FOREWORD

DNV GL offshore standards contain technical requirements, principles and acceptance criteria related to classification of offshore units.

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Any comments may be sent by e-mail to rules@dnvgl.com

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CURRENT – CHANGES

This document supersedes DNVGL-OS-E403, July 2015.
Changes in this document are highlighted in red colour. However, if the changes involve a whole chapter, section or sub-section, normally only the title will be in red colour.

Main changes April 2016, entering into force 1 October 2016

• General
  — Renaming the standard from buoys to units to underline increased scope
  — Align with industry standards
  — Align with adjacent DNVGL service documents
  — Minor adjustments to scope of document
  — Further detailed certification requirements
  — Updated technical requirements.

• Ch.1 Sec.1 Introduction
  — Table 1: Included more standards
  — [4]: Moved document requirements to Ch.3.

• Ch.2 Sec.2 Materials and corrosion protection
  — [3.2]: Added reference to DNVGL RPs for corrosion protection design
  — [4.2]: Reference made to DNVGL-OS-E201 for material certification requirements
  — Table 2: Updated corrosion allowances.

• Ch.2 Sec.3 Structural strength
  — [1]: Added description on how to handle loads from connected vessel
  — [2.2]: Added more items for structural categorisation
  — [5.2]: Added references to applicable standards for slewing bearings.

• Ch.2 Sec.4 Anchoring and mooring
  — [2]: Added new paragraphs [2.3] and [2.4] for foundations and grouted connections.

• Ch.2 Sec.5 Stability and watertight integrity
  — [3.2]: Added requirement about damaged waterline.

• Ch.2 Sec.6 Piping, equipment and hoses
  — [1]: Added reference to ASME B31.4 for piping systems.

• Ch.2 Sec.10 Control systems

• Ch.3 Sec.3 Certification of materials and equipment
  — [2.1]: Added certification category IC
  — [3]: Deleted table with certification requirements and made reference to DNVGL-OS-E201.
• Ch.3 Sec.4 Survey during construction
  — Added reference to DNVGL-OS-E301.

Editorial corrections

In addition to the above stated changes, editorial corrections may have been made.
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CHAPTER 1 INTRODUCTION

SECTION 1 INTRODUCTION

1 General

1.1 Introduction

1.1.1 This standard gives criteria and guidance on design, fabrication, installation and testing of offshore loading units.

1.1.2 The standard applies to floating (e.g. buoy) or fixed (e.g. tower or template) systems intended for loading/unloading of fluid cargoes such as crude oil, petroleum gas etc. into/from ships or other units temporarily connected to the loading unit.

   Guidance note:
   Temporarily connected means connections for a limited duration and operating within defined disconnection criteria.
   ---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

1.1.3 The standard has been written for general worldwide application in benign waters. Units intended for harsh environment use shall be subject to special consideration.

Governmental regulations may include requirements in excess of the provisions of this standard depending on the size, type, location and intended service of the offshore loading unit.

   Guidance note:
   In the context of this Offshore Standard benign waters is defined as areas with significant wave height less than 8.5 m with a probability of exceedance of $10^{-2}$ (100 years return period).
   ---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

1.2 Objectives

The objectives of this standard are to:
— provide an internationally acceptable standard of safety for offshore loading units by defining minimum requirements for the design, materials, construction and commissioning of such objects
— serve as a technical reference document in contractual matters between suppliers and purchasers
— serve as a guideline for designers, suppliers, and purchasers
— specify requirements for offshore loading units subject to DNV GL certification and classification.

1.3 Organisation of the standard

This standard is divided into three main chapters:
— Ch.1: General information, scope, definitions and references.
— Ch.2: Technical provisions for offshore loading units for general application.
— Ch.3: Specific procedures and requirements applicable for certification and classification of offshore loading units in accordance with this standard.
1.4 Scope and application
The standard covers the following systems and arrangements, including relevant equipment and structures:
— arrangements
— loads and load effects
— structural strength
— anchoring and mooring
— stability and watertight integrity
— hazardous areas and ventilation
— marine machinery and piping
— electrical installation
— fluid transfer system and equipment
— instrumentation and control systems.

2 References

2.1 General

2.1.1 In case of conflict between requirements of this standard and a reference document, the requirements of this standard shall prevail.

2.1.2 For undated references, the latest edition of the referenced document (including any amendments) applies. For dated references, the edition cited applies.

2.1.3 Codes and standards other than those listed may be acceptable as alternative or supplementary requirements, provided that they can be demonstrated to achieve a comparable, or higher, safety level.

2.1.4 Any deviations, exceptions and modifications to the codes and standards shall be documented and agreed between the contractor, purchaser and verifier, as applicable.

2.2 Normative references

2.2.1 The referenced documents listed in Table 1 include provisions, which through reference in the text constitute provisions of this standard. The latest issue of the references shall be applied unless otherwise stated or agreed.

2.2.2 Alternative recognised standards may be applied provided it can be demonstrated that these meet or exceed the requirements of the standards referenced below.

2.2.3 Any deviations, exceptions and modifications made in relation to the codes and standards shall be documented and agreed between the supplier, purchaser, and verifier, as applicable.

Table 1 Normative reference documents

<table>
<thead>
<tr>
<th>Reference</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>API RP 2RD</td>
<td>Design of Risers for Floating Production Systems (FPSs) and Tension-Leg Platforms (TLPs)</td>
</tr>
<tr>
<td>API RP 17B</td>
<td>Recommended Practice for Flexible Pipe</td>
</tr>
<tr>
<td>Reference</td>
<td>Title</td>
</tr>
<tr>
<td>---------------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>API Spec 17J</td>
<td>Specification for Unbonded Flexible Pipe</td>
</tr>
<tr>
<td>API Spec 17K</td>
<td>Specification for bonded flexible pipe</td>
</tr>
<tr>
<td>API RP 1111</td>
<td>Design, Construction, Operation and Maintenance of Offshore Hydrocarbon Pipelines (Limit State Design)</td>
</tr>
<tr>
<td>ASME</td>
<td>Boiler and Pressure Vessels Code, Section VIII, Rules for Construction of Pressure Vessels</td>
</tr>
<tr>
<td>ASME B31.3</td>
<td>Process piping</td>
</tr>
<tr>
<td>ASME B31.4</td>
<td>Pipeline transportation systems for liquids and slurries</td>
</tr>
<tr>
<td>ASME B31.8</td>
<td>Gas transmission and distribution piping systems</td>
</tr>
<tr>
<td>ASME 77-DE-39</td>
<td>Design criteria to prevent core crushing failure in large diameter, case hardened, ball and roller bearings</td>
</tr>
<tr>
<td>BSI PD 5500</td>
<td>Specification for unfired fusion welded pressure vessels</td>
</tr>
<tr>
<td>DNVGL-OS-A101</td>
<td>Safety Principles and Arrangement</td>
</tr>
<tr>
<td>DNVGL-OS-B101</td>
<td>Metallic Materials</td>
</tr>
<tr>
<td>DNVGL-OS-C101</td>
<td>Design of Offshore Steel Structures, General – LRFD method</td>
</tr>
<tr>
<td>DNVGL-OS-C201</td>
<td>Structural Design of Offshore Units – WSD Method</td>
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<tr>
<td>DNVGL-OS-C301</td>
<td>Stability and Watertight Integrity</td>
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<tr>
<td>DNVGL-OS-C401</td>
<td>Fabrication and Testing of Offshore Structures</td>
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<tr>
<td>DNV-OS-C502</td>
<td>Concrete Structures</td>
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<tr>
<td>DNVGL-OS-D101</td>
<td>Marine and Machinery Systems and Equipment</td>
</tr>
<tr>
<td>DNVGL-OS-D201</td>
<td>Electrical Installations</td>
</tr>
<tr>
<td>DNVGL-OS-D202</td>
<td>Instrumentation and Telecommunication Systems</td>
</tr>
<tr>
<td>DNVGL-OS-D301</td>
<td>Fire Protection</td>
</tr>
<tr>
<td>DNVGL-OS-E201</td>
<td>Hydrocarbon Production Plant</td>
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<tr>
<td>DNVGL-OS-E301</td>
<td>Position Mooring</td>
</tr>
<tr>
<td>DNV-OS-F101</td>
<td>Submarine Pipeline Systems</td>
</tr>
<tr>
<td>DNV-OS-F201</td>
<td>Dynamic Risers</td>
</tr>
<tr>
<td>DNV-RP-B401</td>
<td>Cathodic protection design</td>
</tr>
<tr>
<td>DNVGL-RP-B101</td>
<td>Corrosion protection of floating production and storage units</td>
</tr>
<tr>
<td>DNV</td>
<td>Standard for Certification No. 2.22 Lifting Appliances</td>
</tr>
<tr>
<td>DNV</td>
<td>Rules for Flexible Risers and Pipes</td>
</tr>
<tr>
<td>EN 13445</td>
<td>Unfired Pressure Vessels</td>
</tr>
<tr>
<td>ISO 76</td>
<td>Roller bearings – static load ratings</td>
</tr>
<tr>
<td>ISO 281</td>
<td>Roller bearings – dynamic load ratings and rating life</td>
</tr>
<tr>
<td>ISO 898</td>
<td>Mechanical properties of fasteners</td>
</tr>
</tbody>
</table>
3 Definitions

3.1 Verbal forms

Table 2 Verbal forms

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>shall</td>
<td>verbal form used to indicate requirements strictly to be followed in order to conform to the document</td>
</tr>
<tr>
<td>should</td>
<td>verbal form used to indicate 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</td>
</tr>
<tr>
<td>may</td>
<td>verbal form used to indicate a course of action permissible within the limits of the document</td>
</tr>
</tbody>
</table>

3.2 Terms and definitions

Table 3 Terms and definitions

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>alarm</td>
<td>a combined optical and acoustic signal, where the acoustic part calls the attention of personnel, and the optical part serves to identify the fault</td>
</tr>
<tr>
<td>alarm systems</td>
<td>comprise the total systems for warning of abnormal conditions (including sensors, central units and panels, and devices for calling the attention of the personnel)</td>
</tr>
<tr>
<td>anchoring system</td>
<td>equipment needed for the positioning of the unit</td>
</tr>
<tr>
<td>benign waters</td>
<td>areas where the significant wave height is less than 8.5 m for a probability of exceedance of $10^{-2}$ (100 years return period)</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| buoy                             | a floating body, normally of a cylindrical shape, and fitted with mooring equipment as necessary to perform the mooring of a vessel and ensuring fluid transfer between production and/or storage unit or onshore installation and the moored vessel.  
The buoy normally consists of the following main parts:  
— hull (buoy structure) providing buoyancy and stability  
— rotating part to which the vessel is moored and allowing weathervane  
— fixed part to which the mooring lines and underbuoy pipes are connected  
— mooring system  
— riser system  
— fluid transfer system  
— auxiliary and safety systems  
— accommodation. crane and helideck (as applicable). |
| control stations                 | those spaces in which the following equipment and functions are located:  
— emergency shutdown system (ESD)  
— radio and main internal communication control  
— control of the emergency source of power. |
| emergency shelter area           | the area comprising facilities for overnight stays, simple catering, sanitary, office facilities and service spaces, as applicable |
| emergency shutdown (ESD)         | system for initiation of, either by central manual controls or automatic, shutdown of all ignition sources and oil transfers on abnormal conditions |
| equipment                        | term used in general to denote all components constituting a system such as pressure vessels, heat exchangers, atmospheric tanks, pumps, compressors, engines, turbines, piping, skids etc. |
| fluid transfer area              | the area below and above the deck of the unit that accommodates piping and equipment containing the loading fluid |
| fluid transfer system            | denotes the transfer of fluids from the terminating end of riser, at riser top, e.g. connector, a passage for fluid through the unit and up to the unit moored for loading including loading hose |
| machinery                        | general term used to denote rotating and reciprocating type of equipment |
| 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.  

**Guidance note:**  
Lowest daily mean temperature may be used as ambient temperature. |
<p>| mooring system                   | equipment needed for mooring ships or other units to the unit |
| not permanently manned units     | unit which is occasionally manned for maintenance/testing purposes during loading/unloading |
| offshore loading units           | facility needed for loading of ships or other units in the open sea from a stationary source of fluid |
| pressure containing equipment    | implies in general to equipment or its component subjected to internal and external pressure above or below atmospheric pressure |
| unmanned units                   | unit which is not manned during fluid transfer operation |</p>
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>utility area</td>
<td>area used for the equipment not handling hydrocarbons</td>
</tr>
</tbody>
</table>
| utility piping | a piping for the support systems such as:  
                   |   — starting air for combustion engines  
                   |   — cooling water  
                   |   — steam or thermal fluid heating  
                   |   — lubricating oil  
                   |   — hydraulic power supply  
                   |   — pneumatic power supply  
                   |   — fuel oil or fuel gas supply  
                   |   — helicopter fuel  
                   |   — crude oil and gas used directly from production facilities, where applicable  
                   |   — vent pipes  
                   |   — drainage. |
3.3 Abbreviations
Abbreviations as shown in Table 3 are used in this standard.

**Table 4 Abbreviations**

<table>
<thead>
<tr>
<th>Abbreviations</th>
<th>In full</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANSI</td>
<td>American National Standards Institute</td>
</tr>
<tr>
<td>API</td>
<td>American Petroleum Institute</td>
</tr>
<tr>
<td>BS</td>
<td>British Standards (issued by British Standard Institution)</td>
</tr>
<tr>
<td>DVR</td>
<td>design verification report</td>
</tr>
<tr>
<td>EN</td>
<td>Euro-norm</td>
</tr>
<tr>
<td>ESD</td>
<td>Emergency shutdown</td>
</tr>
<tr>
<td>IEC</td>
<td>International Electrotechnical Committee</td>
</tr>
<tr>
<td>IEEE</td>
<td>Institute of Electrical and Electronics Engineers</td>
</tr>
<tr>
<td>ISO</td>
<td>International Standards Organisation</td>
</tr>
<tr>
<td>LEL</td>
<td>lower explosion limit</td>
</tr>
<tr>
<td>LRFD</td>
<td>load and resistance factor design</td>
</tr>
<tr>
<td>MDT</td>
<td>minimum design temperature</td>
</tr>
<tr>
<td>MSA</td>
<td>manufacturing survey arrangement</td>
</tr>
<tr>
<td>NACE</td>
<td>National Association of Corrosion Engineers</td>
</tr>
<tr>
<td>NDE</td>
<td>non destructive examination</td>
</tr>
<tr>
<td>NFPA</td>
<td>National Fire Protection Association</td>
</tr>
<tr>
<td>OCIMF</td>
<td>Oil Companies International Marine Forum</td>
</tr>
<tr>
<td>SPM</td>
<td>Single point mooring</td>
</tr>
<tr>
<td>SWL</td>
<td>Safe working load</td>
</tr>
</tbody>
</table>

4 Design documentation
Documentation requirements are given in Ch.3:
CHAPTER 2 TECHNICAL PROVISIONS

SECTION 1 LOADING/UNLOADING FACILITIES AND ARRANGEMENTS

1 Application
The requirements in this section give design principles for systems and equipment related to safety and utility on board the unit.

2 Environment and site location

2.1 General

2.1.1 The unit shall be suitable for the environmental conditions at the site of location. The following aspects shall be taken into consideration when establishing the environmental loads, as applicable:
— motions of the unit (i.e. heave, roll, pitch, sway, surge and yaw)
— wind forces
— air and sea temperatures
— waves
— current
— loads from possible snow and ice accumulation, sea ice and icebergs
— tidal variations.

2.1.2 The applicability of the site shall be evaluated and documented with regard to bottom conditions, manoeuvring area and water depth.

2.1.3 Loading units intended for operation in cold areas shall be arranged so that water cannot be trapped in local structures or machinery exposed to the ambient temperature.

3 Arrangements

3.1 Structural arrangements

3.1.1 The structural arrangement of the unit shall be capable of preventing complete structural collapse, loss of floatability or capsizing due to malfunction, mal-operation, collision or other accidental events.

3.1.2 For hawser moorings a detachment criterion shall be established, expressing the worst environmental criterion under which the ship or offshore unit is allowed to remain attached.

Guidance note:
For practical purposes the detachment criterion should be related to the hawser tension.

3.1.3 For units provided with yoke connection or other similar systems, the system design is either to be based on environmental conditions with a return period of 100 years or the ship/unit shall be provided with a detachment system which releases when the maximum environmental criteria are exceeded.
3.2 Separation of areas

3.2.1 The unit shall be divided into main areas such as:
— fluid transfer area
— utility area
— emergency shelter area, as applicable.
Each area shall be arranged to reduce the consequences of fire and explosion.

3.2.2 The need for emergency shelter shall be evaluated for each unit. Complexity of the unit, frequency of manning, environmental limitations etc. shall be considered.

3.2.3 Emergency shelter area, when provided on the unit, shall be separated from the fluid transfer area by A 60 rated fire resisting division.

3.2.4 Where equipment for power generation and distribution, fuel tanks and fire pumps are provided, such equipment shall be located in an utility area. The area shall be enclosed by A 60 rated partitions.

3.2.5 Entrances, air inlets and openings to emergency shelter area shall normally not face the fluid transfer area.

3.3 Safety provisions

3.3.1 Requirements for rescue and evacuation means shall be in compliance with relevant National Authority requirements in the area where the unit will be located.
Unless governed by national requirements, the following shall be provided:
— obstruction lights
— fog signal
— radar reflector
— fire fighting equipment
— identification marks
— lifesaving appliances.

Guidance note:
For range for light and horn, refer to IALA recommendation O-139 “The marking of Man-Made Offshore Structures”

3.3.2 Areas that can be manned shall be provided with an escape route. The escape route shall facilitate escape from all enclosed areas and work stations and shall lead to boat landing and helicopter deck, as applicable.

3.3.3 Escape routes shall be clearly marked.

3.4 Equipment and piping

3.4.1 All equipment and parts which shall be operated or subject to inspection and maintenance on board shall be installed and arranged for easy access.

3.4.2 Efficient control apparatus, guards, shields and other means of protecting the personnel shall be incorporated, where necessary.
3.4.3 Where flammable fluids may leak and accumulate, adequate spill collection and drain discharge shall be arranged.

3.4.4 Drain systems for non hazardous and hazardous areas shall be kept separated from each other. For hazardous area classification, ref Sec.7.

3.4.5 Piping containing flammable gases or liquids shall not pass through emergency shelters and control stations.

3.5 Precautions against fire
The requirements in DNVGL-OS-D301 Ch.2 Sec.8 and DNVGL-OS-D101 Ch.2 Sec.1 [1] shall be complied with, as applicable. Ref. also Sec.9.

4 Marking and warning signboards

4.1 General

4.1.1 Markings and signboards shall be placed at visible locations.

4.1.2 Warning signs shall be displaced at locations and on machinery when the inadvertent use is dangerous to the safety.

5 Fluid transfer systems

5.1 General

5.1.1 Design limits, i.e. maximum and minimum allowable conditions for a component, shall take into account the effects of operational conditions such as start up, change over, run down, hydrate formation, water hammer, and slugs.

5.1.2 When it is essential for the safety that the function of a component is maintained for a specific period of time in the event of fire, the qualifying properties shall be verified.

6 Equipment design

6.1 General

Equipment or components which shall be lifted for installation, maintenance etc. shall be provided with properly designed lifting attachment, e.g. lifting lugs.

6.2 Loads
Any part of the equipment shall be designed for the most un-favourable load condition. For each loading condition, and for each component or cross section to be considered, the most un-favourable combination, position and direction of forces, which may act simultaneously shall be used in the analysis.
6.3 Design pressure and temperature
The lowest and highest design temperature at the corresponding maximum design pressure shall be specified with adequate margins to cover uncertainties in the prediction. Both internal and external conditions shall be considered.
SECTION 2 MATERIALS AND CORROSION PROTECTION

1 Objective
This section provides requirements for materials and corrosion protection applicable to offshore loading units.

2 Principles
2.1 General

2.1.1 Selection of materials shall be based on type and level of stresses, temperatures, corrosive and erosive conditions, consequences and possibilities of failure associated with installation, operation and maintenance.

2.1.2 The materials selected shall be suitable for the purpose and have adequate properties of strength and ductility. Materials incorporated in any portion of a system or structure which are critical to the integrity and safety shall have good weldability properties for manufacture and installation, if welding shall be performed. Materials shall be corrosion resistant or protected against corrosion where this is deemed necessary.

2.1.3 Non-combustible materials shall be used. Where any required property does not permit the use of such material, alternative materials may be used subject to agreement between contracting parties.

2.1.4 For selection of acceptable materials suitable for H₂S contaminated products (sour service), see ANSI/NACE MR0175.

3 Specific requirements
3.1 Structural materials

3.1.1 Material specifications shall be established for all structural materials. Such materials shall be suitable for their intended purpose and have adequate properties in all relevant design conditions. Material selection shall be undertaken in accordance with the principles given in DNVGL OS C201 Ch.2 Sec.3.

3.1.2 Structural materials shall comply with the requirements given in DNVGL OS B101.

3.2 Corrosion protection of structures
Corrosion protection of the structure shall comply with DNVGL-OS-C201 Ch.2 Sec.9. Refer also DNV-RP-B101 and DNV-RP-B401.

3.3 Materials for pressure vessels, piping and equipment
Materials for equipment and piping shall be in accordance with the requirements given by the referred recognised codes.

3.4 Bolts and nuts

3.4.1 Bolts and nuts considered as essential for structural and operational safety shall conform to a recognised standard, e.g. ISO 898.
3.4.2 For general service, the specified tensile properties shall not exceed ISO 898 property class 10.9 when the installation is in atmospheric environment. For equipment submerged in seawater, the tensile properties shall not exceed property class 8.8 or equivalent.

Guidance note:
For bolted joints to be part of equipment designed for sulphide stress cracking service, lower tensile properties than for 8.8 class may be necessary in order to comply with ANSI/NACE MR0175.

---end---of---guidance---note---

3.5 Sealing materials and polymers
The materials to be 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.

4 Material certificates

4.1 General
All materials for structural application and pressure containing components shall be furnished with documentation stating process of manufacture and heat treatment (metallic materials) together with results of relevant properties obtained through appropriate tests carried out in accordance with recognised standards.

Guidance note:
The following mechanical properties should normally be tested and recorded on a material certificate:
— ultimate tensile strength and yield strength
— elongation and reduction of area
— Charpy V-notch impact toughness
— hardness, where applicable e.g. for sour service
— through thickness properties, where applicable.

---end---of---guidance---note---

4.2 Type of document

4.2.1 Material certificate types shall be as given in Table 1.

Table 1 Material certification

<table>
<thead>
<tr>
<th>Certification process</th>
<th>EN 10204</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test report</td>
<td></td>
</tr>
<tr>
<td>Confirmation by the manufacturer that the supplied products fulfil the purchase specification, and test data from regular production, not necessarily from products supplied</td>
<td>2.2</td>
</tr>
<tr>
<td>Work certificate</td>
<td></td>
</tr>
<tr>
<td>Test results of all specified tests from samples taken from the products supplied. Inspection and tests witnessed and signed by QA department</td>
<td>3.1</td>
</tr>
<tr>
<td>Test certificate</td>
<td></td>
</tr>
<tr>
<td>As work certificate, inspection and tests witnessed and signed by an independent third party body</td>
<td>3.2\textsuperscript{1)}</td>
</tr>
</tbody>
</table>

\textsuperscript{1)} Equivalent to an NV certificate when validated by a surveyor.
5 Corrosion protection of systems and equipment

5.1 General

5.1.1 Equipment and piping shall be corrosion resistant or protected against corrosion where considered necessary for safety or operational reasons.

Guidance note:
Unprotected carbon steel and stainless steel materials should not be used for seawater service except for high molybdenum stainless steel or equivalent.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.1.2 Corrosion allowance of low alloy carbon steel shall be dependent on corrosivity of commodity, lifetime of equipment and corrosion control method used.

Guidance note:
Corrosion allowance in Table 2 is given as guidance.

Table 2 Corrosion allowance “c” for steel materials

<table>
<thead>
<tr>
<th>Service 1) 2)</th>
<th>c (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superheated steam</td>
<td>0.3</td>
</tr>
<tr>
<td>Saturated steam</td>
<td>0.8</td>
</tr>
<tr>
<td>Steam coils</td>
<td>2.0</td>
</tr>
<tr>
<td>Feed water for boilers in open circuit systems</td>
<td>1.5</td>
</tr>
<tr>
<td>Feed water for boilers in closed circuit systems</td>
<td>0.5</td>
</tr>
<tr>
<td>Blowdown pipes for boilers 3)</td>
<td>1.5</td>
</tr>
<tr>
<td>Compressed air</td>
<td>1.0</td>
</tr>
<tr>
<td>Hydraulic oil</td>
<td>0.3</td>
</tr>
<tr>
<td>Lubricating oil</td>
<td>0.3</td>
</tr>
<tr>
<td>Fuel oil</td>
<td>1.0</td>
</tr>
<tr>
<td>LPG</td>
<td>0.3</td>
</tr>
<tr>
<td>Refrigerants</td>
<td>0.3</td>
</tr>
<tr>
<td>Fresh water</td>
<td>0.8</td>
</tr>
<tr>
<td>Hydrocarbon service</td>
<td>2.0</td>
</tr>
<tr>
<td>Mud or cement</td>
<td>3.0</td>
</tr>
<tr>
<td>Hull structure</td>
<td>See note 4)</td>
</tr>
</tbody>
</table>
5.1.3 Dissimilar metallic materials in contact shall be avoided or adequately protected against galvanic corrosion.

5.1.4 External steel surfaces exposed to the marine atmosphere and splash zone shall be protected by coating. Special metallic materials may be used.

5.1.5 Steel components submerged in seawater shall be externally protected by cathodic protection or a combination of cathodic protection and coating.

5.1.6 Internal corrosion control shall be used if the commodity contains water or has a relative humidity of more than 50% and if the partial pressure of corrosive gases is above the following limits:
   — oxygen: 100 Pa
   — hydrogen sulphide: 10 kPa
   — carbon dioxide: 20 kPa.

Increased corrosivity due to combination of gases shall be considered.

5.1.7 Inhibitors shall be selected when relevant to suit the actual internal environment.

5.1.8 Corrosion monitoring shall be used where considered necessary.

<table>
<thead>
<tr>
<th>Service</th>
<th>( c \ (mm) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) An additional allowance for external corrosion shall be considered according to the figures given in the table, depending on the external medium.</td>
<td></td>
</tr>
<tr>
<td>2) Where efficient protective methods against corrosion are used, the corrosion allowance may be reduced up to 50%.</td>
<td></td>
</tr>
<tr>
<td>3) For pipes passing through tanks, an additional allowance for external corrosion shall be considered according to the figures given in the table, depending on the external medium.</td>
<td></td>
</tr>
<tr>
<td>4) Loading units that are not intended for dry docking at 5 year intervals should have corrosion allowance. Recommended allowance is 2 mm on wet surfaces and 4 mm in the splash zone. For loading buoys the splash zone is defined as +/- 1 meter relative to the water line. For other types of units, the vertical extent of splash zone is defined in DNVGL-OS-C101 Ch.2 Sec.9 [2.2].</td>
<td></td>
</tr>
</tbody>
</table>
SECTION 3 STRUCTURAL STRENGTH

1 General

1.1 Application

1.1.1 Special aspects for structural design of offshore loading units are given in this section.

1.1.2 General requirements and guidance for structural design by use of working stress method are given in DNVGL-OS-C201. Loads from connected vessel are considered as functional loads.

Guidance note:
For unmanned units the allowable usage factor may be taken as 0.67 in loading condition a)

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

1.1.3 Offshore loading units may also be designed according to the LRFD (load and resistance factor design) method. General requirements and guidance for structural design by use of LRFD method are given in DNVGL-OS-C101.

2 Materials and structural categorisation

2.1 Materials

2.1.1 General principles and requirements for materials are given in DNVGL-OS-B101. Selection of steel grades are given in DNVGL-OS-C201 Ch.2 Sec.3.

2.1.2 Concrete constituents and reinforcements shall comply with DNV-OS-C502.

2.2 Structural categorisation

2.2.1 The following elements are normally categorised as special structural elements:
— intersection which incorporates novel construction
— complex padeyes
— external brackets. portion of bulkheads, flats and frames which are designed to receive concentrated loads at major intersections
— highly stressed elements of anchor line attachments
— chain stopper support
— main connection points for soft yoke systems.

2.2.2 The following elements are normally categorised as primary structural elements:
— external hull not classified as special
— turntable construction
— bearing support structure
— riser support structure
— yoke construction
— hawser connections
— padeyes and lifting brackets not classified as special
— main support structure for helideck, lifeboat platforms and other important equipment.
2.2.3 The following elements are normally categorised as secondary structural elements:
— bulkheads, stiffeners, flats or decks not categorized as special or primary
— plating of stiffeners of helideck, lifeboat platforms, fenders not taking part in global strength, walkways, etc.

3 Design loads

3.1 General

3.1.1 Applicable load categories and load categories and load combinations relevant for offshore loading units are given in this sub-section.

3.1.2 General definition and specification of load categories is given in DNVGL-OS-C201 Ch.2 Sec.2.

3.2 Functional loads

3.2.1 Functional loads are defined in DNVGL-OS-C201 Ch.2 Sec.2 [4].

3.2.2 Functional loads on decks should normally not be less than the values given in DNVGL-OS-C201 Ch.2 Sec.2 Table 3.

3.3 Environmental loads

3.3.1 Environmental loads are defined in DNVGL-OS-C201 Ch.2 Sec.2.

3.3.2 Variation in hydrostatic pressure and buoyancy on members caused by changes in the water level due to waves and tides shall be regarded as environmental loads.

3.3.3 Loading buoys shall be designed for hydrostatic pressure equivalent to minimum 1 m submerged.

Guidance note:
For buoys installed in waters not considered benign, the design loads should be specially considered.

3.3.4 The local environmental pressure due to waves shall not be taken less than 10 kN/m².

3.4 Accidental loads

3.4.1 Accidental loads are defined in DNVGL-OS-C201 Ch.2 Sec.2 [7].

3.4.2 Any one compartment adjacent to sea shall be assumed flooded.

4 Loading conditions

4.1 General

Relevant loading conditions by use of the working stress method are given in DNVGL-OS-C201 Ch.2 Sec.2 [2].
4.2 Load cases

4.2.1 Operational limitations characterised by the environmental conditions under which the moored ship or unit will remain attached to the loading unit shall be established.

4.2.2 The maximum environmental forces acting on the unit shall be determined based on likely directions for wind, current and waves.

4.2.3 Relevant design conditions are given in Table 1.

The loading conditions are defined as follows:

a) functional loads including tanker mooring loads
b) maximum environmental loads and associated functional loads
c) accidental loads and associated functional loads
d) annual most probable value of environmental loads and associated functional loads after credible failures, or after accidental events.

Table 1 Relevant design conditions

<table>
<thead>
<tr>
<th>Design condition</th>
<th>Loading condition</th>
<th>a)</th>
<th>b)</th>
<th>c)</th>
<th>d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal operation</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Construction</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transportation</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Installation</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Retrieval</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modification</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

1) Design in loading condition a) or b) of the unit includes the moored ship/unit connected or disconnected depending on the service limitations, see Table 2.
2) The structure shall be able to resist expected fatigue loads which may occur during operating design conditions.
3) Design against loading conditions c) and d) and fatigue may normally be omitted for design condition, construction, transportation, installation and modification, provided adequate measures are taken to prevent, avoid or control such situations.
4) Temporary condition is normally not part of classification.

Table 2 Environmental loading

<table>
<thead>
<tr>
<th>Tanker disconnected, loading condition b)</th>
<th>Tanker connected, loading condition a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survival condition, ref. DNVGL-OS-C201 Ch.2 Sec.2 [5]</td>
<td>Limiting environmental conditions under which the ship/unit will remain attached</td>
</tr>
</tbody>
</table>
4.2.4 Basic usage factors for the relevant design conditions are given in table 3.

**Table 3 Basic usage factors**

<table>
<thead>
<tr>
<th>Loading conditions</th>
<th>a)</th>
<th>b)</th>
<th>c)</th>
<th>d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\eta_0$</td>
<td>0.60</td>
<td>0.80$^{1)}$</td>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

1) For units unmanned during extreme environmental conditions, the usage factor $\eta_0$ may be taken as 0.84 for loading conditions b)
5 Local strength

5.1 General

5.1.1 Scantlings shall be checked against the maximum local forces superimposed on the overall forces.

5.1.2 Scantlings of plates, stiffeners and girders shall comply with the requirements given in DNVGL-OS-C201 Ch.2 Sec.5. Requirements to weld connections are given in DNVGL-OS-C201 Ch.2 Sec.8.

5.2 Slewing bearings

5.2.1 The slewing bearing and support structure shall be of sufficient stiffness to prevent harmful deflections. Design to be carried out according to the following codes:

— ASME 77-DE-39 “Design criteria to prevent core crushing failure in large diameter, case hardened, ball and roller bearings”
— ISO 76 “Roller bearings – static load ratings”
— ISO 281 “Roller bearings – dynamic load ratings and rating life”.

5.2.2 Requirements for materials and fabrication of slewing bearings are given in DNV Standard for Certification No. 2.22 Lifting Appliances.

5.2.3 For slewing bearings of ball and roller type, the following aspects shall be considered:

— plastic deformation of rolling elements and raceways (raceway capacities)
— fatigue of critical local sections of outer and inner rings
— fatigue of bolts
— yield limit load (capacity) of the slewing bearing as a whole, based on the capacities of bolts and ring cross sections with due regard to the rigidity of the structures supporting the (fixed and the revolving) rings.

5.2.4 Yield limit load (capacity) of the slewing bearing shall be evaluated considering equilibrium between the rolling element forces and the following reactions acting on an element of the ring:

— bolt forces acting on the considered element, possible shear included
— possible interface pressure between the considered element and the structure supporting the ring
— forces acting in the cross section of the ring (i.e. on the end surfaces of the considered element).

5.2.5 The safety factors for slewing rings shall not be less than:

— 1.7 (i.e. ratio between ultimate carrying capacity (ring and bolts) and calculated load on the slewing ring).
— 1.5 against fatigue referred to stresses (90% probability) applying a load spectrum factor of 0.7.

5.2.6 Bolt material having yield strength exceeding 900 N/mm² (10.9 ISO strength class) shall only be used after special consideration and agreement between contracting parties.

5.2.7 Slewing ring fasteners shall be pre-stressed according to a written procedure. The degree of permanent pre-stressing shall be as high as possible without producing yield in bolt material during pre-stressing. The degree of permanent pre-stressing shall at least be 65%, but normally not more than 80% of bolt material yield strength.
5.2.8 The holding down bolts shall, as far as practical, be equally spaced over the 360° circumference.

5.3 Universal joints

5.3.1 Universal joints used for connection to the ship or offshore unit shall be checked against the maximum load amplitudes as given in [4].

5.3.2 Fatigue strength shall normally be checked against estimated stress history or acceptable simplified methods. Bearing bolts shall be pre-tensioned to reduce altering loads.

5.3.3 Materials shall be in accordance with Sec.2.

5.3.4 Bearing surfaces shall be of non corrosive material.

5.3.5 For sealed bearings, lubricating and seals shall be arranged so that penetration of seawater and impurities is prevented.
SECTION 4 ANCHORING AND MOORING

1 Anchoring

1.1 General
Requirements for anchoring systems are given in DNVGL-OS-E301.

1.2 Special provision for loading units

1.2.1 For installations equipped with hawser load monitoring and hose and hawser Quick Disconnect systems the Safety Factors given in DNVGL-OS-E301 for intact condition may be reduced by 10%.

1.2.2 Damage to the under buoy hoses may be accepted in survival condition provided the damage is limited to the hoses only and the damage of the hoses will not result in pollution. The owner/operator of the installation shall agree to such a design.

1.2.3 Design based on “Intact condition” only may be acceptable provided the factors given in DNVGL-OS-E301 for intact condition is increased by a factor of 1.2 and a anchor line failure will not result in a major pollution or major damage to the unit.

1.3 Anchors
The conditions of the seabed, based on site investigations, shall be taken into account in the selection of anchor type, see DNVGL-OS-E301.

1.4 Anchor lines
Anchor lines may consist of chain cable, steel wire, fibre ropes or combination of these.

2 Mooring

2.1 Mooring hawsers

2.1.1 Mooring hawser(s) and equipment shall be designed with a safety factor of 1.5 of the rated static breaking strength.

2.1.2 The mooring hawser(s) and equipment shall not cause incompatibility between the unit and the moored ship/unit.

2.1.3 For single mooring hawser systems, the hawser shall be designed with a safety factor of 3.0 on the rated static breaking strength.

2.1.4 For double separated mooring hawser systems, each individual hawser shall be designed for the total maximum mooring load with a safety factor of 1.5 of the rated static breaking strength.

2.1.5 Mooring hawsers and associated equipment shall be designed, fabricated, tested and installed in accordance with the requirements of a recognised standard, e.g.:
— OCIMF Guidelines for the Purchasing and Testing of SPM Hawsers
— OCIMF Recommendations for Equipment Employed in the Mooring of Ships at Single Point Moorings
2.1.6 The mooring hawser strong point on the unit shall be designed for a load equivalent to the mooring hawser MBL. The resulting stress shall not exceed the yield stress of the material. Local peak stresses may exceed the allowable stress with a factor of 1.3 when the mesh size is $2t \times 2t$, where $t = $ plate thickness.

2.2 Compensators
Compensators based on steel springs, hydraulic/ pneumatic spring systems, etc. may be used provided they are safely designed.

Guidance note:
Normally the chafe chain shall be the weak link.

2.3 Foundations
Foundations shall be designed according to DNVGL-OS-C101.

2.4 Grouted connections
Grouted connections shall be designed according to DNV-OS-J101.
SECTION 5 STABILITY AND WATERTIGHT INTEGRITY

1 General

1.1 Application
The requirements in this section apply to units intended for loading/unloading of fluid cargoes.

1.2 Draft marks
Anchored offshore units shall have draft marks applied visibly on the outside of the hull indicating maximum permissible draft.

2 Intact stability

2.1 General
The intact stability criteria to be taken into account shall be as follows:
— the met centric height shall be positive
— the area under the righting moment curve to the second intercept, or a lesser angle, shall not be taken less than 40% in excess of the area under the heeling moment.

Guidance note:
This requirement is not applicable for CALM buoys.

2.2 Stability calculations
2.2.1 Intact stability calculations shall be carried out in accordance with principles given in DNVGL-OS-C301 as applied for deep-draught units.

2.2.2 The stability shall be calculated in a disconnected mode corresponding to environmental condition with return a period of 100 years.

2.2.3 It shall be verified that loss of single anchor line provides sufficient stability.

3 Damage stability

3.1 General
Provisions shall be made to avoid progressive flooding after flooding of at least one compartment. The unit shall remain afloat without causing damage to the fluid and utility systems. Evacuation of personnel shall be possible in this condition. Damaged water line to be below any flooding points (deck preferably emerged).

3.2 Exposed collision zones
Exposed collision zones are those portions of the structure subjected to accidental flooding due to collision with the ship/unit that is normally moored to the unit. The collision exposed zones shall normally be taken according to DNVGL-OS-C301 Ch.1 Sec.1 [4].
SECTION 6 PIPING, EQUIPMENT AND HOSES

1 General
The fluid transfer piping system shall be in accordance with DNVGL-OS-E201.

Guidance note:
ASME B31.4 may be applied as design code for the piping system by agreement

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2 Mechanical equipment

2.1 Bilge and sounding systems

2.1.1 Units shall be provided with means for pumping from and draining any watertight compartment. Pumping by means of a portable pump may be accepted.

2.1.2 Watertight compartments shall have provisions for sounding.

2.2 Pipe swivel

2.2.1 The pipe swivel shall normally satisfy all the requirements applicable for the comprising piping systems.

2.2.2 Where applicable, the pipe swivel shall be designed for external forces, e.g. forces on combined pipe swivel and rotation bearing of unit, mooring forces etc.

2.2.3 For pressure and leak proof testing of the pipe swivel, see Sec.11.

2.3 Lifting equipment

2.3.1 Structural and mechanical components for lifting equipment shall comply with recognised standards, e.g. DNV Standard for Certification No. 2.22 Lifting Appliances.

2.3.2 Individual components such as sheaves, hooks, shackles, wire slings, permanent attachments, etc. shall be marked with the maximum permissible working load (SWL).

3 Floating hoses

3.1 General

3.1.1 The dimensions and the type of reinforcement for floating hoses shall be determined from strength analysis of the hose system taking into account design pressure differential, fluid flow, weight of hose with contents, buoyancy forces, wave forces, accelerations and relative motions.

3.1.2 The longitudinal strength requirements shall normally be based on the assumption that the hose acts as a cable, disregarding possible effect of bending moments on the equilibrium configuration. In areas of maximum curvature, special reinforcement or support arrangements may be required to restrict the curvature.
3.1.3 The length of the loading hose shall be determined in accordance with response analysis in order to prevent overstressing or extension beyond its presumed operational configuration.

3.1.4 The hose shall be properly arranged with respect to support and configuration during loading as well as when the terminal is unoccupied in order to restrict the curvature and to reduce change of curvature and thereby fatigue effects. The loading hose shall also be properly protected against fouling and mechanical damage.

3.1.5 The ship/unit end of the hose shall be provided with suitable means for closure.

3.1.6 The floating hose shall be provided with a weak link.

3.1.7 For floating hoses, depending on buoyancy elements, the floatation media, added as either individual floats or integral floatation, shall be considered with regard to toughness, flexibility and low water absorption. The attachment points for individual floats shall be designed for suitable transition of point loads.

Guidance note:
Normally hoses complying with “Guide to Purchasing, Manufacturing & Testing of Loading & Discharge Hoses for Offshore Moorings” issued by Oil Companies International Marine Forum (OCIMF). will be acceptable.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4 Underbuoy hoses and pipes

4.1 General

4.1.1 Underbuoy hoses and associated components shall be designed, fabricated, tested and installed in accordance with the requirements of a recognised standard, e.g.:

For rigid underbuoy pipe systems:
— DNV-OS-F101
— DNV-OS-F201
— API RP 2RD
— API RP 1111

For non-bonded flexible underbuoy pipe systems:
— DNV rules for flexible risers and pipes
— API Spec 17J
— API RP 17B

For bonded flexible underbuoy pipe systems:
— OCIMF Guide to Purchasing, Manufacturing and Testing of Loading and Discharge Hoses for Offshore Moorings within 100 m water depth
— API Spec 17K
4.1.2 Dynamic analyses shall be performed (fully or partially coupled) with sensitivity to water depth, fluid densities and combinations of environmental conditions (directions). The extreme tension, shear force, curvature along the hose strings shall be assessed in operating and survival conditions, with tanker connected and not connected.

The fatigue life of the underbuoy hoses shall be assessed.

Interference with seabed or anchor lines that may damage the hoses is normally not permitted, see Sec. 4 [1.2.2].

Guidance note:

Floating and underbuoy hoses may be considered as consumable items with expected service life shorter than the design life of the installation. See also OCIMF “Single Point Mooring Maintenance and Operations guide 3rd edition”.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---
SECTION 7 HAZARDOUS AREA AND VENTILATION

1 General

1.1 Application

1.1.1 The provisions of this section are intended to avoid ignition of potential flammable releases that may occur on the unit during normal operation. Release as a result of accidental events is not addressed by area classification, but shall be covered by emergency measures.

1.1.2 All offshore loading units shall be subjected to hazardous area classification assessment.

1.1.3 General requirements for hazardous area classification are given in DNVGL-OS-A101.

2 Specific requirements

2.1 General

2.1.1 Flanges and fittings in the fluid transfer system shall be regarded as secondary grade source of release.

2.1.2 Swivel, loading hose connectors and ventilation outlets may be regarded as either primary or secondary source of release depending on frequency of operation and operational experience.

2.2 Enclosed areas

2.2.1 An enclosed area adjacent to hazardous areas containing no source of release may be classified non-hazardous provided gastight doors/hatches are installed.

2.2.2 Emergency shelter may be accepted without mechanical ventilation provided adequate louvers or similar arrangements are installed.
SECTION 8 ELECTRICAL INSTALLATIONS

1 General
Electrical installations shall comply with DNVGL-OS-D201, as applicable.
Other codes and standards such as IEEE, NFPA, IEC, BS or similar may be applied upon consideration in each case.
SECTION 9 FIRE SAFETY

1 General

1.1 Application

1.1.1 Fire protection, detection and extinction shall be according to DNVGL-OS-D301, as applicable.

1.1.2 Attention shall be given to any statutory requirements of the National Authority having jurisdiction in the waters where the unit is located.

2 Specific requirements for offshore loading units

2.1 General

2.1.1 The arrangement of fire control and extinguishing shall be adequate for the unit during its intended operation. Compensating procedures and measures, e.g. standby vessel with fire fighting equipment during manned periods shall be credited.

2.1.2 All fire-extinguishing appliances shall be kept in good order and shall be available for immediate use.

2.2 Unmanned units

An unmanned unit does not require permanent arrangement for fire control and extinction.

Guidance note:
Examples are simple buoys without helicopter deck, boat-landing or working platforms.

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2.3 Not permanently manned units

2.3.1 A unit that may be manned for maintenance or testing purposes shall be equipped with fire control and fire extinction systems, including:
— approved portable fire extinguishers shall be provided in service and working spaces
— emergency shelter and other enclosed areas, e.g. for machinery
— electrical power generation and distribution shall be arranged with a fixed fire extinguishing system as outlined in DNVGL-OS-D301
— provision for helicopter facilities.

2.3.2 Helicopter facilities shall in principle comply with the requirements in DNVGL-OS-D301 Sec.5. For installations where adequate arrangement of fire control and fire extinction for the unit is achieved without the provision of a fire pump, fixed dry powder system of capacity 250 kg is at least to be installed.
SECTION 10 CONTROL SYSTEMS

1 General

1.1 Application

1.1.1 The requirements in this section covers the following aspects:
— control of fluid transfer
— communication
— gas detection system, where applicable
— alarm, where applicable.

1.1.2 Control, monitoring and shutdown functions shall to be according to DNVGL-OS-E201, as applicable.

2 Basic requirements

2.1 Control of fluid transfer

2.1.1 The loading system shall be provided with fluid transfer monitoring display either at a local or central control station.

2.1.2 The control system shall be designed so that pumps can not be operated until specific valves are opened and the connection to the loading ship/unit has been successfully completed. The pumps shall stop immediately upon commencement of an emergency disconnection procedure.

Guidance note:
This paragraph is relating to the overall operational system philosophy and may extend beyond the scope of the buoy/unit vendor.

2.1.3 Pressure sensors shall be located at suitable positions to secure loading pump shut down if the line pressure exceeds the maximum allowable pressure by a preset amount or drops below a preset minimum value.

Guidance note:
Pressure sensors that are installed on board the ship/unit’s loading pumps may be accepted.

2.1.4 Interlocks shall be provided to ensure that:
— main control valves can not be opened unless the hose end coupling is connected to the mating flange on the vessel
— outboard and inboard valves adjacent to the coupling are closed before the coupling can be released.

Guidance note:
Operational procedures may replace physical interlocks.

2.1.5 Pressure relief, depressurising and disposal systems are to be according to DNVGL-OS-E201, as relevant.
2.2 Communication

2.2.1 A two way communication system on the unit and a continuously manned control station on a neighbouring installation or a stand by vessel shall be provided whenever the unit is manned.

2.2.2 In order to ensure reliable communication, equipment duplication is required.

2.2.3 The communication may be arranged by portable or permanent equipment on the unit or combination thereof.

2.2.4 A two way communication between the control station in command of loading operation and the ship/unit shall be established before connecting to the loading unit. The communication shall be maintained during loading.

3 Gas detection system

3.1 General

3.1.1 Units that may be manned for maintenance/testing purposes shall be monitored for flammable gas. Monitoring may be performed by a permanently installed system or portable equipment. Upon entering the unit, all areas shall be checked for flammable gas.

3.1.2 The gas detection system shall give audible alarm when a concentration of 25% of lower explosion limit (LEL) for hydrocarbon gas is reached.

3.1.3 Where a permanently installed system is provided, automatic shutdown of the installation shall take place when 60% LEL is reached, or gas is detected in or at an non hazardous area.

4 Alarm system

4.1 General

4.1.1 Units with enclosed areas or otherwise arranged such that personnel onboard cannot be readily aware of a dangerous situation shall be equipped with a suitable alarm system.

4.1.2 The alarm system shall be connected to an emergency source of power.

4.1.3 Areas protected by gas extinguishing systems, shall be provided with alarm inside the area before discharge.

4.1.4 Emergency shelter areas shall be equipped with smoke detectors releasing audible alarm in case of fire.

5 Telemetry system

Telemetry system shall be designed according to DNVGL-OS-D202 as applicable.
SECTION 11 MANUFACTURE AND COMMISSIONING

1 General

1.1 Application

1.1.1 This section provides requirements for:
— fabrication of unit structure
— manufacture of equipment
— Yard commissioning
— installation and in-place commissioning.

1.1.2 The fabrication and testing of structures shall comply with DNVGL-OS-C401.

1.1.3 The manufacture, installation and testing of components and equipment systems, e.g. pressure vessels, piping, machinery on skids, shall comply with DNVGL-OS-E201.

2 Manufacture of equipment and piping

2.1 Pipe swivel
The pipe swivel assembly shall be hydrostatically shop tested as follows:

a) Test procedure as given by the design code.

b) At design pressure with no leakage and with rotations as below:
   — two complete revolutions in each direction at a rate of approximately ten minutes per revolution.
   — four complete revolutions: The first revolution shall be clockwise and the final anti-clockwise. Each rotation shall be in stages of 30 degrees at a rate of approximately one degree per second with a 30 second degrees rotation. The breakaway torque and the rotating torque shall be recorded. Where the fluid assembly swivel rotates in unison with the mooring swivel, concentricity of the fluid and mooring swivel shall be demonstrated.

2.2 Torsional seals
Hydrostatic pressure testing shall be conducted to 1.5 times the design pressure.

3 Yard commissioning

3.1 General
Commissioning to be performed according to agreed procedures.

4 Installation and in-place commissioning

4.1 Installation
Installation to be performed according to agreed procedures.
Testing procedure for anchors shall be according to DNVGL-OS-E301.
4.2 In-place commissioning
All systems shall be tested according to written procedures.
CHAPTER 3 CERTIFICATION AND CLASSIFICATION

SECTION 1 CERTIFICATION AND CLASSIFICATION

1 General

1.1 Introduction
As well as representing DNV GL’s recommendations of good engineering practice for general use by the offshore industry, the offshore standards also provide the technical basis for DNV GL classification, certification and verification services.

1.2 Definitions
Client: The applicant for the certificate who may be either the yard, the owner, or with regard to components, the manufacturer.

2 Certification

2.1 General

2.1.1 Upon request from a Client, a certificate to a unit may be issued for a complete installation which has been designed, built, inspected and tested in compliance with this Offshore Standard and applicable codes, standards and regulations.

2.1.2 Applicable codes, standards and regulations as well as operational limitations and basic assumptions and conditions for use will be stated in the Certificate.

3 Classification

3.1 General

3.1.1 Units designed, built, installed, tested and intended to be followed up in-service under supervision of the Society in compliance with the requirements of this standard will be entitled to the class notation: Offshore Loading Unit.

3.1.2 A complete description of principles, procedures, applicable class notations and technical basis for offshore classification is given by DNVGL-RU-OU-0102, Rules for Classification of Floating Production and Storage Units.

3.1.3 Due to the particular nature of offshore loading units' operations and ownership, the precise scope of classification shall be decided on a case-by case basis after agreement with the client.

3.1.4 The extent of classification is identified in the appendix to class certificate. The following is normally included:
— arrangements
— structural strength
— anchoring and mooring
— stability and watertight integrity
— hazardous areas and ventilation
— marine machinery and piping
— electrical installation
— fluid transfer system and equipment
— instrumentation and control systems.

3.1.5 Offshore loading units shall be approved according to the following principles:
— design approval
— survey of fabrication
— survey of installation
— functional test after installation.

3.2 Assumptions

3.2.1 It is assumed that all marine operations necessary for construction, transportation and installation of unit are conducted by competent personnel and that the operating planning is based on experience and sound engineering practice. It is also assumed that the conditions during the actual marine operations do not depart from those assumed.

3.2.2 Limitations for operation, systems and equipment will be included in the appendix to classification certificate.

3.3 National regulations

Some items because of their specific nature are assumed to be controlled by National Authorities and hence are not considered to be within the scope of classification. These items include:
— arrangement for personnel safety on board, i.e. stairs, ladders, access ways etc.
— evacuation and lifesaving appliances
— navigation/obstruction aids
— temporary equipment/installation, e.g. for storage, operation, maintenance etc.
SECTION 2 DESIGN APPROVAL

1 General
This section gives requirements for certification and classification related to design. When deemed necessary, the Society may require that special studies or calculations are performed in order to define particular operational limitations.

2 Documentation

2.1 Design documentation

2.1.1 The following plans and particulars shall be submitted for approval, as applicable:
— unit structure including fairleads/anchor line stoppers
— turntable and bearings
— universal joints
— loading boom/yoke
— helideck
— superstructure
— anchoring arrangement
— mooring arrangement
— arrangement of fluid transfer systems with following information to be included:
  — materials to be applied for pipes, hoses, fittings, branches, unions, plugs, flanges, bolts, nuts, gaskets, etc.
  — materials to be applied for valve bodies, bonnets, stems, seat seals, springs, actuators, etc.
  — corrosion allowances
  — wall thickness listed for each applicable line size
  — rating and type of flanges, valves, fittings, branches, unions, and type of gaskets, etc.
  — drawings or certified proof test reports for non-standard piping components
  — pressure test plan
  — complete specification of fire extinguishers
  — drawings showing details such as the means for access to different enclosed areas
  — general arrangement showing extent of hazardous areas/main layout drawings.

2.1.2 The following plans, descriptions and calculations shall be submitted for information, as applicable:
— structural analysis
— stability analysis
— anchor and foundation analysis
— mooring analysis
— main particulars for fluid transfer system such as:
  — applicable codes and standards
  — design temperature (min. and max.)
  — design pressure rating
— fabrication specifications including pipe bending, welding, heat treatment, type and extent of NDE, testing etc.
— flow sheets of piping and instrumentation diagram (P&ID) with reference to appropriate designation
— strength calculations
— operation manual.

3 Stability and watertight integrity
For simple unmanned buoys, other stability requirements may be considered by the Society.

4 Piping, equipment and loading hoses
If torsional seals are used, a prototype test may be required by the Society.

5 Survey arrangement
A facility plan for in service inspection shall be submitted for approval. The plan shall show the types of facilities which are or will be provided to make important structural parts accessible for survey in accordance with the in-service inspection programme.

Guidance note:
Annual and special surveys may be carried out on location based on approved procedures outlined in a maintenance system and survey arrangement, without interrupting the function of the installation. The following matters will be taken into consideration for acceptance of surveys to be carried out on location:

— arrangement for underwater inspection of structure and openings affecting the floatability of the unit
— means for blanking off all openings
— accessibility of all spaces for inspection
— corrosion protection of structure
— testing facilities for equipment, as applicable.

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SECTION 3 CERTIFICATION OF MATERIALS AND EQUIPMENT

1 Certification of materials
Certification of materials shall be carried out as described in Ch.2 Sec.2 [4].
For DNV GL classification projects the test certificates shall be DNV GL material certificates in compliance with the requirements given in DNVGL-OS-B101.

2 Certification of components and equipment
2.1 General
2.1.1 Components and equipment shall be certified consistent with its functions and importance for safety.

2.1.2 Equipment referred to in this standard will be categorised as follows:
Category I:
— equipment related to safety for which a DNV GL certificate is required.
— category I equipment is subdivided into IA, IB and IC categorisation.
Category II:
— equipment related to safety for which a works certificate prepared by the manufacturer is accepted.

2.1.3 For equipment category I, the following approval procedure shall be followed:
— design approval, followed by a design verification report (DVR) or type approval certificate.
— fabrication survey followed by issuance of a product certificate.

2.1.4 Depending on the required extent of survey, category I equipment is subdivided into IA, IB and IC with the specified requirements as given below.
Guidance note:
It should be noted that the scopes defined for category IA, IB and IC are typical and adjustments may be required based on considerations such as:
— complexity and size of a delivery
— previous experience with equipment type
— maturity and effectiveness of manufacturer's quality assurance system
— degree of subcontracting.

Category IA:
— pre-production meeting, as applicable, prior to the start of fabrication.
— class survey during fabrication.
— witness final functional, pressure and load tests, as applicable.
— review fabrication record.

Category IB:
— pre-production meeting (optional).
— witness final functional, pressure and load tests, as applicable.
— review fabrication record.
Category IC:
— witness final functional, pressure and load tests, as applicable.
— review fabrication record.

The extent of required survey by DNV GL shall be decided on the basis of manufacturer's QA/QC system, manufacturing survey arrangement (MSA) with DNV GL and type of fabrication methods.

2.1.5 Equipment of category II is accepted on the basis of a works certificate prepared by the manufacturer. The certificate shall contain the following data as a minimum:
— equipment specification or data sheet.
— limitations with respect to operation of equipment.
— statement (affidavit) from the manufacturer to confirm that the equipment has been constructed, manufactured and tested according to the recognised methods, codes and standards.

Guidance note:
Independent test certificate or report for the equipment or approval certificate for manufacturing system may also be accepted.

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3 Equipment categorisation
Categorisation of equipment normally installed is given in DNVGL-OS-E201 Ch.3 Sec.3 [2].
SECTION 4 SURVEY DURING CONSTRUCTION

1 General

General description of activities related to survey during construction is given in DNVGL-RU-OU-0102, Floating production, storage and loading units.

Detail scope of survey is given in Ch.3 of the relevant DNV GL offshore standards (as applicable):

- DNVGL-OS-C401 for structural fabrication
- DNVGL-OS-D101 for mechanical systems
- DNVGL-OS-D201 for electrical installations
- DNVGL-OS-D202 for instrumentation
- DNVGL-OS-E201 for hydrocarbon related systems
- DNVGL-OS-E301 for mooring systems.
SECTION 5 SURVEYS AT INSTALLATION AND COMMISSIONING

1 Installation

1.1 General

1.1.1 Unit and mooring systems to be installed under the supervision of a surveyor. Refer to DNVGL-OS-E301.

2 Commissioning

2.1 General

2.1.1 Prior to commissioning, all systems shall be tested according to approved procedures.

2.1.2 Procedures for hook-up at site, if applicable, and pre-commissioning tests shall be agreed with the Society in each case.

2.1.3 DNV GL shall be requested to inspect the unit and attend the final tests.

2.1.4 Equipment in category I for which the functional and or performance tests are not witnessed at manufacturer's place, shall be tested after installation and witnessed by DNV GL.

2.1.5 A record of pressure valve setting shall be made available to DNV GL on request.

2.1.6 Function, performance testing of the following systems and equipment shall be in accordance with a written test program accepted by DNV GL:

— fluid transfer system
— riser connections
— mooring hawser tension measurement system
— ventilating systems for hazardous area, where applicable
— fire extinction and deluge systems where applicable
— alarm and intercommunication systems.

2.1.7 Any modifications after testing shall be in agreement with the Society.
SECTION 6 CLASSIFICATION IN OPERATION

1 General
In order to maintain class in the operational phase, classed loading units are required to undergo periodical surveys. The objective of the surveys is to ascertain that the condition of the structure, systems and equipment covered by class meet, and will continue to meet, the applicable class requirements. Periodical survey principles and requirements for retention of class in the operational phase is given in DNVGL-RU-OU-0102, Floating production, storage and offloading units.
CHANGES - HISTORIC

July 2015 edition

Main changes July 2015

• General
  — The revision of this document is part of the DNV GL merger, updating the previous DNV standard into a DNV
  — GL format including updated nomenclature and document reference numbering, e.g.:
    — Main class identification 1A1 becomes 1A.
    — DNV replaced by DNV GL.
    — DNV-RP-A201 to DNVGL-CG-0168. A complete listing with updated reference numbers can be found on DNV GL's homepage on internet.

To complete your understanding, observe that the entire DNV GL update process will be implemented sequentially. Hence, for some of the references, still the legacy DNV documents apply and are explicitly indicated as such, e.g.: Rules for Ships has become DNV Rules for Ships.

As a part of the reformatting, the structure of this document has furthermore been converted to decimal numbering. Older references to this document may normally be interpreted by analogy to the following example:
  — Ch.2 Sec.3 D506 is now Ch.2 Sec.3 [4.5.6] etc.
Driven by our purpose of safeguarding life, property and the environment, DNV GL enables organizations to advance the safety and sustainability of their business. We provide classification and technical assurance along with software and independent expert advisory services to the maritime, oil and gas, and energy industries. We also provide certification services to customers across a wide range of industries. Operating in more than 100 countries, our 16 000 professionals are dedicated to helping our customers make the world safer, smarter and greener.