 Alarms at workstations shall normally be manually acknowledged in two steps:

Silence audible signal and additional visual signal (e.g. rotating light signals) leaving the visual signal on the workstation unchanged. After acknowledgement, the audible signal shall operate for any new failure.

Acknowledge the visual alarm. Alarms, including the detection of transient faults, shall be maintained until acknowledgement of the visual indication. The visual indications of individual alarms shall remain until no abnormal condition is being detected. Acknowledged alarms shall be clearly distinguishable from unacknowledged alarms.

Guidance note:

Unacknowledged alarms should be flashing.

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508 Acknowledgement of visual signals shall be separate for each signal, or may be common for a limited group of signals. Acknowledgement shall only be possible when the user has visual information regarding the alarm condition for the signal or all signals in a group.

509 Local audible signal for an alarm included in a centralised alarm handling system shall be suppressed when localised in the same workplace as the centralised alarm handling system.

510 Permanent blocking of alarm units shall not be possible. Where justified, manual blocking of separate alarms may be acceptable provided that the blocked alarm is clearly indicated as such.

511 Sufficient information shall be provided to ensure optimal alarm handling. Alarm text shall be easily understood.

512 The more probable or frequent failures within the alarm system, such as broken connections to measuring elements, shall initiate alarm.

513 Interlocking of alarms shall be arranged so that most probable failures in the interlocking system, e.g. broken connection in external wiring, do not prevent alarms.

514 The ability to lock alarm and safety functions in certain operating modes (e.g. during start-up) shall be automatically disabled in other modes.

515 It shall be possible to delay alarms in order to prevent spurious alarms during normal transient conditions.

F 600 Pre-warning

601 Pre-warnings shall be acknowledged. Pre-warnings shall be distinguishable from alarms.

F 700 Indication

701 Sufficient indications to enable safe operation of essential and important functions shall be installed at all control locations from which the function shall be operated. Alarms or pre-warnings are not considered as suitable substitutes for such operating indications.

Guidance note:

It is advised that indicating and recording instruments are centralised and arranged to facilitate watch-keeping, e.g. by standardising the scales, applying mimic diagrams, etc.

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F 800 Planning and reporting

801 Planning and reporting system elements shall have no outputs for real-time process equipment control during planning mode.

Guidance note:

The output may, however, be used to set up premises for process equipment control, e.g. route plan used as input to an auto-pilot or load plan used as input for automatic or user assisted sequence control of the loading.

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Guidance note:

Planning and reporting functions are used to present a user with information to plan future actions.

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F 900 Calculation, simulation and decision support

901 Output from calculation, simulation, or decision support modules shall not suppress basic information which is neces-

sary for safe operation of essential and important functions.

Guidance note:

Output from calculation, simulation or decision support modules may be presented as additional information.

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G. Computer Based Systems, System Software

G 100 Software requirements

101 *Basic software* on processor systems which *run application software* belonging to different functions, shall have facilities for:

— running several modules under allocated priorities
— detection of execution failures of individual modules
— discrimination of faulty modules to ensure maintained operation at least of modules of same or higher priority.

102 Individual application software modules which are allocated tasks under an operating system as specified in 101 shall not perform operations related to more than one function. These modules shall be allocated priorities in accordance with the relative priority between the functions they serve.

103 When hardware belonging to input, output, communication links, and user interface is configured to minimise the consequences of failures, the related software shall be separated in different computer tasks so as to secure the same degree of separation.

104 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 shall be designed to facilitate such simplified operation.

105 System set-up, process equipment configuration, and setting of process equipment parameters which is performed onboard the installation shall take place without modification of program code or recompilation. Where such actions cannot be avoided, all changes shall be thoroughly verified.

106 The version(s) of the software in use shall be readily identifiable.

Guidance note:

For integrated systems, identification should be available in the system overview.

For any screen based system, identification should be readily available on the VDU during normal operation.

PROM's should be labelled.

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G 200 Software manufacturing

201 Manufacturing of software for complex system(s) shall include all relevant actions to reduce the probability of errors in the program code to an acceptable level.

202 Relevant actions shall, at minimum, include actions to:

— ensure that the programming of applications is based on complete and valid specifications
— ensure that software purchased from other parties has an acceptable track record and is subject to adequate testing
— impose full control of software releases and versions during manufacturing, installation onboard and during the operational phase
— ensure that program modules are subject to syntax and function testing as part of the manufacturing process
— minimise the probability of execution failures.

Guidance note:

Typical execution failures are:

- deadlocks
- infinite loops
- division by zero
- inadvertent overwriting of memory areas
- erroneous input data.

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203 The actions taken to comply with 201shall be documented, and the execution of these actions shall be retraceable. The documentation shall 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.

H. Computer Based Systems, User interface

H 100 General

101 The status of the controls and information displayed shall be clearly indicated.

Guidance note:

This applies to e.g. indications not being updated or indication of blocked alarm.

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102 Alarm messages for alarms under this standard (and other alarms which may contribute to safety onboard) shall, when initiated, be given priority over any other information presented on the VDU. Such alarms shall be easily distinguishable from other alarms. The entire list of alarm messages shall be easily available.

103 Alarms shall be time tagged.

104 Time tagging for all alarms shall be consistent throughout the system.

Guidance note:

This is required to handle inconsistency of time tagging when the same alarm is available at several positions on the unit.

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105 Full redundancy shall be provided for VDUs receiving and displaying alarm presentations of essential screen based systems.

Guidance note:

A printer or other equivalent means may provide the necessary redundancy.

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106 UIDs shall be designed and arranged so as to avoid inadvertent operation. Dedicated function keyboards shall be provided for essential and important systems.

107 Symbols and associated information shown in a mimic diagram shall have a logical relationship.

108 Means shall 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.

109 If the user provides the system with insufficient input, the system shall 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.

H 200 Illumination

201 Illumination of all VDUs and UIDs shall be adjustable to a level suitable for all applicable light conditions. However,

illumination reduction which inhibits readability of information belonging to essential and important functions shall not be possible.

Guidance note:

Adjustments may be arranged by use of different sets of colours suited for the applicable light conditions.

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I. Computer Based Systems, Data Communication Links

I 100 General

101 Failure in a node shall not result in any adverse effect on the remaining part of the data communication link and vice versa.

102 Data communication links shall be automatically initialised on "power on". Following a power interruption, the links shall regain normal operation without manual intervention.

103 The capacity of the data communication link shall be sufficient to prevent overload at any time.

104 The data communication link shall be self-checking, detecting failures on the link itself, and also data communication failures on nodes connected to the link. Detected failures shall initiate an alarm on dedicated workstations.

105 For essential and important functions means shall be provided to prevent acceptance of corrupted data at the receiving node.

106 When two or more essential functions are using the same data communication link, this link shall be redundant.

107 Redundant data communication links shall be routed with as much separation as practical.

I 200 Local area networks

201 Means shall be provided to monitor the usage and status of the network.

202 It shall be possible to remove and insert nodes without interrupting normal network operation.

203 Facilities shall be provided to ensure that a messages relating to essential or important functions are received within a predefined time.

I 300 Redundant local area networks

301 The requirements of 200 shall be applied.

302 Switching between networks shall be automatic when serving functions with category R0 and R1. In other cases, switching may be manual provided that the switching is simple and unambiguous.

I 400 Instrument net

401 Instrument nets shall meet the requirements of local area networks.

I 500 Interconnection of networks

501 Interconnected networks shall be mutually independent.

Guidance note:

Means of interconnections may be routers, bridges or gateways.

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J. Component Design and Installation, General

J 100 Environmental strains

101 Instrumentation equipment shall be suitable for marine use, and shall be designed to operate under environmental conditions as described in K, unless it is ascertained that the equipment parameters will not exceed these values. A lower value may be acceptable provided that the actual environmental conditions will not exceed the proposed values for any foreseeable operational scenario. All contracting parties shall agree to the revised values.

102 Data sheets shall be available, and shall be sufficiently detailed to ensure proper application of the instrumentation equipment.

103 Performance and environmental testing may be required to ascertain the suitability of the equipment.

J 200 Materials

201 Explosive materials, and materials which may develop toxic gases, shall not be used. Covers, termination boards, printed circuit cards, constructive elements, and other parts that may contribute to spreading fire shall be of flame-retardant material.

Guidance note:

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.

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J 300 Component design and installation

301 The component design and installation shall facilitate operation, adjustment, repair, and replacement. As far as practicable, screw connections shall be secured.

302 Mechanical resonance with amplification greater than 10 is not to occur.

303 Electric cables and components shall 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 shall be provided with drainage and located in a separate section from desks, consoles, and switchboards which contain electrical equipment.

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

305 Differential pressure elements (dp-cells) shall be able to sustain a pressure differential at least equal to the highest process equipment pressure.

306 Thermometer wells shall be used when measuring temperature in fluids, steam, or gases under pressure.

307 The installation of temperature sensors shall enable easy dismantling for functional testing.

308 Clamps used to secure capillary tubes shall be made of a material that is softer than the tubing.

309 Isolation valves in essential instrument sensor piping, and speed control valves in actuator control tubing, shall be designed to avoid inadvertent maloperation. Speed control valves in essential control systems shall be locked in position after adjustment.

J 400 Maintenance and checking

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

402 Provisions for testing, e.g. three-way cocks, should be arranged in pipes connecting pressure switches or transducers to process equipment normally in operation at sea.

Guidance note:

The installation should as far as possible be built up from easily replaceable units and designed for easy troubleshooting, checking and maintenance. When a spare unit is mounted, only minor adjustments or calibration of the unit should be necessary. Faulty replacements should not be possible.

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J 500 Marking

501 All units and test points shall be clearly and permanently marked. Transducers, controllers and actuators should be marked so that they can be easily and clearly identified on plans and in instrument lists.

Guidance note:

The marking should preferably be adjacent to the unit, and not directly on the unit itself.

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J 600 Standardising

Guidance note:

Systems, components, and signals should be standardised as far as practicable.

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K. Component Design and Installation, Environmental Conditions

K 100 General

101 The environmental parameters given in 200 to 1200, including any of their combinations, represent «average adverse» conditions, which will cover the majority of applications on board offshore installations. See J100 for application of this requirement. Where environmental strains will exceed those specified, special arrangements and special components shall be considered.

Table K1 Parameter class for different locations on board

Parameter	*Class*	*Location*
Temperature	A	Machinery spaces, control rooms, accommodation, bridge
	B	Inside cabinets, desks etc. with temperature rise of 5°C or more installed in location A
	C	Pump rooms, holds, rooms with no heating
	D	Open deck, masts and inside cabinets, desks, etc. with a temperature rise of 5°C or more installed in location C
Humidity	A	Locations, where special precautions are taken to avoid condensation
	B	All locations except as specified for location A
Vibration	A	On bulkheads, beams, deck, bridge
	B	On machinery such as internal combustion engines, compressors, pumps, including piping on such machinery
	C	Masts

102 Components and systems designed in compliance with IEC environmental specifications for ships, *Publication No. 60092-504*, and for EMC, *IEC Publication No. 60533,* may be suitable when considered on a case by case basis.

Guidance note:

For details on environmental conditions for instrumentation, see Certification Note 2.4.

Navigation and radio equipment shall comply with IEC Publication No. 60945, Marine navigational equipment - "General requirements", Ch.8 and Ch.9.

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K 200 Electric power supply

201 «Average adverse» criteria for power supply is for successive power breaks with full power between breaks with:

— 3 interruptions during 5 minutes
— switching-off time 30 s each case

202 «Average adverse» criteria for power supply variations to equipment connected to A.C. systems shall be:

— combination of permanent frequency variations of ±5% and permanent voltage variations of + 6/–10% of nominal
— combination of frequency transients (0.15 s duration) ± 10% of nominal and voltage transients (1.5 s duration) ± 20% of nominal.

203 «Average adverse» criteria for power supply variations for equipment connected to D.C. systems shall be:

— voltage tolerance continuous ± 10% of nominal
— voltage transients cyclic variation 5% of nominal
— voltage ripple 10%.

204 «Average adverse» criteria for power supply variations for equipment connected to battery power sources shall be:

— + 30% to – 25% for equipment connected to battery during charging
— + 20% to – 25% for equipment connected to battery not being charged
— Voltage transients (up to 2 s duration) ± 25% of nominal.

K 300 Pneumatic and hydraulic power supply

301 «Average adverse» nominal pressure is ± 20% (long and short time deviations).

K 400 Temperature

401 «Average adverse» temperature criteria shall be:

Class A: Ambient temperatures + 5°C to + 55°C

Class B: Ambient temperatures + 5°C to + 70°C

Class C: Ambient temperatures – 25°C to + 55°C

Class D: Ambient temperatures – 25°C to + 70°C

K 500 Humidity

501 «Average adverse» humidity criteria shall be:

Class A: Relative humidity up to 96% at all relevant temperatures, no condensation.

Class B: Relative humidity up to 100% at all relevant temperatures.

K 600 Salt contamination

601 «Average adverse» salt-contamination is an atmosphere up to 1 mg salt per m^3 of air, at all relevant temperatures and humidity conditions.

K 700 Oil contamination

701 «Average adverse» oil-contamination is mist and droplets of fuel and lubricating oil, and oily fingers.

K 800 Acceleration

801 «Average adverse» acceleration due to the offshore

installation movement in waves shall be:

— peak acceleration ± 1.0 g for floating offshore installations with length less than 90 m, or ± 0.6 g for floating offshore installations of greater length
— period 5 to10 s.

K 900 Vibrations

901 «Average adverse» vibration criteria are:

Class A: Frequency range 3 to 100 Hz
Amplitude 1 mm (peak value) below 13.2 Hz
Acceleration amplitude 0.7 g above 13.2 Hz

Class B: Frequency range 2 to 100 Hz
Amplitude 1.6 mm (peak value) below 25 Hz
Acceleration amplitude 4.0 g above 25 Hz

Class C: Frequency range 3 to 50Hz
Amplitude 3 mm (peak value)
Acceleration amplitude 2.1 g above 13.2 Hz

K 1000 Inclination

1001 *Column stabilised units and self elevating units*

All systems: 15 ° in any direction.

1002 *Ship shaped units*

Minimum inclination for ship shaped units is given in Table K2.

Table K2 Inclination - Ship shaped units

Installations, components	*Angle of inclination (degrees)*[1]			
	Athwartships		*Fore and aft*	
	Static	*Dynamic*	*Static*	*Dynamic*
Safety equipment, e.g. emergency power installations, emergency fire pumps and their devices, electronic appliances [2] and remote control systems	22.5	22.5	10	10

1) Athwartships and fore-and-aft inclinations may occur simultaneously.

2) Up to an angle of inclination of 40° no undersized switching operations or operational changes shall occur.

K 1100 Electromagnetic compatibility

1101 Minimum immunity requirements for offshore equipment are given in Table K3.

Guidance note:

Electrical and electronic equipment should be designed to function without degradation or malfunction in their intended electromagnetic environment. The equipment should not adversely affect the operation of, or be adversely affected by, any other equipment or systems used on board or in the vicinity of the offshore installation. Upon installation, it may be necessary to take adequate measures to minimise the electromagnetic noise signals, see Classification Note 45.1. Such measures may be in form of a list of electromagnetic noise generating- and sensitive equipment, and an estimate on required noise reduction, i.e. an EMC management plan. Testing may also be required to demonstrate electromagnetic compatibility.

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Table K3 Minimum immunity requirements for equipment

Port	*Phenomenon*	*Basic Standard*	*Performance criteria*	*Test value*
AC power	Conducted low frequency interference	IEC 60945	A	50 - 900 Hz: 10% AC supply voltage 900 - 6 000 Hz: 10 - 1% AC supply voltage 6 - 10 kHz: 1% AC supply voltage
	Power supply variation	IEC 60092-504 IEC 61000-4-11	A	voltage: ± 20% for 1.5 s frequency: ± 10% for 5 s
	Power supply failure	IEC 1000-4-11	C	60 s interruption
	Electrical fast transient (Burst)	IEC 61000-4-4	B	2 kV 3)
	Surge voltage	IEC 61000-4-5	B	0.5 kV 1) /1 kV 2)
	Conducted radio frequency interference	IEC 61000-4-6	A	3 Vrms 3); (10 kHz)6) 150 kHz - 80 MHz sweep rate ≤ 1.5 x 10^{-3} decade/s 7) modulation 80% AM (1 kHz)
D.C. power	Conducted low frequency interference	IEC 60945	A	10% DC Supply voltage 50 Hz - 10 kHz
	Power supply variation	IEC 60092-504 IEC 61000-4-11	A	voltage + 20% / - 25% equipment non connected to battery
	Power supply failure	IEC 61000-4-11	C	60 s interruption
	Electrical fast transient (Burst)	IEC 61000-4-4	B	2 kV 3)
	Surge voltage	IEC 61000-4-5	B	0.5 kV 1) /1 kV 2)
	Conducted radio frequency interference	IEC 61000-4-6	A	3 Vrms 3); (10 kHz)6) 150 kHz - 80 MHz sweep rate ≤ 1.5 x 10^{-3} decade/s 7) modulation 80% AM (1 kHz)
I/O Ports, Signal or Control	Electrical fast transient (Burst)	IEC 61000-4-4	B	1 kV 4)
	Conducted radio frequency interference	IEC 61000-4-6	A	3 Vrms 3); (10 kHz)6) 150 kHz - 80 MHz sweep rate ≤ 1.5 x 10^{-3} decade/s modulation 80% AM (1 kHz)
Enclosure	Electrostatic discharge (ESD)	IEC 61000-4-2	B	6 kV contact/8 kV air
	Electromagnetic field	IEC 61000-4-3	A	10 V/m5) 80 MHz-2 GHz sweep rate ≤ 1.5 x 10^{-3} decade/s modulation 80% AM (1 kHz)
	Electromagnetic field, pulse modulated	EN 50082-2	A	10 V/m 900 ± 5 MHz and 1 800 ± 5 MHz duty cycle 50% modulation frequency: 200 Hz

1) line to line

2) line to ground

3) capacitive coupling

4) coupling clamp

5) special situations to be analysed

6) test procedure to be described in the test report

7) for equipment installed in the bridge and deck zone the test levels are to be increased to 10 Vrms for spot frequencies in accordance with IEC 60945 at 2/3/4/6.2/8.2/12.6/16.5/18.8/22/25 MHz. For screened cables, a special test set-up is to be used enabling the coupling into the cable screen.

Performance criterion A: The equipment under test (EUT) is to continue to operate as intended during and after the test. No degradation of performance or loss of function is allowed as defined in the relevant equipment standard and in the technical specification published by the manufacturer.

Performance criterion B: The EUT is to continue to operate as intended after the test. No degradation of performance or loss of function is allowed as defined in the relevant equipment standard and in the technical specification published by the manufacturer. During the test, degradation or loss of function or performance that is self recoverable is however allowed but no change of actual operating state or stored data is allowed.

Performance criterion C: Temporary degradation or loss of function or performance is allowed during and after the test provided the function is self-recoverable, or can be restored by the operation of the controls as defined in the relevant equipment standard and in the technical specification published by the manufacturer

K 1200 Miscellaneous

1201 In certain applications, other environmental parameters may influence the equipment, e.g.:

- fire
- explosive atmosphere
- temperature shock
- wind, rain, snow, ice, dust
- audible noise
- mechanical shock or bump forces equivalent to 20 g of 10 ms duration
- splash and drops of liquid
- corrosive atmospheres of various compositions, e.g. ammonia on an ammonia carrier.

These parameters should be considered as and where appropriate.

L. Component Design and Installation

L 100 General

101 Fused isolating transformers shall be fitted between the main power supply and the different units or systems.

102 On / off switching of the power supply shall not cause excessive voltage or other strains that may damage internal or external components.

103 Units requiring cables and wiring with insulating resistance higher than 200 kΩ shall not normally be used. Special cable arrangements may be excepted where justified.

104 Key components of computer based systems necessary for maintaining essential and important functions shall demonstrate that functionality and reliability are not compromised during performance at elevated temperatures which could result from a failure in the ventilation system (unit or/and in a room) or power supply (e.g. failure of air condition system).

Guidance note:

This can be achieved in principle by referring to 'standard tests' (equivalent screening procedure) performed by the manufacturer to assess the reliability at elevated temperatures or by demonstrating the availability of the 'cooling systems' (fan, ventilation, air condition system) at all times.
An example of an equivalent screening procedure is the use of components subjected to recognised tests at elevated temperature by the manufacturer.

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105 Circuits should 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 should lead to a comparatively safe condition (fail to safety).

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

107 The components shall be effectively secured so as to avoid mechanical stressing of wires and soldered joints through vibrations and mechanical shock.

L 200 Protection provided by enclosures

201 Enclosures for equipment shall be made of steel or other flame retardant material capable of providing EMC protection, and shall satisfy the minimum requirements of Table L1. The required degree of protection is specified in IEC 60529.

Table L1 Minimum requirements for equipment enclosures

Class	*Location*	*Degree of protection*
A	Control rooms, accommodation, bridge	IP 22
B	Machinery space	IP 44
C	Open deck, masts, below floor plates in machinery space	IP 56
D	Submerged application	IP 68

L 300 Cables and wires

301 Cables and wires shall comply with the relevant DNV standard for electrical systems and equipment. Special cables used for communication and control systems shall be considered on a case by case basis.

L 400 Cable installation

401 Cable installations shall comply with the relevant DNV standard for electrical systems and equipment. Special cables used for communication and control systems shall be treated on a case by case basis.

L 500 Power supply

501 When using low voltage battery supply, the charging equipment, batteries and cables shall keep the voltage at equipment terminals within + 25% to – 20% of the nominal voltage during charging and discharging.

502 Reverse current to the battery through the charging device shall be prevented.

503 Systems including a standby battery which is connected for continuous charging shall not be disturbed in any way by disconnection of the battery.

504 Battery installations shall be in accordance with the relevant DNV standard for electrical systems and equipment.

505 Regulated rectifiers shall be designed for the variations in voltage and frequency as stated in K.

506 Different system voltages should be supplied through different cables.

507 Terminal lists shall be clearly marked. Varying system voltages shall be distinguished.

508 Uninterruptible power supplies shall be according to the requirements given in the relevant DNV standard for electrical systems and equipment.

L 600 Fibre optic equipment

601 Fabrication and installation of fibre optic cables shall comply with the requirements of the relevant DNV standard for electrical systems and equipment.

602 Power budget calculations shall be used in order to:

— determine the length between I/O units
— select components to obtain a safe reliable transmission system
— demonstrate that adequate power reserve has been provided.

603 After installation, Optical Time Domain Reflectometry (OTDR) measurements for each fibre shall be used to correct and re-evaluate the power budget calculations.

604 The construction of fibre optic devices shall generally comply with relevant specifications of International Electrotechnical Commission (IEC) Publications.

605 The safety of personnel and operations shall be considered in the installation procedures. Warning signs and labels giving information to operators shall be placed where hazard exists. Care must be taken to prevent fibres from penetrating eyes or skin.

Guidance note:

It is advised to use equipment with 'built-in' safety, e.g. interlock the power to the light sources with the covers, possible to disconnect or lock parts of the system under service, screen laser beams.

Safe distance between the light source or fibre end and the eye of the operator may be determined by applying the formulae:

$$L_{safe} = (P_n + 10)/2$$

L_{safe} = safe distance [cm]

P_n = nominal power [mW]

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606 For fibre optic systems using standard single- and multimode fibres, a power level below 10 mW is considered as intrinsically safe in hazardous areas.

SECTION 5
DRILLING SYSTEMS AND EQUIPMENT

A. General

A 100 Objective

101 The requirements of this section are intended to ensure safe and effective design and use of specific items of drilling equipment and facilities.

A 200 Scope and application

201 These requirements shall be applied to all drilling facilities, where relevant to the type of equipment to be used.

202 Systems for which requirements could vary depending on type of installation (fixed, floating, permanently moored, DP operated etc.) are specified under each drilling system in question.

However, the impact this will have on other non-drilling systems are not included within this standard, see other offshore discipline standards relevant for the system in question.

Guidance note:

E.g. requirements for passive or active fire protection of permanently moored installations compared to that required for DP operated vessels.

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A 300 Control and monitoring

301 Requirements for control and monitoring are grouped to the extent possible under each system. Systems shall also be in line with the general system requirements found in this section and general requirements for all systems and components in Sec.1 and Sec.4.

A 400 Hydraulic and pneumatic systems

401 *Hydraulic systems*

.1 For design requirements for components of a hydraulic system, see Sec.3. For components not covered in this section (pressure vessels etc.), see Ch.1 Sec.1 Table C1.

.2 The hydraulic fluid shall not corrode or attack chemically the components in the system. The fluid shall have a flash point not lower than 150°C and shall be suitable for operation at all temperatures to which the system may normally be subjected.

.3 Excessive pressure surges and pulses generated by pumps and valve operations shall be avoided. When necessary, pulsation dampers shall be fitted and shall preferably be connected directly to the source of vibrations. Design of the system shall normally be such that laminar flow is obtained.

.4 Detachable pipe connections and valves in hydraulic pressure piping shall be at a safe distance from electrical appliances, boilers, exhaust pipes and other sources of ignition.

.5 Air pipes from hydraulic oil circulation tanks and expansion tanks shall be lead to safe locations so that any escaping oil does not reach possible ignition sources.

.6 Design of hydraulic systems shall ensure smooth operation of the system, and that operation will be within the design limitations (e.g. within the dynamic factor ψ, buffer loads, etc. applied).

Guidance note:

This will include e.g. dampening of end stroke of cylinders and soft characteristics of operating valves.

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.7 Means for filtration and cooling of the fluid and for deflation of entrapped gases shall be incorporated in the system where found necessary.

Guidance note:

Where applicable, filtration of return lines is recommended to avoid possible impurities from being spread to interconnected systems.

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.8 Systems requiring continuous operation or for which impurities may cause critical maloperation shall be provided with two filters in parallel and continuous filter status monitoring. Alarm shall be initiated for abnormal conditions.

Guidance note:

E.g. hydraulic heave compensated system during fixed bottom operations.

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.9 Unintentional leakage from detachable pipe connections, valves, hose rupture etc. shall not endanger the safety of installation or personnel.

Guidance note:

E.g. protective covers on hoses situated at operator's stand in event of hose rupture, hose rupture valves on systems critical to loss of hydraulic pressure, ignition sources at a safe distance from potential leakage sources of flammable hydraulic liquid systems etc.

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.10 Local accumulators which are used as back up supply for essential systems shall be designed and located or protected so as to avoid inadvertent isolation or mechanical damage which could prevent correct operation on demand.

.11 Piping, tubing, and components in systems which are required to operate during a fire scenario shall have adequate fire resistance properties to ensure correct system operation. This is particularly important for systems where hydraulic energy is required to activate or maintain system control. Where appropriate, fire test certificates shall be obtained as documentation for such system components.

.12 Piping and tubing shall be flushed and cleaned before being connected to control systems.

Guidance note:

The cleanliness limit of the hydraulic fluid wetting the internals of a hydraulic system should be established during the design phase.

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.13 Hydraulic oil return lines shall be designed with sufficient capacity for the maximum return flow during extreme condition without reducing overall system performance. Care shall be taken to avoid the possibility of blockages at filters, vents, by mechanical damage, or by inadvertent operation of valves.

.14 Hydraulic cylinders for lifting or heave compensation shall be in compliance with Standard for Certification 2.9 Type approval program 5-778.93 "Hydraulic Cylinder" with the following addition: The Charpy impact requirements specified in OS-E101 Sec.2, table B1 shall apply.

402 *Pneumatic systems*

.1 Components that require better than instrument air quality for operation shall not be used. Extremely small openings in air passages shall be avoided.
.2 Main pipes shall be inclined relative to the horizontal, and drainage shall be arranged.
.3 Pipes and other equipment made of plastic materials shall have satisfactory mechanical strength, low thermoplasticity, high oil resistance, and flame retardation properties.
.4 Instrument air shall be free from oil, moisture, and other contamination. Condensation shall be avoided at relevant pressures and temperatures.

Guidance note:

For air flowing in pipes which are located entirely inside the machinery space and accommodation, the dew point should be more than 10°C below the ambient temperature, but need not normally be lower than 5°C. The dew point of air flowing in pipes on open deck should be below – 25°C.

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.5 Reduction valves and filters shall be duplicated when serving more than one function (e.g. more than one control loop).
.6 Local accumulators that are used as back up air supply for essential systems shall be designed and located or protected to avoid inadvertent isolation or mechanical damage that could prevent correct operation on demand.
.7 Piping and tubing shall be cleaned and dried before connection to control systems.

A 500 Ignition prevention of machinery and electrical equipment

501 Machinery or electrical installations and other equipment necessary for the drilling operations (e.g. HPU) which are installed in hazardous areas shall be suitable for the intended purpose and shall comply with the requirements of DNV-OS-A101 and the relevant DNV standard for electrical systems and equipment.

Guidance note:

For mechanical equipment located in an hazardous area, attention should be brought to minimise risk of sparking during normal operation of the equipment, by applying non-sparking materials where relevant (e.g. dice of iron roughneck, braking system of drawworks), greasing of wheels (e.g. dolly guidewheels) etc.

DNV-OS-A101 refers to recognised standards such as EEMUA publication 107 for protection of diesel engines for use in zone 2 hazardous area or API RP 14J, paragraphs 5.5 and 5.6. In addition, specific requirements for arrangement, location of air intakes etc. is included.

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502 Electrical equipment and instrumentation that shall be operable during extended gas danger shall be Ex-rated and designed to operate for the intended time interval. Where this is not feasible, means shall be provided to minimise risk of ignition.

Guidance note:

This applies for e.g. BOP control system located in a safe area. Protection may be provided by Ex-p, or by ensuring that the gas can not be transported by the HVAC system in quantities sufficient to cause ignition.

The equipment should be operable for reduced ventilation or cooling when necessary.

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A 600 Emergency stops

601 Emergency stops shall be located at convenient locations on machinery for immediate use by personnel in the event of a hazardous situation occurring.

602 Emergency stops shall neither be used as an alternative to proper safeguarding measures, nor as an alternative for automatic safety devices, but may be used as a back-up measure.

603 All emergency stops shall function according to either of the following principles:

— stopping by immediate removal of power to the machine actuators or mechanical disconnection (declutching) between the hazardous elements and their machine actuator(s); and, if necessary, braking (uncontrolled stop)
— stopping with power to the machine actuator(s) available to achieve the stop and then removal of power when the stop is achieved.

Upon activation, the emergency stops shall automatically result in the hazard being avoided or mitigated in the best possible manner.

Guidance note:

"In the best possible manner" includes, among others:

- choice of optimal deceleration rate
- selection of stop principle (as listed above).

"Automatically" means that upon activation of emergency stop, achievement of the emergency stop function may be the result of a predetermined sequence of internal functions.

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604 The emergency stops shall, as a principle, overrule all other functions, unless an alternative approach is thoroughly justified on the basis of safety benefit. It shall also ensure that emergency stops are not in conflict with the fail safe philosophy, see Sec.1 Table B2.

605 Following an emergency stop, it shall not be possible to restart the system before all control devices which have been actuated are reset manually, individually and intentionally.

606 When an emergency stop is not hardwired, self-check facilities as given in Sec.1 F102 shall be implemented.

A 700 Automatic start of pumps

701 Faults in the mechanical or electrical system of the running pump shall not inhibit automatic start of the standby pump.

702 Automatic start of the standby pump shall be initiated by the process parameter which is being monitored, e.g. low pressure signal, and shall be arranged so that the standby pump does not stop automatically when first started («locking circuit»).

703 Manual start and stop of the pumps shall be possible without initiation of alarm for automatic start of the standby pump.

704 When a pump is standby, this shall be clearly indicated on the switch panel by indicating lamps, etc.

B. Drilling Related Structures

B 100 General

101 Components shall be designed in accordance with recognised codes, standards and guidelines.

102 Components shall be designed with regard to their intended use, their interaction with or near other components, and their safe use under all known operating conditions including any anticipated overload.

103 Where flanges and clamp or hub connections are used, consideration shall be given to external loads in addition to internal pressure.

104 For structures such as derrick, flare boom, BOP frames etc. the Charpy V-notch requirements given in *Rules for Certification of Lifting Appliances* shall apply.

105 Relevant loads and loading combinations for calculation of structural strength shall be specified in accordance with Sec.1 H and Sec1 I.

B 200 Drilling structures

201 *Standard design*

Standard derrick design for which the hook load is transferred through the derrick structure may be according to the requirements of API Spec 4F, subject to additional consideration of the following (as applicable):

- pre-stress from fasteners
- snow and/or ice loads (including increase of wind induced loads)
- where operational requirements exceed API Spec 4F, wind speeds shall be according to the unit specific operating requirements, and associated wind loads shall be calculated according to the relevant Offshore Standard for structures
- fatigue evaluations
- vortex shedding evaluations
- adequacy of local design strength (i.e. fixture and support) for major equipment fitted on structure, such as pipe handling equipment, heave compensators etc. (Local design strength shall also be included in the design loads for the structure if not listed under API Spec 4F).

202 See DNV-OS-A101 for requirements for walkways, ladders etc.

203 *Other designs*

Other designs of drilling and well servicing structures not covered by API Spec 4F, (e.g. where hook load is transferred directly to drill floor or substructure), shall be thoroughly evaluated for all applicable loads and loading combinations as listed in Sec.1 H and Sec.1 I.

B 300 Drill floor

301 The drill floor is the base structure for the derrick, mast or hoisting structure, and shall be designed to withstand the loads and forces imposed by the hookload, setback area(s), rotary loads, and all installed equipment. Accidental loads shall also be considered, see Sec.1 H400.

302 Adequate local design strength (i.e. fixture and support) shall be specified and documented for major equipment fitted on drill floor, such as rotary table, deadline anchors, drawworks etc.

303 Relevant combinations of operational and environmental loads as outlined in Sec.1 H and Sec1 I shall be specified for all relevant loading conditions.

In particular, setback-loads shall be specified at 100% for survival condition unless a reduction is justified, as time constraints do not normally allow for reducing the setback-loads.

B 400 Substructure

401 See DNV-OS-C101 to DNV-OS-C106.

402 The substructure shall be designed to withstand all combined loads as outlined in Sec.1 H.

B 500 Support structure for drilling or well testing equipment

501 Adequate local design strength (i.e. fixture and support) shall be specified and documented for major drilling equipment fitted such as mud pumps, tensioners, compressors etc.

502 The flare boom structure shall be designed for loads in both the operating and the stowed condition.

503 Design of the flare or burner boom structure shall include due consideration of the thermal loads during flaring.

B 600 Lifting of equipment

601 The intention of 600 is to provide guidance for design purpose of lifting of equipment, both during installation and regular lifting, as applicable.

602 The design of lifting brackets shall specify maximum sling angle and include resulting bending stresses in the design calculations.

603 If the lifting force is transferred through the thickness direction of a plate, then plates with specified through thickness property (z-quality) shall be used.

604 Design requirements for lifting brackets installed on permanently fixed structures also intended for installation lift(s) shall be as given above, with the exception of lifting brackets potentially used for 2-fall applications, for which the design factor shall be doubled.

Guidance note:

For more detailed requirements, reference is made to other standards or as referenced by relevant national legislation.

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605 *Skids and lifting brackets intended for installation lift(s), only*

.1 Primary structure design of lifting skids used during installation lift(s) shall be specified based on design calculations.

Guidance note:

A design factor DF should be included where:

$$DF = SF \times \psi$$

SF is the safety factor, ψ is the dynamic factor. Unless otherwise specified, the values of DF as given in Table B1 apply:

Table B1 Design factors

Component	*Design factor (DF)*
Skids	2.5
Multiple point lifting brackets	3
Single point lifting brackets	5

The dynamic factor ψ may be specified in accordance with the actual intended lifting operation. The safety factor SF shall, however, never be taken as lower than 1.5 (2.5 for single lifting bracket skids).

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.2 Skids and lifting brackets intended only for installation lifts as described above do not require load testing. Means shall be provided to avoid use of such brackets for regular lifting.

Guidance note:

Lifting brackets within this category should not be marked SWL, or otherwise clearly marked (e.g. “for installation lifting only”).

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606 *Skids and lifting brackets intended for regular lifting*

.1 Skids and lifting brackets intended for regular lifting (including maintenance lifting) shall be provided with proper certification.

Guidance note:
ILO Form No. *CG3, or equivalent,* is one scheme in accordance with international regulations, see e.g. *Rules for Certification of Lifting Appliances* for further details.

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.2 Essential and non-redundant primary structural members, in addition to lifting brackets, shall be welded with full penetration welds.

C. Well Control Systems

C 100 General

101 Well control systems normally comprise the following systems:

— blow out prevention
— diverter system
— choke and kill system
— marine riser system.

102 The well control system or components as specified in C shall be regarded as essential.

103 The blowout preventer shall in general consist of the following, as a minimum:

— a BOP stack consisting of:
  — one bag-type or annular preventer
  — one blind shear ram
  — two pipe rams
— necessary control equipment as stated in 204 and 300
— riser connector (LMRP, for floating installations only)
— wellhead connector.

C 200 Blowout prevention

201 *Blowout preventer stack*

.1 The blowout preventer stack shall be designed to enable fluid and gas to be conducted out of the system, and to enable fluid to be pumped into the system.
.2 Two valves shall be installed in series close to the blowout preventer stack for each of the choke and kill lines. The valves shall be provided with remote control and, where installed subsea, shall be of the fail-to-close type. The valves shall be located so that they are protected against damage from falling objects.
.3 The shear rams shall be capable of shearing the thickest section of the heaviest drillpipe, casing, slack wire/cable or landing string shear sub specified for use with the blowout preventers. If tool joints can not be sheared, either 2 shear rams must be installed, or lifting or lowering of main hoisting system shall be possible in all operational modes, including emergency operation.
.4 Pipe rams shall be designed for any hang-off loads to which they may be subjected.
.5 Surface control lines and fittings shall be capable of withstanding a fire for sufficient time for necessary operation of the BOPs.

Guidance note:
If a dimensioning fire is not specified, the requirements of API Spec 16D as a minimum should be applied, i.e. 1 093°C (2 000 °F)/3 minutes.

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.6 Where surface BOPs are used, the lower kelly cock shall be of such a design that it can be run through the BOP stack.
.7 Shear or blind ram(s) and pipe rams shall be equipped with mechanical locking devices.

202 *Riser and wellhead connector*

.1 Emergency operation of the riser connector or LMRP shall be available from an additional location to the place of normal operation. The location of the additional control shall be selected such that at least one control point is likely to be accessible in the event of an emergency.
.2 Hydraulically operated wellhead and riser (LMRP) connectors shall have redundant mechanisms for unlock and disconnect. The secondary unlock mechanism may be hydraulic or mechanical but shall operate independently of the primary unlocking mechanism.
.3 The maximum tilt angle of riser (LMRP) connector for mechanical freeing shall be stated.

Guidance note:
Friction of guide posts as well as flex joint should be assessed.

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.4 For subsea BOP's, activation of the wellhead connector shall be protected with a key lock.

203 *Valves in drill string*

.1 The requirements in 203.2 to 203.6 shall be applied unless other means with sufficient pressure rating are provided to prevent back flow in the drill string during all drilling conditions, including both disconnected and connected conditions.
.2 The drillstem shall be provided with 2 valves located at either side of the kelly or directly below the topdrive (as applicable) with sufficient pressure rating, of which one shall be remotely operated.
.3 A manual valve in open position for the drillstring shall be available for immediate use at all times.
.4 If a wrench or other tools are required to close the manually operated valve in 203.2 and 203.3 , such tools shall be kept in a readily accessible place.
.5 An open or close drill string safety valve shall be located in open position on the drill floor where it is available for immediate use. The valve shall be of proper size and thread configuration to fit the pipe in use at the time, and shall be capable of withstanding the same well surface pressures as the blowout preventers in use. It shall not be possible to mount this safety valve in a wrong direction.
.6 Crossovers etc. used when running of other types of pipe (e.g. casing) and forming part of a barrier against back flow shall also have sufficient pressure rating.

204 *Control and monitoring, blowout prevention*

.1 The blowout preventers shall be connected to at least two control panels. All control panels shall be mutually independent, i.e. directly connected to the control system, and not connected in series. The control panels shall include controls for at least, but not limited to:

  — diverter operation
  — close or open of all rams, annular preventers and choke and kill valves at BOP.

  For subsea BOPs for floating installations, the following additional controls shall be included:

  — operational disconnect of riser connector
  — emergency disconnect of riser connector.

Guidance note:

Activation of emergency disconnect should sequentially perform BOP closure, cutting of drillpipe and disconnection to enable the unit to move off to a safe location.

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.2 For electrical or computer based subsea systems, activation of the emergency disconnect shall initiate and complete disconnection in the correct sequence.

Guidance note:

For normal single shear ram, the following sequence is recommended to increase the possibility of successful shearing:

- soft closing of pipe ram below shear ram
- lowering of drill pipe until tool joint is resting on pipe ram
- hard closing of pipe ram
- shearing
- riser disconnect.

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.3 Design of emergency disconnect shall take into account required total time for disconnection.

Guidance note:

For subsea BOPs, the operational limitations (i.e. maximum deviation from well centre in a given weather condition) is dependent on the following:

- maximum inclination of riser for successful mechanical disconnection
- length of telescopic joint
- emergency disconnect total time (including unsuccessful shearing, if applicable)

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.4 One control panel shall be located at the driller's stand.

.5 A second control panel shall be located at a suitable distance from the driller's stand, and shall be arranged for easy access, including when the control panel at the driller's stand is not functioning or is out of reach.

.6 Control panels shall give clear indication of blowout preventer status (i.e. open or closed), and shall indicate available pressure for the various functions and operations.

Guidance note:

Indication of open or closed status may be fulfilled by e.g. direct position indication measurement at the BOP, or through flow monitoring.

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.7 Control panels shall be fitted with visual and audible alarm signals for:

— low accumulator pressure
— loss of power supply
— low levels in the control fluid storage tanks.

.8 When the system is started or reset, normal operation shall be resumed automatically.

Guidance note:

E.g. regulators should not loose their set point.

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.9 For hydraulic systems, the main unit of the control system, including the pilot valves, shall be situated so as to be shielded from the drill floor or cellar deck. The unit shall be easily accessible both from the drill floor, and also from the outside without requiring entry via the drill floor or the cellar deck. The main unit shall be designed to withstand any single failure.

.10 For electrical or computer based systems, two mutually independent systems shall be installed. This independence shall include all design events.

.11 The closing unit accumulators for surface and subsea BOPs shall as a minimum meet the capacity requirements (volume and pressure) of API Spec 16D with the following addition: The accumulator capacity requirement shall be based on the 4 larger rams (and not the 4 smaller rams as specified in API Spec 16D).

.12 When subsea BOP systems are fitted with a rapid secondary disconnection system in the event of failure of main system during an uncontrolled well situation, the following shall apply:

— it shall be possible to activate the system from a portable unit
— the secondary disconnection system shall be independent of the main system, including accumulator capacity
— the system shall be able to perform BOP closure, cutting of drillpipe, and disconnection to enable the unit to move off to a safe location.

.13 When installed, the secondary disconnection system shall be fitted with a dedicated closing subsea accumulator unit. Such accumulator unit shall have sufficient capacity (volume and pressure), with pumps inoperative, to close-open-close one pipe ram preventer, close shear ram(s) and open riser connector (LMRP), in the specified sequence order.

.14 The control system of the blowout preventers shall be designed in such a way that each blowout preventer response time is within acceptable limits according to recognised codes and standards.

Guidance note:

For surface BOPs, this is normally within 30 s (from activation until close function is completed), up to 45 s for annular preventers.

For subsea BOPs, this is normally within 45 s.

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.15 Subsea BOP systems shall be provided with two independent pods for all BOP hydraulic lines from the main hydraulic unit.

.16 To prevent inadvertent operation, activation of all functions shall be arranged as required in Sec.1 E100.

Additionally, for floating installations, the activation devices for riser disconnection and shear ram(s) shall have additional protection against inadvertent operation.

Guidance note:

E.g. hinged covers in front of activation buttons.

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C 300 Diverter

301 The design of diverter systems shall take account of possible erosion during operation. Assumptions for the design of the diverter system shall be stated in the operation manual.

Guidance note:

Parameters to take into consideration include e.g. pipe bends, particle content (p.p.m.), flow rate and required time of operation.

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302 The diverter piping shall have sufficient length to ensure that shallow gas is lead away from the installation and will not seriously affect other systems that shall be operable during a shallow gas event.

Guidance note:

This includes e.g. HVAC system.

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303 *Control and monitoring, diverter*

.1 The diverter system shall at least be connected to a control panel which is manually operable from a place near the driller's stand.

.2 The diverter control system shall be equipped with an interlock to ensure that the valve in the diverter pipe which leads out to the leeward side is opened before the diverter closes around the drilling equipment.

.3 Valves in the diverter system shall be capable of operation under worst predictable conditions.

Guidance note:

E.g. specified flow, pressure, temperature.

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.4 The control system of the diverter shall be designed in such a way that the response time is within acceptable limits according to recognised codes and standards.

Guidance note:

E.g. API RP 16E: 30 s for packing elements nominal bore < 20", 45 s for packing elements nominal bore > 20".

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.5 Accumulator capacity shall as a minimum comply with API Spec 16D or equivalent.

Guidance note:

I.e. 150% of the volume required to operate all the divert mode functions.

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.6 Necessary back-up shall be provided to ensure availability of the system at all times.

Guidance note:

E.g. isolated accumulators, back-up supply of pneumatically operated valves etc.

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C 400 Choke and kill

401 The high pressure side of the choke and kill manifold shall be rated to at least the same working pressure as the rated working pressure of the blowout preventer stack.

402 It shall be possible to pump mud through the kill and choke manifold, up to the rated pressure of the blowout preventer stack.

403 It shall be possible to route the returns from the choke and kill manifold through an installed mud and gas separator. It shall also be possible to route the returns through a fixed piping arrangement leading directly overboard (overboard lines).

404 The pressure rating of the overboard lines and associated valves shall not be less than the pressure rating of the buffer chambers of the choke manifold.

Guidance note:

Full pressure of an open ended piping system may be reached through e.g. clogging or supersonic flow velocity.

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405 The mud and gas separator shall be fitted with adequate pressure monitoring and a liquid seal to prevent separated gas from breaking through to the mud tanks.

Guidance note:

Regulating valve(s) should not be considered suitable due to risk of hydrate plugging.

The vent capacity is dependent on the liquid seal height and diameter of the gas vent line.

The following recommendations apply for normal drilling operations (e.g. excluding HPHT wells):

- liquid seal height should not be less than 3 m (10 ft)
- gas vent line should not be less than 0.2 m (8 inches).

U-tube liquid seals should be fitted with secondary vent pipe at the highest point of the pipework to avoid siphon effects and in order to dispose possible gas carried through the seal. The secondary vent should be vented to a suitable location, and never into the primary vent.

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

407 The choke and kill manifold shall be equipped with the following:

a) At least 3 chokes, of which one shall allow for remote control, and one for manual adjustment. It shall be possible to isolate and change each choke while the manifold is in use.

b) 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 shall be used. Manifolds for 345 bar or higher pressures shall be equipped with minimum 2 valves before each of the chokes. The working pressure of the valves shall be the maximum working pressure of the choke manifold.

408 The maximum and minimum design temperature of the choke and kill manifold shall be specified.

Guidance note:

See API Spec 16C for further guidance.

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409 Choke and kill lines shall be provided from the blowout preventer stack and shall be connected to a choke manifold.

410 Choke and kill lines with connections, valves, etc., shall be rated to at least the same working pressure as the rated working pressure of the blowout preventer stack.

411 *Control and monitoring, choke and kill*

Clear indications of drill pipe pressure and choke manifold pressure shall be available on all kill and choke control stands (remote and local). Choke valve position and drilling fluid pump rate shall in addition be available at the remote control stand.

C 500 Marine riser system

501 Marine risers shall be designed to withstand applicable combined design loads for the application in the required water depth.

Guidance note:

Relevant loads to evaluate include:

- waves
- current
- riser tensional loads
- vessel motion
- drilling fluid specific gravity (SG)
- collapse pressure
- handling loads.

See DNV-OS-F201, API RP 16Q or equivalent for further guidance.

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D. Heave Compensation and Tensioning System

D 100 General

101 Sub-section D describes the overall requirements for motion compensating equipment and systems for non-fixed

drilling units including, but not necessarily limited to, the following:

— marine riser tensioners, including re-coil system
— guideline tensioners
— podline tensioners
— idler sheaves
— heave motion compensators
— APVs
— control and monitoring.

Systems or components that are not described in further details below shall follow the respective standards in Ch.1 Table C1.

102 Anti recoil or similar systems (e.g. for deepwater application or dynamic positioned units) shall be regarded as essential. Heave compensation function shall be regarded as an essential function during fixed-to-bottom operations.

Guidance note:

If such operations are not applicable, the system may be regarded as important. This will, however, impose very important operational limitations for such operations.

For semi-active systems (i.e. systems consisting of one active and passive heave compensation system, the active system may be regarded as important also for fixed-to-bottom operations, provided it is completely independent of the passive system (i.e. failure of active part of system is not regarded as critical).

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103 Single component failure shall not lead to overall failure of the system.

Guidance note:

E.g. accumulator banks should be sufficiently segregated in the event of leakage of one accumulator bank.

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

Guidance note:

This may be achieved by means of e.g. a flow restriction valve.

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105 Air control panels and accumulators shall be fitted with safety valves.

106 Air relief lines from safety valves shall be self draining.

107 Compressed air shall be used only with non-combustible fluids.

108 Hydraulic cylinders shall be designed both for internal pressure loads, and for loads resulting from their function as structural members.

109 Necessary condition monitoring of the system shall be provided and be available at the drilling console in order to detect abnormal conditions that may lead to critical failures. Alarms shall be initiated for abnormal conditions.

Guidance note:

Monitoring of the following should be considered, as applicable:

- fluid level of leakage tank
- leakage level (by e.g. trip counter on the leak transfer pump)
- position of cylinder pistons (i.e. stroke position).

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110 Where applicable, leak transfer pump system shall comply with A700.

D 200 Heave compensation

201 The requirements of 202 to 205 apply for hydraulically and pneumatically based systems only.

202 Single failure in the heave compensation system shall not lead to overall failure of the system.

Guidance note:

E.g. unintentional valve closing:

During normal drilling operation, unintentional locking of e.g. flow restriction valve (104) is not normally categorised as critical.

However, attention should in particular be drawn to locked-to-bottom operations, during which consequences of unintentional locking of the mentioned valve can be severe. Probability reducing measures should therefore be considered, by e.g. having the main hydraulic valve(s) locked open. The maximum allowable operating pressure during such operations should be limited and as means of protection cushioning at end strokes for this, limited maximum pressure should be provided in the design.

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203 The system shall be designed to allow for certain loss of fluid during operation.

Guidance note:

E.g. fluid capacity of fluid or gas accumulator should be higher than that of the hydraulic cylinders.

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204 For partially active systems, failure in the active part shall not lead to overall failure of the system.

205 For fully active systems, single component failure shall not lead to overall failure of the system. Power shall be available during normal and emergency operation.

Guidance note:

This apply to e.g. active heave compensated drawworks.

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D 300 Riser tensioner systems

301 The requirement of single failure in 103 also applies with one riser tensioner line removed.

302 Dynamic positioned units shall be fitted with an anti recoil system or equivalent if required by the water depth for drilling operations, see also 303.

303 Where applicable (i.e. deepwater drilling), the system shall be designed to prevent any significant upward motion of the riser that may otherwise cause damage to the riser, installations or personnel resulting from the impact.

Guidance note:

The control of such systems may be manual or automatic (e.g. anti recoil system), but it should be operable also after an ESD.

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E. Hoisting and Rotating Systems

E 100 General

101 Sub-section E describes the requirements for hoisting and rotary systems including equipment such as:

Hoisting system

— drawwork
— crown block or structural parts of compensators
— travelling block or yoke
— drilling hook or adapter
— drill line spool and anchor.

Rotating systems

— rotary swivels
— top drive
— guide dollies
— rotary table.

Systems or components that are not addressed in further requirements below shall follow the respective standards as indicated in Ch.1 Table C1.

102 Specific functions related to the hoisting system shall be regarded as essential, see 203 for details.

103 Equipment installed above the drill floor shall be properly fastened and secured against falling down.

Guidance note:
E.g. securing of bolts against unintentional unscrewing or use of secondary securing devices.

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104 Brakes relying on mechanical friction shall be properly shielded against possible dirt or spillage which may affect the performance of the brakes.

Guidance note:
For brake discs there shall also be a protection against spillage of oil from the brake callipers onto the brake disc.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

105 Capacity calculation of the braking system shall be based on the worst allowable conditions for the mechanical components.

Guidance note:
E.g. coefficient of friction, air gap between 2 discs.

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106 Where applicable, emergency stops and automatic stopping shall not impose unacceptable dynamic loads on the system.

Guidance note:
Design dynamic factors applied should be in line with expected maximum peak loads.

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E 200 Hoisting system

201 The maximum permissible working load for a system of interdependent equipment shall be that of the weakest component of the system, e.g. winches, wire, hooks, pulleys, etc.

202 Unless more stringent requirements are found in this standard or other applied reference code or standard, the safety factors of wire ropes shall be according to API RP 9B or equivalent. The diameter, construction and tensile grade of the wire rope shall be compatible with the hardness levels and groove profile dimensions specified by the equipment supplier.

203 The following functions of the hoisting system shall be considered as essential:

— braking function
— hoisting or lowering function if facilitating disconnection from well (i.e. successful operation of shear ram)
— heave compensation function if performed by the hoisting system (e.g. active heave compensated drawworks) during fixed-to-bottom operations.

204 Where fitted, wire clamps shall have 2 gripping areas. The number of clamps shall be in accordance with API RP 9B Table 2.1 or equivalent, but shall not be less than 3.

Guidance note:
Other clamping device designs should be according to other appropriate recognised code or standard.

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205 The braking capacity of brakes relying on mechanical friction shall be minimum as follows:

a) For systems where loads are lowered by powered descent: 110% of the sum of static braking moment resulting from lifting SWL with maximum layers of wire on the drum and the maximum obtainable static moment of the motor, when both moments are exerted in the same direction.
b) For systems where loads are not lowered by powered descent: 200% of SWL.

206 See also 104 regarding conditions used in capacity calculations.

207 Where plastic covered wire is used, special consideration shall be given to the number and type of clamps used.

208 Individual components such as sheaves, hooks, shackles, wire slings, permanent attachments, etc. shall be marked with the safe working load (SWL).

209 Sheaves are normally exempted from impact testing if not required by applied code or standard.

210 *Control and monitoring, hoisting system*

.1 Means shall be provided as necessary to prevent the main hoisting equipment (travelling block or top drive) from being run into the crown block in operations where:

— hoisting and related operations are automated
— the driller and other personnel operating the systems do not have an adequate overview of the operation from the place of operation
— the speed of the operation involved is too high for the operator to react in time.

Guidance note:
Such means may be e.g. an anti-collision system.

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.2 If an anti-collision system is fitted as described in 210.1 and when possible collision is detected, the hoisting system shall be stopped automatically. See also F302.3.

.3 For automatic hoisting operation, any system failure shall initiate alarm and automatically return to the fail-safe mode relevant for each particular mode of operation.

Where braking is the fail state both primary and secondary brakes shall be activated.

Guidance note:
Examples
Tripping of el-motors caused by heat, overload etc. shall automatically activate brakes.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

.4 In case of failure of the brake activation system (including operator error), the hoisting shall be stopped automatically.

Guidance note:
The operation may be by means of an operating handle which will return automatically to the stop position when not being manually operated. The stop position should be clearly marked.

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.5 The hoisting system shall be equipped with a readily identifiable and accessible emergency stop device for use in the event of main brake failure. The emergency stop device shall be independent of the control system and have functional capabilities to both stop and safely lower the load in the event of main brake failure.

Guidance note:
If the draw-work is equipped with an electro magnetic brake system (Elmagco brake) the activation of the emergency stop shall also be hardwired to activate the electromagnetic brake at full power. To avoid overheating the coils it will be permissible to include a timer that releases the electromagnetic brake after a given time.

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.6 Necessary condition monitoring of the system shall be provided and be available at the drilling console in order to detect abnormal conditions that may lead to critical failures. Alarms shall be initiated for abnormal conditions.

Guidance note:

Monitoring of the following should be considered, as applicable:

- anti-collision
- slack-wire detection
- failure in the hoisting system
- for fluid cooled braking system: temperature, flow and level
- for electromagnetic brake coils: current and earth leakage
- UPS status and charge condition of batteries
- primary power supply status
- activation of emergency stop.

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.7 The following parameters shall be indicated at the drilling console:

— vertical position of hoisting device
— weight of the drill string
— rate of penetration and drilling depth.

.8 Maximum expected dynamic loads when brakes are activated shall not exceed the derrick design conditions.

211 For drawwork drums with simple type cylinder designs, the following shall apply: The hoop stress (σ_h) in the barrel shall not exceed 85% of the material yield stress, where:

$$\sigma_h = C \cdot \frac{S}{p \cdot t_{av}}$$

σ_h = hoop stress in drum barrel
S = rope tension under spooling
p = pitch or rope grooving
= distance between ropes, center to center, within one layer
t_{av} = average wall thickness of drum barrel
C = 0.85 for the first layer of wire, 1.0 for the second layer of wire, 1.3 for the third layer of wire and 1.75 for 4 layers and above.

Guidance note:

The requirement regarding different C – values may lead to different maximum rope tensions depending upon the number of layers spooled on the drum. If this is incorporated in the operational limitations for the draw work means shall be provided to monitor the actual number of wire layers spooled on the drum.

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212 For other drum designs with e.g. internal stiffeners, other recognised calculation methods should be applied.

213 The drum flanges shall be designed for an outward pressure corresponding to the necessary lateral support of the windings near the drum ends. Unless a lower pressure is justified by tests, the pressure is assumed to be linearly increasing from zero at the top layer to a maximum value of:

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

D = outer diameter of the barrel.

214 The hoop stress calculation shall be based on the maximum number of wire layers on the drum.

215 If brakes relying on mechanical friction are fitted, see 104.

E 300 Rotating system

301 The following parameters shall be monitored and indicated at the drilling console:

— rotating speed and torque.

F. BOP and Pipe Handling

F 100 General

101 Sub-section F describes the requirements for BOP and pipe handling systems and includes:

— tongs, grippers, magnets
— horizontal pipe handling (see 200 for further details)
— vertical pipe handling (see 300 for further details)
— BOP handling (see 400 for further details).

102 Grippers and magnets holding function shall be regarded as essential.

Guidance note:

To protect against unintended loss of the holding function, this will normally entail the following:

- To protect against possible operator error, 2 signals from operator may be required to activate opening of gripper or deactivation of the magnets.
- To protect against possible computer hardware and software failure, the requirements of Sec.4 may apply for computers. Exception to this is where the gripper function is activated independently of the computer (hardwired).

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103 *Tongs*

.1 All tongs shall be securely attached to the derrick, mast, or a back-up post and shall be anchored by a wire rope or stiff arm having a minimum breaking strength greater than the breaking strength of the pulling cable or chain.
.2 Tongs shall be arranged with safety lines. The lines working on the side opposite the safety line shall have a minimum breaking strength greater than the force of the make-up torque.
.3 All fittings and connections shall have at least the minimum breaking strength of the cable, wire rope, or stiff arm to which they are attached. Knots shall not be used to fasten cable or wire rope lines.
.4 Power tong pressure systems shall be equipped with a safety relief valve.
.5 Failure of the torque sensor is not to lead to a critical situation.

Guidance note:

E.g. use of 2 sensors or detection of sensor failure.

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104 *Grippers*

.1 Grippers where frictional forces are required to prevent the load from dropping shall be designed to hold an equivalent of 2 x SWL by frictional forces in the worst operational direction. Frictional coefficients applied in design calculations shall take into account realistic operational surface conditions (e.g. greasy pipe). The holding power shall be verified through testing.

Guidance note:

This should not be confused with load testing of the lifting appliance.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

.2 Grippers shall be protected from potential destructive loads that could occur if a gripper with associated pipe

load were exposed to additional vertical loads caused by operating the pipe handling systems downwards toward the respective foundations.

Guidance note:

This may be arranged by interlocking the vertical movement of the pipe handling system with the load cell(s) fitted.

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.3 Power failure shall not lead to loss of gripper function.

Guidance note:

Gripper should be either spring activated to close or hydraulic power back-up should be available.

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.4 For hydraulically operated grippers, hose rupture valves and hydraulic accumulator or equivalent shall be installed as necessary to maintain gripper function in the event of hose rupture.

Guidance note:

The requirement for e.g. accumulator may be waived for grippers, which maintain satisfactory gripper function in the event of hose rupture, e.g. horizontally operated grippers.

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105 *Magnets*

.1 To ensure sufficient holding capacity for all operational conditions, magnets shall be designed to hold 3 x SWL at normal operating conditions.
.2 The holding power for ideal conditions is dependent on type of material, size (diameter or wall thickness), and mass. The holding power shall therefore be verified through testing for each combination of these parameters present in the pipes intended to be lifted.
.3 To ensure proper contact with the pipe lifted, lifting magnets shall be hinged to the yoke or element to which they are attached, and alignment of magnets shall be ensured.
.4 Battery back-up shall be provided where necessary and alarm shall be initiated upon loss of back-up power.

Guidance note:

Attention should be paid to requirements for emergency manoeuvring related to the time available before non-permanent magnets are overheated and loose their holding capacity.

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106 *Emergency manoeuvring*

Necessary means shall be provided for emergency manoeuvring of each pipe handling or BOP handling system to a safe stowed position. Unless otherwise justified, it shall be possible to complete emergency manoeuvring within 10 minutes of the start of the emergency.

F 200 Horizontal pipe handling

201 Structural design of horizontal pipe handling equipment shall include consideration of all relevant loadings, including rig movements (where applicable), as outlined in Sec.1 H. The dynamic coefficient ψ shall be in the range 1.3 to 1.6 depending on type of design.

Guidance note:

For overhead or gantry cranes, typical value of ψ is 1.6, whereas for wire rope suspended type cranes, typical value is 1.3. See e.g. *Rules for Certification of Lifting Appliances* for further details.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

Guidance note:

Horizontal pipe handling includes transportation within the pipedeck area, as well as transportation between pipedeck area and drill floor. For additional requirements for grippers and magnets see 104 and 105, respectively.

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202 Access to operating areas shall be clearly restricted during equipment operation. This will normally include proper enclosure, visual and/or audible warnings.

Guidance note:

This is particularly important for systems having automated functions (e.g. automatic return to "standby" position upon delivery of pipe).

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203 If access cannot be restricted, such that the area has to be regarded as normally manned (due to e.g. access through the pipe handling area), the safety features outlined for vertical pipe handling in 302.1 to 302.4 apply.

F 300 Vertical pipe handling

301 *General*

.1 Vertical pipe handling includes equipment such as racking board, standlift arrangement, stand guide arrangement and make-up or break-out arrangement. For additional requirements for grippers and magnets see 104 and 105, respectively.
.2 Equipment such as casing stabbing boards and baskets are regarded as manriding equipment (see I300).
.3 The requirement in 201 applies.
.4 There shall be provisions for location of drill pipe collars, tubing, rods, and casing.
.5 The storage racks shall be designed to prevent drill collars, pipe, risers and other tubular material from accidentally being released from the rack.

302 *Safety features*

.1 The requirements in 302.2 to 302.4 apply to remotely operated vertical pipe handling systems, where installed.
.2 The drill floor area shall be regarded as permanently manned, and thus special safety features are required to safeguard personnel during remote pipe handling operations. In particular, the potential for accidents and injuries resulting from single failure shall be avoided.

Guidance note:

Single failures for hardware of the computer based system, including sensors, actuators and associated cables, computer software and operator error should be assessed.

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.3 If unintended collisions could be caused through automated operations, means shall be implemented as necessary to avoid unintended collisions between e.g. topdrive and racking arms.

Guidance note:

By means of e.g. anti-collision system or interlocks.

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.4 In case of system failure, the operation of the computer based pipe handling system shall be automatically halted in its present location or brought to a safe location, as appropriate.

Guidance note:

Typically, failure of a positioning device should result in halted operation, whereas loss of battery back-up power to the magnets should result in immediate manual lowering to safe location.

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F 400 BOP handling system

401 *General*

.1 Design of the BOP carrier or skid shall take into account relevant loads induced by the maximum operational and survival conditions, including maximum static heel for the installation. Securing arrangements during operational and survival conditions shall also be taken into account.

.2 BOP guiding systems, including wire rope guidelines, shall take into account operational and accidental conditions.

Guidance note:

Due consideration should be given to the effects of wave slamming and sea current forces on the guideline system as the BOP is deployed.

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G. Bulk Storage, Drilling Fluid Circulation and Mixing and Cementing

G 100 General

101 Sub-section G describes the overall requirements for bulk storage and mixing equipment and systems, and includes, but is not necessarily limited to, the following:

Bulk storage

— dry bulk storage tanks (e.g. cement, baryte, bentonite) and associated piping and valves
— bulk transfer system
— surge tanks.

Drilling fluid circulation and mixing

— mud mixing and circulation facilities.

Cementing.

102 The following functions shall be regarded as essential:

— emergency mixing and circulation of drilling fluid.

Guidance note:

This is typically arranged by using the cement pump for emergency circulation and by having dedicated emergency transfer pumps (with e.g. emergency power supply), which transfer drilling fluid from the mud pits to the cement pump. However, it may also be possible to have an arrangement with one of the main mud pumps and associated feeding pumps dedicated for emergency circulation purposes.

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103 The capacity and availability of the mud mixing facilities (inclusive passive mud tanks) shall be adequate for the intended drilling program.

Guidance note:

This includes at least:

- ensuring rapid weight increase of drilling fluid in an active system
- mixing sufficient drilling fluid in case of instability in the well
- enabling the drilling fluid to be mixed in order to maintain or re-establish complete well control in a situation where a well barrier is lost and the ordinary power source of the installation has failed, see also 102 regarding availability of emergency circulation system.

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G 200 Bulk storage

201 Hydraulic or pneumatic equipment shall be fitted with safety valves.

202 All bulk storage tanks shall be equipped with safety valves or rupture discs to prevent damage due to overpressure. Rupture discs may only be used for bulk storage tanks in open areas, or if fitted with a relief line to an open area.

203 Safety valves for bulk storage tanks in enclosed areas shall be testable and vented outside the enclosed area.

204 Enclosed bulk storage areas shall be sufficiently ventilated to avoid overpressure of the enclosed space in the event of a break or a leak in the air supply system.

205 The design of atmospheric vessels shall take account of the static pressure developed by vent pipes or similar connections where such are fitted.

G 300 Drilling fluid circulation and mixing

301 G 300 describes the overall requirements for drilling fluid circulation including, but not necessarily limited to:

— high pressure mud pumps and pulsation dampeners
— discharge manifolds, lines and valves
— charge pumps
— control and monitoring.

302 Degasser and mud and gas separator shall be vented to a safe location.

Guidance note:

The poorboy degasser vent should be located as high as possible. If this does not provide adequate separation from ignition sources, alternative venting locations or other means of protection should be considered.

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303 High pressure mud pumps shall be fitted with pulsation dampeners and safety relief valves set at the maximum allowable pressure of the systems.

304 Mud relief lines from safety valves shall be self draining.

305 *Control and monitoring, drilling fluid circulation and mixing*

.1 Necessary condition monitoring of the system shall be provided and be available at the drilling console in order to detect abnormal conditions that may lead to critical failures. Alarms shall be initiated for abnormal conditions.

Guidance note:

Monitoring of the following should be considered, as applicable:

- mud pump discharge pressure and rate
- weight of mud entering and leaving the borehole
- drilling fluid volume, indicating the increase or decrease in drilling fluid volume
- drilling fluid return indicator, showing the difference in volume between the drilling fluid discharged and returned to the unit. The indicator should be capable of compensating for unit movements
- gas content in the mud.

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.2 Alarm shall be initiated for abnormal conditions in active drilling fluid tank volume.

Guidance note:

E.g. loss of volume due to loss of circulation, gain in volume due to influx, low level in active tanks.

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306 When the cementing unit is used as means of emergency circulation, facilities for transferring mud to the cementing system shall be provided.

Guidance note:

This includes e.g. mud supply pump, emergency power to the mud supply pump.

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307 The drilling fluid tank volume shall, in all operational modes, be sufficient for the intended well volume.

Guidance note:

Sufficient volume may be ensured by automatic or manual transfer. Alarm should be initiated for low level in the active tanks.

Activation time and capacity of the transfer system from the passive tanks should be taken into consideration.

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308 When the transfer is automatic, high level alarm shall be initiated.

G 400 Cementing system

401 For requirements for cementing system when required during emergency circulation see 306.

H. Well Testing and Associated Well Control System

H 100 General

101 For general requirements for drainage, blowdown system and shutdown, see DNV-OS-E201.

102 Sub-section H only apply for well testing of limited duration. For extended well testing (EWT), see DNV-OS-E201.

Guidance note:

Typically, a duration of a well test exceeding 1 month is considered as an extended well test.

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103 For requirements for supporting systems not listed in this sub-section, see other relevant sections in this standard.

H 200 System requirements

201 Units designed as, or potentially to be operated as, atmospheric units shall include design features to prevent return of air into the unit, which could cause an explosive mixture or backfiring to occur.

202 The interconnecting piping system shall be permanently installed with an effort to minimise elastomers in the connections. Permanently installed piping shall be covered with grating wherever appropriate to provide a safe working environment.

203 Unless more stringent requirements apply, any water dumped overboard at offshore location shall contain less than 40 ppm of hydrocarbons. Discharged water shall be sampled and the hydrocarbon content measured.

204 API RP 14C or an equivalent standard shall be used as a guideline to safeguard the surface process equipment.

205 The main process equipment area shall be bunded to prevent any oil spillage from spreading outside the dedicated process area. The requirements for drainage in DNV-OS-E201 shall be applied.

206 Where piping installations include a change of pressure rating ("spec. break"), the lower rated pipe shall be adequately protected against overpressure. Double isolation valves shall be installed where practicable.

207 All surface pressure-containing piping and vessels shall be arranged and mounted in such a manner that blow-down of the equipment can be manually activated from a safe area.

208 Tripping of and alarms of the ESD system shall be available both locally and at the main control room.

209 There shall be an inlet ESD valve to isolate the test facilities from the well.

210 During well testing, the maximum attained shut in pressure shall not exceed the design pressure of relevant (pressure boundary) equipment.

211 The ESD valves shall be designed for fire exposure, and shall be of fail-safe close type.

212 Air compressors shall be suitable for installation in zone 2 areas.

213 The master valve shall, when installed, have the function of emergency shutdown valve. See also 209.

214 A check valve should be installed in the final flow segment (i.e. upstream steam exchanger, separator).

215 Where double PSV's are used, each shall provide 100% capacity. The PSV's shall be interlocked or locked open, as appropriate.

216 To avoid overpressure, a PSV shall be fitted between the choke manifold and the steam exchanger, unless the maximum allowable working pressure for the piping and steam exchanger is greater than the maximum shut in tubing pressure of the well.

217 Two valves in series shall be fitted in possible bypasses of pressure reducing devices (as for example chokes).

218 Heat exchangers shall be equipped with safety valves.

219 The swivel and kelly hose (rotary hose) shall not be a part of the test line.

220 At least two complete flare lines, or other devices through which any flow from the well may be directed, shall be provided. These lines or devices shall run to different sides of the drilling unit.

221 Any flare line or any other line downstream of the choke manifold shall have an internal diameter not less than the internal diameter of the largest line in the choke manifold.

222 Arrangements for cooling of flare burners shall be available.

223 The flare burners shall be located at a safe distance from the unit, and this distance shall be justified by means of heat intensity calculations.

224 Where used, compressed air supply to burner assemblies shall be designed so as to prevent hydrocarbon contamination of the compressed air systems.

225 For capacity requirements of fire water or deluge system for well test area, see DNV-OS-D301.

226 For general requirements for ESD system, see DNV-OS-A101 and the relevant DNV standard for electrical systems and equipment.

227 The suitability of the following aspects should be thoroughly evaluated prior to installation of well testing system and associated equipment on an offshore installation:

— area classification
— location assessed in relation to air intakes, lifeboats, control room etc.
— deluge and passive or active fire protection
— drain system
— fire and gas detection system
— ESD and safety philosophy.

I. Other Systems

I 100 Winches

101 Sub-section I is applicable to all winches within the drilling area, except those used for manriding purposes (see 300), but including winches used for integrated purposes.

102 All winches in the derrick, drill floor, cellar deck, and catwalk area shall be shielded for personnel protection and marked with the maximum permissible working load (SWL).

103 Winch operation shall be by means of an operating handle or equivalent (e.g. push button) which will return automatically to the stop position when not being manually operated. The stop position shall be clearly marked.

104 Winches shall have an automatic brake which comes into operation in the event of a power supply failure. The brake shall be able to stop the winch at full speed when lowering the maximum load.

105 The winch brake should preferably be fitted directly on the drum. If this is not feasible, all components transmitting brake forces shall be dimensioned as the brake itself.

106 The air supply to air-powered winches shall not exceed the pressure which is sufficient to reach the SWL.

107 The brake shall be capable of holding a static load of 1.8 x SWL.

108 All loadbearing components of the winch, including those transmitting brake forces, shall normally be supplied with traceable material work certificates (3.1b). Where this is not accomplished, the system shall include necessary component redundancy so that 100% braking capacity remains available upon possible failure of any single component.

109 If brakes relying on mechanical friction are fitted, see E104.

110 When spooling operation is not directly visible for the operator of the winch, fitting of spooling device should be considered.

I 200 Gear transmissions

201 Non-redundant gear units transmitting braking forces for critical applications shall have documented mechanical strength based on a recognised code and according to a relevant load spectrum (i.e. load-time characteristics). The load spectrum shall include both operational loads and possible brake loads.

Guidance note:

Gear transmissions for "non-critical" application, as for example units for non-hoisting purpose, may be accepted without such documented design.

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I 300 Manriding equipment

301 *Scope*

.1 For the purposes of this standard, manriding equipment includes all lifting appliances intended for lifting of personnel, and having a height of fall above 3 m.

Guidance note:

This includes equipment such as manriding winches, stabbing boards, stabbing baskets, etc.

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302 *General requirements for manriding equipment*

.1 The safety factor for all loadbearing parts of structures, machinery components and lifting devices (including lifting lugs) for manriding equipment shall be 2 times that required for other lifting appliances and lifting devices, which do not involve lifting of personnel.

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

.3 The motion regulating equipment shall be smooth, continuous and repeatable. The winch shall not be operable at a speed above the maximum operating speed for safe transport of personnel, e.g. through use of speed limiting devices. The maximum acceleration or deceleration and braking, including emergency braking, shall not injure or harm personnel being transported.

.4 Control panels for manriding equipment shall include all necessary devices for normal operation of equipment, including emergency stops. Operating panels shall be situated at convenient locations, clearly marked, and control handles or equivalent shall return automatically to stop position when not being operated.

.5 Inadvertent operation shall not be possible.

Guidance note:

This may be arranged by means of an enable function prior to the activating action or by activation of 2 devices simultaneously.

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.6 Load limiting devices shall be fitted to prevent loads above SWL from being lifted. Frictional couplings shall not be used for this purpose.

Guidance note:

For hydraulic and pneumatic systems, this may be accomplished by means of a PCV on the supply line.

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.7 Wire ropes shall have a minimum breaking strength of 10 x SWL and shall otherwise be in accordance with a recognised standard applicable to the intended use.

.8 Hydraulically operated systems shall be designed to remain safe and stable (i.e. avoid loss of control of the winch) during all operating conditions, including loss of power and emergency operation.

.9 The potential for accidents and injuries resulting from single failure shall be avoided.

Guidance note:

Single failures for hardware of the computer based system, including sensors, actuators and associated cables, computer software, and operator error should be assessed.

Lines where hose rupture may be critical (e.g. casing stabbing basket) should be fitted with a hose rupture valve or equivalent means of protection against uncontrolled lowering.

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.10 Access routes and platforms associated with manriding equipment shall comply with recognised safety standards or regulations. A means of safe egress shall be provided in case of power or equipment failure, or other hazardous events.

Guidance note:

Means of safe egress may be fulfilled through ability to lower or elevate equipment to access ways (without power supply), or provision of escape ladder or other adequate means of egress.

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.11 Emergency stop shall be implemented according to A600.

.12 The control (manoeuvring) position shall 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 shall at all times have ready access to an emergency stop device.

.13 The system shall be provided with means which will automatically stop lifting outside the safe operating limits.

Guidance note:

This may be provided e.g. by means of limit switches.

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.14 Wire-fitted systems where slack wire may be critical shall for all operating modes be provided with slack wire detection, which initiates automatic stop when activated. Unless other means are proven to be safer, deactivation of this system shall only be possible directly on the winch, and in the presence of an operator, i.e. the detection system shall automatically re-activate when operator is no longer present at the winch.

Guidance note:

Slack wire detection may be waived for e.g. systems operated locally for which a possible slack wire situation is easily detected visually by the operator. This further requires that the operator has a clear view of the person being lifted at all times.

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.15 Controlled lowering of the lifting device shall be possible in the event of power failure or other unintended stop. Frictional coupling or clutch shall not be used for emergency operation.

.16 Provision for emergency hoisting shall be present where this may be required for safe escape during an emergency.

Guidance note:

E.g. if operating under deck or over open sea where evacuation possibilities are poor upon lowering.

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.17 Both emergency lowering and hoisting shall ensure the safe escape of person(s) lifted within 10 minutes of the start of the emergency. The lowering and hoisting speed should not exceed 1.0 m/s.

.18 If brakes relying on mechanical friction are fitted, see E104.

303 *Specific requirements for manriding winches*

A manriding winch includes winch with foundation, drum and driving gear, wire rope, sheave arrangement, and lifting tool to be connected to the riding belt.

304 *Arrangement*

.1 The arrangement shall be such that the weight of wire rope between sheave arrangement and winch never exceeds the weight of wire rope and manriding device on the other side of the sheave arrangement. This may be accomplished by means of counterweights. Such counterweights shall be arranged to avoid interference or jamming with other components, or potential for personnel injury.

.2 The sheave arrangement with fastening to structure shall be dimensioned according to the same principle as the winch itself. The geometry shall ensure free path for the person lifted or lowered and ensure no damage to wire rope. The geometry shall ensure that the angle between wire rope and drum or sheave is within ± 4°. The sheave arrangement shall be fitted with protection ensuring that derailing of wire rope does not occur. The diameter ratio between sheave and wire rope shall be minimum 18:1.

.3 Winches used for manriding equipment shall be designed with fixed operation up and down (i.e. no free fall with brakes).

.4 Man riding winches shall have a maximum SWL of 150 kg.

305 *Drum*

.1 Spooling apparatus shall be fitted as necessary to ensure satisfactory spooling of wire rope and to prevent derailing of wire rope.

.2 The diameter ratio between drum and wire rope shall be minimum 18:1.

.3 At least 3 turns of wire rope shall remain on the drum at the lowest possible operating position of lifting device.

306 *Brakes*

.1 The winch shall be fitted with 2 separate, independently operated braking systems, of which one is considered as parking brake and the other as operational brake. Each brake shall be capable of stopping and holding the load upon activation.

Guidance note:

The motor of the winch normally satisfies the requirements for operational brake.

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.2 Each brake shall automatically engage upon emergency stop, power loss, or other related energy failure (e.g. hydraulic accumulator, spring, etc.). During normal operation, the parking brake may be operated manually.

.3 Each brake shall be capable of holding a static load of 1.8 x SWL.

.4 The brakes should preferably be fitted directly on the drum. If this is not feasible, all components transmitting brake forces shall be dimensioned as the brake itself.

.5 The operational brake shall be engaged with the control devices in neutral position.

.6 The brakes shall be designed to avoid unintentional release.

Guidance note:

E.g. an unintentional pressure build-up in excess of the preset maximum return pressure caused by e.g. restricted flow in the return line may typically cause release of the parking brake.

Monitoring of return pressure with initiation of alarm if preset maximum return pressure is exceeded or dedicated return line may be considered.

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307 *Additional requirements for casing stabbing boards*

.1 The casing stabbing board shall be fitted with an additional mechanical locking device, which will safely stop and hold the board in the event of main hoisting system failure.

.2 The failure of a roller or wheel on a manriding platform shall not endanger the safety of the rider.

.3 The person being lifted shall have the possibility to operate and override the same functions as those operated at the remote operating panel(s).

.4 Means of safe return of personnel by override of local control from a remote operating position shall be installed.

J. Workover and Well Intervention Equipment and Systems

J 100 General

101 For general requirements to workover and well intervention equipment end systems reference is made to DNV-OSS-101 Section 3.

102 The systems or components as described in F shall be regarded as essential.

SECTION 6
MANUFACTURE, WORKMANSHIP AND TESTING

A. General

A 100 Application

101 This section covers equipment, structures and systems during fabrication, installation and final testing onboard.

102 Equipment, structures and systems shall be fabricated, examined and tested according to this section and the applied codes and standards.

A 200 Quality assurance and quality control

201 The manufacturer shall utilise the necessary production facilities, qualifications, procedures, and personnel to ensure that the product will be manufactured to the specified requirements.

A 300 Marking

301 All equipment shall be clearly marked with identification and serial number which relates the equipment to certificates and fabrication documentation.

Guidance note:

Low stress stamping may be required for certain materials. Paint markings may be accepted, but care must be exercised during handling and storage to preserve the identification.

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B. Manufacture

B 100 Qualification of welders

101 Welding of pressure containing components, piping systems, load carrying equipment and structures shall be carried out by qualified welders only.

102 Qualification of welders shall be in accordance with DNV-OS-C401 or the applied design code.

Guidance note:

Welders qualified to another code than the design code may be suitable provided that the design code is demonstrated to be suitable and relevant qualifications are documented.

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103 The manufacturer shall supply each welder with an identification number or symbol to enable identification of the work carried out by each particular welder.

B 200 Welding

201 All welding as specified in DNV-OS-C401 shall be performed in accordance with a qualified welding procedure specification (WPS).

202 A welding procedure qualification test (WPQT) should be performed when applying a WPS for which there is insufficient experience at the plant or elsewhere, or where applied to new complicated structural details. The extent of the procedure test shall be agreed before the work is started.

203 Fabrication welding production test (WPT) shall be provided where necessary to verify that the produced welds are of acceptable quality.

204 The welding of drilling derrick and flare booms shall be in accordance with relevant section of the *Rules for Certification of Lifting Appliances*.

205 Butt welded joints shall be of the full penetration type. Special provisions shall be taken to ensure a high quality of the root side.

206 If supports and similar non-pressure parts are welded directly to pressure retaining parts, the welding requirements for the pressure retaining parts shall be applied.

207 Welding repairs shall be performed according to a qualified and approved repair procedures.

B 300 Heat treatment

301 After forming and/or welding, the component shall be heat treated if required according to the applied code or standard, or if found necessary to maintain adequate notch ductility and avoid hydrogen induced cracking.

302 Rate of heating and cooling, hold time, and metal temperature shall be properly recorded.

303 A normalising heat treatment shall be applied for hot formed parts, unless the process of hot forming has been carried out within the appropriate temperature range, duration, and cooling rate.

304 The heat treatment for cold worked materials shall be selected with respect to the degree of plastic deformation in the material.

305 Preheating and/or post weld heat treatment shall be used when necessitated by the dimensions and material composition.

306 Post weld heat treatment (PWHT) shall normally be performed in a fully enclosed furnace. Local PWHT may be performed on simple joints when following a qualified procedure.

307 In the case of defects revealed after heat treatment, new heat treatment shall normally be performed after repair welding of the defects.

308 A heat treatment procedure associated with forming and/or welding which is not covered by the applied code or standard shall be thoroughly reviewed.

B 400 Pipe bending

401 The bending procedure shall be such that the flattening of the pipe cross section and wall thinning are within acceptable tolerances specified in the applied code and standard.

402 The heat treatment procedure in connection with pipe bending shall be independently reviewed if not covered by the applied code or standard.

C. Non-Destructive Testing (NDT)

C 100 General

101 The extent of NDT shall be in accordance with relevant codes, standards, or agreed specifications. Where the extent of NDT is not specified, Table C1 and Table C2 shall be used for guidance.

Acceptance criteria shall be according to relevant codes, standards, or other independently agreed specifications.

Table C1 Extent of NDT for welding of pressure retaining components and piping

Limitations	*Weld joint*	*Radiography* [1)]	*Magnetic particle* [2)]
P ≥ 50 t ≥ 38 T ≥ 400 $\sigma_t \geq 520$	L	100%	100%
	C	25%	25%
	B		100%

10 < P < 50 16 < t < 38 T > 150 for flammable or toxic fluids T > 220 for other fluids σ_t > 460	L	20%	20%
	C	10%	10%
	L+C	20%	
	B		100%
P ≤ 10 σ_τ ≤ 460 and flammable or toxic or compressed air	L	10%	10%
	C	5%	5%
	L+C	10%	
	B		100%

1) Ultrasonic method may be used where practicable and radiography does not give definitive results.

2) Magnetic particle method is preferred. Liquid penetrant method may be accepted as an alternative. For non magnetic materials liquid penetrant method shall be used.

P = pressure in bar

t = thickness in mm

T = temperature in °C

σ_t = ultimate tensile strength in N/mm^2

L = longitudinal

C = circumferential

L+C = crossing between longitudinal and circumferential

B = branches and reinforcement rings.

102 NDT shall be carried out by qualified operators.

103 When post weld heat treatment is required, final NDT should normally be performed after heat treatment.

104 The final NDT shall be performed prior to any possible process which would make the required NDT impossible, or which could have cause erroneous results (e.g. coating of surfaces).

105 If the NDT examination reveals a defect requiring repair, additional testing shall be carried out in accordance with the applied code or standard, unless otherwise justified.

106 All performed examination and results shall be systematically recorded and fully traceable.

107 In addition to above, magnetic particle examination (MPE) is required if the carbon equivalent for the actual material is:

$$C_{Eq} = C + \frac{MN}{6} + \frac{Cr + Mo + V}{5} + \frac{Cu + Ni}{15} > 0.45$$

The extent of MPE testing shall be 100% during initial phase of production, in order to prove absence of surface cracks.

108 NDE procedures and acceptance criteria should be according to DNV-OS-C401.

C 200 Derrick, flare booms and BOP handling

201 NDT of drilling derrick, flare booms and BOP handling equipment shall be in accordance with the relevant section of *Rules for Certification of Lifting Appliances*.

Table C2 Minimum NDT for structural welds

Category of member	*Types of connection*	*Test method*			
		Visual inspection	*Magnetic particle* [1]	*Radiography* [2]	*Ultrasonic*
Special or non-redundant	Butt weld	100%	100%	100%	-
	Cross-and T-joints, full penetration welds	100%	100%	-	100%
	Cross-and T-joints, partial penetration and fillet welds	100%	100%	-	-
Primary	Butt weld	100%	20%	20%	-
	Cross-and T-joints, full penetration welds	100%	20%	-	20%
	Cross-and T-joints, partial penetration and fillet welds	100%	20%	-	-
Secondary	Butt weld	100%	spot [3]	spot [3]	
	Cross-and T-joints, full penetration welds	100%	spot [3]		spot [3]
	Cross-and T-joints, partial penetration and fillet welds	100%	spot [3]		

1) Liquid penetrant testing to be adopted for non ferromagnetic materials.

2) May be partly or wholly replaced by ultrasonic testing upon agreement.

3) Approximately 2 to 5%

D. Testing

D 100 Testing of weld samples

101 Mechanical testing of weldments shall be carried out by competent personnel and only in accordance with DNV-OS-C401 or the applied code or standard.

D 200 Pressure testing

201 Pressure containing piping and components shall be subject to a hydrostatic pressure test in accordance with applied codes and standards.

202 The test pressure shall be determined by the working pressure. This shall be minimum 1.5 x maximum working pressure if not otherwise specified in applied codes and standards.

Guidance note:

This requirement may be waived for small bore piping for instrumentation etc. where justified and reviewed on a case-by-case basis. Aspects to consider are maximum operating pressure compared to design pressure, and experience with workmanship.

For hydraulic piping systems the test pressure need not exceed working pressure by more than 70 bar.

203 The holding time shall be minimum 15 minutes, and shall at least be sufficiently long to allow for thorough visual examination after the pressure has stabilised. A shorter holding time can be considered for very small components in accordance with recognised standards.

204 The pressure and holding time results shall be systematically recorded and documented so as to be fully traceable.

205 Where hydrostatic pressure testing of piping represents particular problems, alternative suitable test methods may be applied where justified as suitable.

D 300 Load testing

301 All lifting appliances shall be tested in "as installed" condition prior to first use.

302 The test load applied to a lifting appliance shall exceed the safe working load (SWL) of the appliance in tonnes, t, as

given in Table D1.

Table D1 Test load for lifting appliances	
SWL	*Test load*
SWL ≤ 20 t	1.25 x SWL
20 t < SWL ≤ 50 t	SWL + 5 t
> 50 t	1.1 x SWL
Man riding equipment	2 x SWL

Guidance note:

Where justified in applied recognised code or standard (e.g. API Spec 8C), drilling hoisting equipment (main hoist) that is subject to independent design and fabrication verification may be accepted without a proof load test.

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303 Manriding equipment (stabbing basket, manrider winch etc.) shall be load tested in the following manner:

1) Static brake capacity test for all brakes operating simultaneously at 2 x SWL.
2) Static brake capacity test for each individual brake at 1.8 x SWL.
3) Dynamic brake capacity test for each individual brake at 1.25 x SWL.

304 The test load shall be hoisted, slewed and luffed at slow speed through the entire operating range, as applicable for the lifting appliance in question.

305 Gantry and travelling cranes, together with their trolleys as applicable, shall be traversed and travelled over the full length of their track.

306 Tests for lifting appliances where the SWL varies with operating radius shall generally be performed with the appropriate test load at maximum, minimum and at an intermediate radius.

307 All items of loose gear and accessories, such as shackles, blocks, hooks etc. with a SWL larger than 500 kg, and that have not been subject to design review, shall be proof load tested to 200% of SWL and thoroughly examined prior to use.

308 The flare boom shall be tested with an overload of 25% related to the required weight of burner and spreader. This overload test shall demonstrate that the boom is capable of carrying out motions such as slewing, hoisting etc. as relevant.

D 400 Functional testing

401 All systems, including associated control, monitoring and safety systems shall be tested as far as possible prior to start of actual drilling operations.

Guidance note:

The objective is to prove the functionality of all systems required for safe commissioning of the drilling plant.

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402 Systems shall be function tested under working conditions in accordance with written test programs. Testing of all safety functions shall be included.

403 Tests shall as a minimum include adjustment of controllers, calibration of sensors and alarms, function and function testing of protection systems.

404 The status of tests shall be recorded in an auditable manner and a system to control status of remedial and outstanding work shall be established.

405 Blowout preventers with control system shall be tested for capacity and performance. Shear rams shall be tested to show that they will be capable of shearing the heaviest and toughest drill pipe to be used.

406 Magnets used for lifting purposes shall be tested against accidental drop of pipe by turning the power supply on or off.

E. Testing of Electrical Systems

E 100 General

101 Testing of electrical installations shall be conducted according to the relevant DNV standard for electrical systems and equipment, as applicable.

F. Testing of Control and Monitoring Systems

F 100 General

101 All control, monitoring, safety and telecommunication systems required under this standard shall be tested in accordance with a written test program.

102 Instrumentation systems and software shall be subject to documented test programs prior to installation and/or operation.

103 If practicable, testing according to 200, 300 and 400 shall be performed at the manufacturer's works.

104 The test procedures shall specify in detail how the various functions shall be tested and what is to be observed during the tests.

105 Failures shall be simulated as realistically as possible, preferably by letting the monitored parameters exceed the alarm and safety limits. Alarm and safety limits shall be checked.

106 It shall be verified that all automatic control functions are working satisfactorily during normal load changes.

F 200 Software module testing

201 Software module testing shall be according to requirements for software manufacturing described in Sec.4 G200.

F 300 Integration testing

301 Integration testing includes integration of hardware components into hardware units and integration of software modules in the same hardware unit.

302 Integration tests shall be performed with the actual software and hardware for use on board and shall include:

a) Hardware tests - hardware failures.
b) Basic software tests - basic software failures.
c) Application software tests.
d) Function tests (normal system operation, normal and abnormal process equipment performance).
e) User interface tests.

Guidance note:

Tests for a representative test system may be acceptable if the computer hardware is type approved.

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F 400 System testing

401 System testing includes the entire system, integrating all units. The tests may also include several systems.

402 System tests shall be performed with the software installed on the actual systems to be used on board, interconnected to demonstrate the functions of the systems with several units and/or the functions of several systems.

Guidance note:

Tests for a representative test system may be acceptable if the computer hardware is type approved.

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403 The tests shall include those tests which were not or could not be completed on unit level.

F 500 On-board testing

501 The tests shall include:

a) *During installation;* the correct function of individual equipment packages, together with establishment of correct parameters for alarm, control and safety (time constants, set points, etc.).

b) *During installation and sea trials*; the correct function of systems and integration of systems, including the ability of the control systems to keep any process equipment within the specified tolerances.

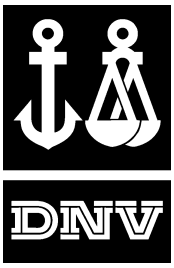
c) The correct protection and capacity of power supplies.

502 A copy of the approved test programme shall be completed with final set points and shall be kept on board the installation.

503 Hydraulic control and shutdown systems with on or off regulation shall be tested with maximum return flow in order to verify that return headers are adequately sized and free of blockages which could prevent correct system performance.

504 For pneumatic and hydraulic control systems which include accumulators to ensure fail safe operation, tests shall include verification of accumulator charge level and capacity.

505 For pneumatic and hydraulic control systems, tests shall confirm setting and function of speed control devices or restrictions used to regulate the response of actuators.



OFFSHORE STANDARD
DNV-OS-E101

DRILLING PLANT

CHAPTER 3

CERTIFICATION AND CLASSIFICATION

CONTENTS PAGE

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SECTION 1
INTRODUCTION

A. General

A 100 Organisation of Chapter 3 of the standard

101 Ch.3 is divided into 3 main sections:

Sec.1; Introduction: Explains how this standard shall be applied in connection with offshore certification and classification.

Sec.2; Documentation requirements: Identifies specific requirements to be applied when using this standard for certification or classification purposes, as well as stating corresponding documentation requirements.

Sec.3; System and equipment certification: States certification requirements for systems and equipment in certified or classified drilling plants and gives a criticality ranking of such equipment.

A 200 Introduction

201 As well as representing DNV's interpretation of safe engineering practice for general use by the offshore industry, the offshore standards also provide the technical basis for DNV classification, certification and verification services.

202 A complete description of principles, procedures, applicable class notations and technical basis for offshore classification is given by Offshore Service Specifications, see Table A1.

Table A1 Offshore Service Specifications

No.	*Title*
DNV-OSS-101	Rules for Classification of Offshore Drilling and Support Units
DNV-OSS-102	Rules for Classification of Floating Production and Storage Units

203 Classification procedures and requirements specifically applicable in relation to the technical provisions in Ch.2 are given in Ch.3 of this offshore standard.

204 DNV may accept alternative solutions found to represent an overall safety level equivalent to that stated in the requirements of this standard.

A 300 Certification and classification principles

301 Drilling plants will be certified or classified based on the following main activities:

— design verification
— fabrication survey and equipment certification
— survey during installation and commissioning.

A 400 Class designation

401 Offshore units and installations fitted with drilling plants which have been designed, constructed and installed in accordance with the requirements of this standard under the supervision of DNV will be entitled to the class notation **DRILL**.

402 DNV may accept decisions by national authorities as basis for assigning class.

A 500 Assumptions

501 Classification is based on the assumption that the drilling plant will be properly maintained and operated by qualified personnel, that operational and testing procedures are followed and that loads and environmental conditions during operation will be within the specified design limits.

502 Any deviations, exceptions and modifications to the design codes and standards given as recognised reference code shall be documented and approved by DNV.

503 Where codes and standards do not call for specific extent of critical inspection and testing, agreed testing or inspection scope between contractor or manufacturer and purchaser shall be agreed with DNV.

SECTION 2
DOCUMENTATION REQUIREMENTS

A. Documentation Requirements

A 100 General

101 For documentation requirements, see Nauticus CIBS Documentation requirements, System 1200 - "Drilling and well intervention".

102 In addition to the documentation indicated in 101, the documentation requirements of discipline specific standards referenced in this standard (see Ch.1 Sec.1 Table A1) shall be provided, avoiding duplication.

SECTION 3
SYSTEM AND EQUIPMENT CERTIFICATION

A. General

A 100 System categorisation

101 Drilling systems are categorised as *essential, important* or *non-important* systems, as stated in Ch.2 Sec.1. All essential and important systems shall fulfil the requirements of this standard or other recognised standards. Other recognised standards may only be used provided that they can be clearly shown to provide a comparable or higher level of safety for the installation, system or equipment than would have been provided under the requirements of this standard. For non-important systems, the principles of this standard may be applied in the absence of other recognised standards.

A 200 Equipment categorisation

201 DNV uses categorisation in order to clearly identify the certification and approval requirements for different equipment and components.

202 Categorisation of equipment depends on importance for safety and takes operating and environmental conditions into account. Once assigned, the category of equipment refers to the scope of activities required for DNV certification and approval, as consistent with the importance of the equipment.

203 If there are any other equipment which is not defined in the following tables, categorisation of the same shall be decided on a case by case basis with prior discussion with DNV.

204 Electrical equipment like motors, transformers, converters, etc. are not categorised here and the same shall follow requirements of the relevant DNV standard for electrical systems and equipment.

205 Equipment categorisation for offshore installations or units is as follows:

I = equipment important for safety and for which a DNV certificate is required.
II = equipment important for safety and for which a works certificate prepared by the manufacturer is accepted.

206 *Equipment category I*

For equipment category I, the following approval procedure shall be followed:

— design approval, documented by a design verification report (DVR) or type approval certificate. (see C100)
— fabrication survey, documented by issue of a product certificate.

Specific requirements:

— pre-production meeting prior to the start of fabrication
— survey during fabrication, as applicable
— witness final functional, pressure and load tests, as applicable
— review of fabrication records.

These requirements are typical and the final extent of DNV survey required, will be decided based on:

— complexity, size and previous experience of equipment type;
— manufacturer's QA/QC system,
— manufacturing survey arrangement (MSA) with DNV
— type of fabrication methods.

207 *Equipment category II*

Equipment of category II is normally acceptable on the basis of a works certificate prepared by the manufacturer. As a minimum, the certificate shall contain the following data:

— equipment specification or data sheet
— operating limitation(s) of the equipment
— statement from the manufacturer to confirm that the equipment has been constructed and manufactured according to recognised methods, codes, and standards
— test records as applicable.

Guidance note:

Independent test certificates or reports for the equipment, or approval certificate for manufacturing system, are also acceptable.

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A 300 Certification and classification principles

301 General DNV certification procedures and requirements are stated in the relevant DNV offshore service specification (see Ch.3 Sec.1 Table A1).

302 Requirements for materials and general fabrication and testing are in DNV-OS-B101 and DNV-OS-C401, respectively.

303 Additional DNV approval and certification requirements for piping are as appropriate to the categorisation stated in Table A9 and 100.

304 Categorisation of relevant systems and equipment is given in Table A1 to Table A12.

Table A1 Categories for drilling systems and equipment

Relevant text	*Material or equipment*	*DNV approval categories*	
		I	*II*
Drilling structures (CIBS 1210)			
Drilling structures	Derrick	X	
	Other design	X	
Miscellaneous	Skids and lifting brackets intended for installation lifts		X
	Skids and lifting brackets intended for regular lifts	X	

Table A2 Categories for drilling systems and equipment			
Relevant text	*Material or equipment*	*DNV approval categories*	
		I	*II*
Well control systems (CIBS 1220)			
Blowout prevention equipment	Hydraulic connectors for wellhead and riser	X	
	Ram preventers	X	
	Annular preventers	X	
	Accumulators for subsea stack	X	
	Subsea fail-safe valves in choke and kill lines	X	
	Clamp	X	
	Test stump	X	
	Valves in drillstring	X	
Blowout prevention, control equipment	Accumulators in control system	X	
	Welded pipes and manifolds 1)	X	
	Unwelded hydraulic piping		X
	Flexible control hoses		X
	Hydraulic hose reel		X
	Control pods	X	
	Acoustic BOP control equipment	X	
	Control panels	X	
Diverter unit, equipment and control equipment	Diverter house with annular valve	X	
	Diverter piping 1)	X	
	Valves in diverter piping	X	
	Control panel	X	
Choke and kill, equipment and control equipment	Choke manifold 1)	X	
	All piping to and from choke manifold 1)	X	
	Piping for choke, kill, and booster lines 1)	X	
	Flexible hoses for choke, kill, and booster lines	X	
	Valves in choke, kill, and booster lines	X	
	Unions and swivel joints	X	
	Emergency circulation pump – pressure side	X	
Marine riser, equipment and control equipment	Ball joint and flexible joint	X	
	Riser sections including joints	X	
	Support ring for riser tensioning	X	
	Telescopic joint	X	
	Accumulators	X	
	Control panel	X	

1) Certification shall cover design, manufacture, testing of the total assembly of individual piping components, see Table A9.

Table A3 Categories for drilling systems and equipment			
Relevant text	*Material or equipment*	*DNV approval categories*	
		I	*II*
Heave compensation and tensioning system (CIBS 1230)			
Heave compensation	Compensator	X	
	Hydro-pneumatic accumulators	X	
	Pressure vessels 1)	X	
	Piping including flexible hoses 2)	X	
	Air compressors		X
	Air dryers		X
	Wire ropes		X
	Sheaves	X	
	Control panel		X 3)
Tensioning system for risers and guidelines	Riser tensioners	X	
	Guidelines and podline tensioners	X	
	Hydro-pneumatic accumulators	X	
	Pressure vessels 1)	X	
	Piping 2)	X	
	Air compressors		X
	Air dryers		X
	Wire ropes for tensioning equipment		X
	Sheaves for riser tension line		X
	Sheaves for guideline and podline		X
	Telescopic arms for tension lines	X	
	Control panel		X 3)

1) See Table A10.

2) Certification shall cover design, manufacture, testing of the total assembly of individual piping components, see Table A9.

3) See Table A11

Table A4 Categories for drilling systems and equipment			
Relevant text	*Material or equipment*	*DNV approval categories*	
		I	*II*
Hoisting and rotating systems (CIBS 1240)			
Hoisting equipment in derrick	Sheaves for crown block and travelling block	X	
	Crown block including support beams	X	
	Guide track and dolly	X	
	Travelling block	X	
	Drilling hook	X	
	Swivel	X	
	Links	X	
	Elevators	X	
	Drilling line and sand line		X
	Deadline anchor	X	
	Drawworks including foundation	X	
	Cranes in derrick	X	
	Casing stabbing arrangement or board	X	
Rotating equipment	Rotary table including skid adaptor and driving unit	X	
	Kelly with kelly cock arrangement		X
	Master bushing		X
	Kelly bushing		X
	Topdrive	X	

Table A5 Categories for drilling systems and equipment			
Relevant text	*Material or equipment*	*DNV approval categories*	
		I	*II*
BOP and pipe handling (CIBS 1250)			
Pipe handling	Racking arms including possible lifting head	X	
	Manipulator arms	X	
	Guide track and dolly	X	
	Catwalk	X	
	Horizontal to vertical (HTV) equipment	X	
	Pipehandling crane	X	
	Finger board		X
	Mousehole		X
BOP handling	Blowout preventer crane or carrier or guideframe or sea fastening, etc.	X	
Miscellaneous equipment for drilling	Power tongs for pipe handling or iron roughneck		X
	Kelly spinner		X
	Power slips		X
	Single joint elevator	X	

Table A6 Categories for drilling systems and equipment			
Relevant text	*Material or equipment*	*DNV approval categories*	
		I	*II*
Bulk storage, drilling fluid circulation mixing and cementing (CIBS 1260)			
Bulk storage	Pressurised storage tanks [1]	X	X
	Piping for pressurised bulk transport [2]	X	X
Drilling fluid circulation and mixing	Piping for mixing of drilling fluid, and suction line to drilling fluid pump [2]		X
	Centrifugal pumps for mixing drilling fluid		X
	Drilling fluid pump – pressure side	X	
	Pulsation dampers	X	
	Piping for drilling fluid in the well [2]	X	
	High pressure flexible hoses	X	
	Standpipe manifold [2]	X	
	Rotary hose assembly	X	
	Kelly cocks	X	
	Non return valve in drill string	X	
	Mixing pumps		X
	Safety valves	X	
	Circulation head	X	
	Mud return pipe [2]		X
	Dump tank		X
	Shale shaker		X
	Drilling fluid tanks		X
	Trip tank		X
	Desander/desilter		X
	Degasser including piping to burners or to vents [2]	X	X
	Chemical mixers		X
	Agitators for drilling fluid		X
Cementing	Centrifugal pumps for cement mixing		X
	Piping for mixing of cement, and suction line to cement pump [2]		X
	Cement pump – pressure side	X	
	Cement manifold	X	
	Pulsation dampers	X	
	Piping for cement pump discharge	X	
	Cement hoses	X	
	Safety valves	X	

1) See Table A10.

2) Certification shall cover design, manufacture, testing of the total assembly of individual piping components, see Table A9.

Table A7 Categories for drilling systems and equipment			
Relevant text	*Material or equipment*	*DNV approval categories*	
		I	*II*
Well test systems (CIBS 1270)			
Well test systems	Pipes, flanges, valves, etc. 1)	X	
	Pressure vessels and separators 2)	X	
	High pressure pumps – pressure side	X	
	Other pumps		X
	Burners	X	
	Flare booms	X	
	Safety valves for the equipment mentioned above	X	
1) Certification shall cover design, manufacture, testing of the total assembly of individual piping components, see Table A9.			
2) See Table A10.			

Table A8 Categories for drilling systems and equipment			
Relevant text	*Material or equipment*	*DNV approval categories*	
		I	*II*
Other systems			
Winches	Winches for lifting purposes	X	
	Winches for non-lifting purposes		X
Manriding equipment	Manriding wiches, casing stabbing boards or baskets, etc.	X	
Miscellaneous	Hydraulic power units including pumps and manifolds		X
	Skids or carriers for handling of equipment	X	
	Rails for skids or rails		X
	Non-redundant gear transmission for critical applications	X	

Table A9 Categories for pipes, fitting and valves			
Relevant text	*Material or equipment*	*DNV approval categories*	
		I	*II*
Piping assembly (spools)	Thickness of wall > 25.4 mm (1 inch)	X	
	Design temperature > 400°C	X	
	Longitudinally welded pipes and all spools in category I	X	
	Piping for compressed gases where p (bar) × V (m^3) of associated pressure vessel > 1.5	X	
	Piping for systems requiring continuous operation or for which failure of piping is considered critical (e.g. main hydraulic and gas piping for heave compensation systems)	X	
	Other than those mentioned above and piping for category II systems		X
Flanges and couplings	Standard flanges and pipe couplings		X
	Non-standard flanges and pipe couplings used in category I piping systems	X	
	Flanges and pipe couplings other than those mentioned above, and flanges and couplings for category II piping system		X
Valves	Valve body of welded construction with ANSI rating > 600 lbs	X	
	Valves designed and manufactured in accordance with recognised standards		X
Components of high strength materials	Specified yield strength > 345 MPa (50 000 psi), or tensile strength > 515 MPa (75 000 psi)	X	

Table A10 Categories for pressure vessels			
Relevant text	*Material or equipment*	*DNV approval categories*	
		I	*II*
Pressure vessels for	Poisonous liquids	X	
	Liquids with flash point below 100°C	X	
	Liquids with temperature above 220°C	X	
	Compressed gases, where pressure × volume (P × V) is above 1.5, where pressure (P) is in bar and volume (V) is in m^3	X	
Other	Pressure vessels that are not included in category I		X
Cylinders	Cylinders for lifting purposes	X	
	Cylinders for non-lifting purposes		X

Table A11 Categories for control systems			
Relevant text	*Material or equipment*	*DNV approval categories*	
		I	*II*
Control systems	Systems listed in Table A2	X	
	Other systems [1]	X	X
1) Categorisation will depend on criticality of the system, i.e. whether any potential failures are considered to be critical or not.			

Table A12 Categories for workover and well intervention systems and equipment			
Relevant text	*Material or equipment*	*DNV approval categories*	
		I	II
Wire Line	Wire line unit including power pack	X	
	Subsea wire line lubricator assembly	X	
	Wire line BOP	X	
	Grease injection skid for braided line and stuffing box for slick line	X	
	Line pressure control head	X	
	Wire line winch	X	
	Skids or carriers for handling of equipment	X	
	Umbilicals for subsea controls	X	
	Downhole tools including depth and weight indicator system	X	
Coiled tubing	Subsea coiled tubing lubricator	X	
	Coiled tubing BOP	X	
	Riser	X	
	Coiled tubing reel	X	
	Injector head	X	
	Coiled tubing	X	
Snubbing equipment	Jack	X	
	Guide tubing system	X	
	Circulating swivel	X	
General system and equipment	Surface flow tree including tension frame	X	
	Workover riser (mono or dual bore)	X	
	Lifting tower and well-servicing derrick	X	
	Lifting equipment	X	
	Skids or carriers for handling of equipment	X	
	High pressure pumping facilities (cement, well stimulation fluids, nitrogen)	X	
	Hydrocarbon handling	X	
	Emergency Disconnect Package (EDP)	X	
	Lower Riser Package (LRP)	X	
	Umbilicals for subsea controls	X	
	Downhole tools including depth and weight indicator system.	X	

B. Fabrication Record

B 100 General

101 Fabrication record shall be maintained by the manufacturer in a traceable manner, so that relevant information regarding design specifications, materials, fabrication processes, inspection, heat treatment, testing, etc. can be checked.

102 Fabrication record for category I equipment shall be available for review. The following particulars shall be included, as applicable:

- manufacturer's statement of compliance
- reference to design specifications and drawings
- location of materials and indication of respective material certificates
- welding procedure specifications and qualification test records
- location of weldings indicating where the particular welding procedures have been used
- heat treatment records
- location of non-destructive testing (NDT) indicating where the particular NDT method has been used and its record
- load, pressure and functional test reports
- as-built part numbers and revisions.

C. Documentation Deliverables for Certification of Equipment

C 100 General

101 The following documentation will normally be issued by DNV for equipment and systems covered by certification activities (CMC):

a) Design verification report, (DVR)

- DVR will be issued by the design approval responsible for all equipment of category I, unless covered by a valid type approval certificate.
- In addition to each individual equipment, DVRs shall be issued for each system (including control systems) not covered by plan approval.

The DVR shall contain all information needed to be followed up by the surveyor attending fabrication survey and installa-

tion of the equipment, and as a minimum include:

— design codes and standards used for design verification
— design specification (e.g. temperature, pressure, SWL, etc.)
— follow-up comments related to e.g. testing, fabrication and installation of the equipment or system.

An approval letter may be issued instead of a DVR, however such a letter shall as a minimum contain the same information as listed above.

b) Inspection release note, (IRN)

— An IRN shall only be issued if the component is delivered prior to issuance of final product certificate (PC). A final PC shall not be issued if there are non-conformances to the equipment or system. The IRN shall be used with detailed description of the non-conformances, and shall always be replaced by a certificate when all non-conformances are closed.

c) Product certificate, (PC)

— PC should be issued for all category I equipment and systems (including control systems)
— PC will be issued upon successful completion of design verification, fabrication survey and review of final documentation. As stated above, PC can not be issued if design verification or non-conformances are outstanding.

d) Survey report

— Survey report shall be issued for all category I equipment or systems (including control systems) upon satisfactory installation, survey and testing onboard. A survey report may cover several systems or equipment installed. The survey report shall contain clear references to all DVRs and PCs on which the survey report is based, and shall state testing and survey carried out.