Safety principles and arrangements
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
CHANGES – CURRENT

General
This document supersedes DNV-OS-A101, July 2014.

Text affected by the main changes in this edition is 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.

On 12 September 2013, DNV and GL merged to form DNV GL Group. On 25 November 2013 Det Norske Veritas AS became the 100% shareholder of Germanischer Lloyd SE, the parent company of the GL Group, and on 27 November 2013 Det Norske Veritas AS, company registration number 945 748 931, changed its name to DNV GL AS. For further information, see www.dnvgl.com. Any reference in this document to "Det Norske Veritas AS", “Det Norske Veritas”, “DNV”, “GL”, “Germanischer Lloyd SE”, “GL Group” or any other legal entity name or trading name presently owned by the DNV GL Group shall therefore also be considered a reference to “DNV GL AS”.

Main changes

• 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.

• Ch.2 Sec.4 Emergency shutdown
  — [2.1.3] Interpretation 3): Old definition of ESD power requirement has been reinstated.

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

SECTION 1 GENERAL

1 General

1.1 Introduction
This standard provides general safety and arrangement principles for mobile units and offshore installations.

1.2 Objectives
The objectives of the standard are to:
— provide an internationally acceptable standard of safety for offshore units and installations by defining requirements for design loads, arrangements, area classification, shut down logic, alarms, escape ways and communication
— serve as a contractual reference document between suppliers and purchasers
— serve as a guideline for designers, suppliers, purchasers and regulators
— specify procedures and requirements for units or installations subject to DNV GL certification and classification services.

1.3 Scope
1.3.1 The scope of this standard covers the following technical topics
— Design principles and accidental loads.
— Area arrangement.
— Hazardous area classification.
— Emergency shutdown (ESD) principles and requirements.
— Escape and communication.

1.3.2 The standard does not cover the location and arrangement of helicopter decks.

Guidance note:
Relevant requirements for helicopter decks are given in MODU Code Ch.13 referring in its turn to publications from the International Civil Air Organisation (ICAO).

1.3.3 This standard is applicable for all types of mobile offshore units and offshore installations.

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

1.4 Application
1.4.1 Interpretations
This standard has been based on internationally accepted principal requirements, defined in the normative references as listed in [2]. In cases where these a) contain only functional requirements, b) allow alternative solutions to prescriptive requirements or c) are generally or vaguely worded, a DNV GL interpretation has been added.

1.4.2 The interpretations are not aiming at introducing additional requirements but at achieving uniform application of the principal requirements. The interpretations can be regarded as norms for fulfilling the principle requirements.

1.4.3 The interpretations do not preclude the use of other alternative solutions. Such solutions shall be documented and approved for compliance to the principal requirement equivalent to the original interpretation.
1.4.4 Classification

For use of this standard as technical basis for offshore classification as well as description of principles, procedures, and applicable class notations related to classification services, see the applicable DNV GL rules for classification of offshore units as listed in Table 1.

Table 1 DNV GL rules for classification - Offshore units

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<td>DNVGL-RU-OU-0101</td>
<td>Offshore drilling and support units</td>
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<td>DNVGL-RU-OU-0102</td>
<td>Floating production, storage and loading units</td>
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<tr>
<td>DNVGL-RU-OU-0103</td>
<td>Floating LNG/LPG production, storage and loading units</td>
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<tr>
<td>DNVGL-RU-OU-0104</td>
<td>Self-elevating units</td>
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1.4.5 The scope of classification may be extended by the voluntary notation ES. The applicable sections or requirements as indicated accordingly shall only be enforced in case this notation is part of this extended classification scope (see also, Ch.3 Sec.1 [1.2]). The relevant requirements are identified by inclusion of ‘ES’ in the head line.

1.5 Structure

This standard is divided into three chapters:

— Ch.1: General introduction, scope, definitions and references.
— Ch.2: Technical provisions for safety principles and arrangement for systems applicable to all types of offshore units and installations in Sec.1 to Sec.5, followed by supplementary requirements for:
  — Drilling units and well intervention units with return of hydrocarbon fluids (Sec.6)
  — Floating production and storage units (Sec.7)
  — Floating storage units (Sec.8)
  — LNG import and export terminals and production units (Sec.9)
— Ch.3: Describing this use of this standard for classification purposes.

2 Normative references

2.1 General

2.1.1 The following standards include requirements that through reference in the text constitute provisions of this offshore standard. Latest issue of the references shall be used unless otherwise agreed. Other recognised standards may be used provided it can be demonstrated that these meet or exceed the requirements of the standards referenced in [2.2] to [2.4].

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

2.2 DNV GL offshore standards

The latest revision of the DNV GL Offshore Standards listed in Table 2 applies.

Table 2 DNV GL offshore standards

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<td>Marine and machinery systems and equipment</td>
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<td>Electrical installations</td>
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<td>DNVGL-OS-D202</td>
<td>Automation, safety, and telecommunication systems</td>
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<tr>
<td>DNVGL-OS-D301</td>
<td>Fire protection</td>
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2.3 DNVGL class guideline
The latest revision of the DNV GL Class Guideline listed in Table 3 applies.

Table 3  DNV recommended practices

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<tr>
<td>DNVGL-CG-0168</td>
<td>Plan approval documentation types – definitions</td>
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2.4 Other references
The latest revision of the documents listed in Table 4 applies.

Table 4  Other references

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<tr>
<td>DNV Rules for Ships</td>
<td>DNV rules for classification of ships</td>
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3 Informative references
The codes and standards in Table 5 are referenced in the text of this offshore standard, and may be used as a source of supplementary information. If not otherwise stated, the latest revision of the documents applies.

Table 5  Informative references

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<td>API RP 14C</td>
<td>Analysis, Design, Installation and Testing of Basic Surface Safety Systems for Offshore Production Platforms</td>
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<td>ISO 10418</td>
<td>Petroleum and natural gas industries - Offshore production platforms - Analysis, design, installation and testing of basic surface safety systems</td>
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<tr>
<td>API RP 14J</td>
<td>Recommended Practice for Design and Hazard Analysis for Offshore Production Facilities</td>
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<td>API RP 505</td>
<td>Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Zone 0, Zone 1, and Zone 2</td>
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<td>API Std 521/ISO 23251</td>
<td>Pressure-relieving and Depressuring Systems</td>
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<td>COLREG</td>
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<td>Oil and Gas Processing Systems</td>
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<tr>
<td>DNV Technical Report 99-3139</td>
<td>Guidelines for Risk and Emergency Preparedness Assessment: MODU (ss), drill ships, well intervention ships and well intervention units (ss)</td>
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<td>EN 1834, Part 1-3</td>
<td>Reciprocating internal combustion engines - Safety requirements for design and construction of engines for use in potentially explosive atmospheres</td>
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<td>EN 1473</td>
<td>Installation and Equipment for Liquefied natural gas. Design of onshore installations</td>
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<td>Electrical apparatus for explosive gas atmospheres - Part 10: Classification of hazardous areas</td>
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<td>IEC 61892-7</td>
<td>Mobile and fixed offshore units - Electrical installations - Part 7: Hazardous area</td>
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<tr>
<td>IMO Res. A.1021(26)</td>
<td>Code on Alerts and Indicators</td>
</tr>
<tr>
<td>Energy Institute: Model Code of Safe Practice Part 15</td>
<td>Area Classification Code for Installations Handling Flammable Fluids</td>
</tr>
<tr>
<td>ISO 13702</td>
<td>Petroleum and natural gas industries - Control and mitigation of fires and explosions on offshore production installations - Requirements and guidelines</td>
</tr>
<tr>
<td>NFPA 59 A</td>
<td>Standard for Production, Storage and handling of Liquefied Natural Gas</td>
</tr>
<tr>
<td>SOLAS</td>
<td>International Convention for the Safety of Life at Sea</td>
</tr>
</tbody>
</table>
4 Definitions

4.1 Verbal forms

Table 6 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>

4.2 Definitions

Table 7 Definitions

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>accommodation area</td>
<td>space used for cabins, offices, lavatories, corridors, hospitals, cinemas, public spaces etc. Service spaces and control stations may be included within the accommodation area.</td>
</tr>
<tr>
<td>product storage area</td>
<td>part of a unit or installation which contains: the storage spaces, the pump rooms and/or cofferdams adjacent to product storage tanks, and includes deck areas over the full beam and length of spaces above. See also Tank deck.</td>
</tr>
<tr>
<td>control station or control room</td>
<td>general term for any location space where essential control functions are performed during transit, normal operations or emergency conditions. Typical examples are central control room, radio room, process control room, bridge, emergency response room etc. For the purpose of compliance with the SOLAS Convention and the MODU Code, the emergency generator room, UPS rooms and fire pump rooms are defined as control stations.</td>
</tr>
<tr>
<td>design accidental events</td>
<td>events which could cause death or serious personal injury to personnel on board the unit or installation, and which are controlled in order to meet risk acceptance criteria. This includes events, which could result in significant damage to the structure of the unit or installation, loss of stability, or the need to evacuate. Design accidental events form one basis for design dimensioning accidental loads.</td>
</tr>
<tr>
<td>design accidental loads</td>
<td>loads or actions resulting from a defined accidental effect. These loads are included in the basis for design of a system or a structure.</td>
</tr>
<tr>
<td>dimensioning accidental loads</td>
<td>loads that are calculated to meet the acceptance criteria</td>
</tr>
<tr>
<td>drilling area</td>
<td>includes the derrick, drill floor, BOP area and the area containing shale shakers and degassers. See utility area for drilling utilities such as mud mixing, pumping, bulk storage and cementing.</td>
</tr>
<tr>
<td>essential services</td>
<td>generally defined as a service which needs to be, in continuous operation for maintaining the unit's manoeuvrability (if applicable), or whose loss or failure would create an immediate danger to the unit</td>
</tr>
<tr>
<td>embarkation area</td>
<td>area immediately adjacent to a transport means of escape or evacuation which is designated for personnel awaiting the instruction leave or abandon the unit or installation</td>
</tr>
<tr>
<td>emergency response</td>
<td>action to safeguard the health and safety of persons on or near the unit or installation. This usually includes all actions through alarm, escape, muster, communications and control, evacuation and rescue.</td>
</tr>
<tr>
<td>enclosed space</td>
<td>space bounded by floors, bulkhead and/or decks that may have doors, windows or other similar openings</td>
</tr>
<tr>
<td>escape</td>
<td>means for leaving the various workplaces on the unit or installation leading to a safe place and without directly entering the sea.</td>
</tr>
<tr>
<td>evacuation</td>
<td>means for leaving the unit or installation and moving away from the vicinity in an emergency in a systematic manner</td>
</tr>
<tr>
<td>hazardous areas</td>
<td>all areas in which a flammable or explosive gas and air mixtures is, or may normally be expected to be, present in quantities such as to require special precautions for the construction and use of electrical equipment and machinery</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| ignition source             | any object in relation to area classification and safety philosophy that could ignite an explosive gas and air atmosphere  
Typical sources could be uncertified electrical apparatus, naked flame, sparks, static discharges, hot surfaces above ignition temperature etc. |
| important for safety        | areas, systems and functions, which are provided to prevent, detect, control and mitigate the effects of an accidental event                                                                                   |
| important services          | generally defined as a service which needs not necessarily be in continuous operation but whose failure or non-availability would not create an immediate danger but impairs the unit’s safety  
**Guidance note:**  
Systems and equipment providing the service above are essential respectively important. This applies also to systems and equipment supporting these like control and electrical systems. |
| integrity                   | ability of the unit or installation to remain safe and stable to safeguard personnel and facilities on board  
Integrity is generally taken to mean structural soundness, strength, stability and buoyancy required to fulfil these actions.                                                                                  |
| LNG export terminal         | an offshore terminal which processes hydrocarbons and refrigerates gas to produce LNG                                                                                                                     |
| LNG import terminal         | an offshore terminal which receives and regasifies LNG to provide gas to the market gas grid                                                                                                               |
| machinery space             | machinery spaces of category A and other spaces containing propulsion machinery, boilers, oil fuel units, steam and internal combustion engines, generators and major electrical machinery, oil filling stations, refrigerating, stabilising, ventilation and air conditioning machinery and similar spaces and trunks to such spaces  
(Ref. SOLAS Reg. II-2/3.30, MODU Code 1.3.33). |
| machinery spaces of category A | spaces and trunks to such spaces which contain:  
— internal combustion machinery used for main propulsion; or  
— internal combustion machinery used for purposes other than main propulsion where such machinery has in the aggregate a total power output of not less than 375 kW, or  
— any oil-fired boiler or oil fuel unit.  
Spaces which contain oil fired equipment other than boilers, such as inert gas generators, incinerators, waste disposal units etc., shall be considered as machinery spaces of category A.  
(Ref. SOLAS Reg. II-2/3.31, MODU Code 1.3.34 and IACS UR F35) |
| major hazards               | hazards that may result in fire, explosion, loss of life, damage to the unit or installation or safety systems, or impaired escape or evacuation                                                                 |
| mobile unit                 | a buoyant construction engaged in offshore operations including drilling, production, storage or support functions, not intended for service at one particular offshore site and which can be relocated without major dismantling or modification  
**Guidance note:**  
The following is the definition in the MODU Code: Mobile offshore drilling unit (MODU) or unit is a vessel capable of engaging in drilling operations for the exploration for or exploitation of resources beneath the sea-bed such as liquid or gaseous hydrocarbons, sulphur or salt (Ref. MODU Code 1.3.40). |
| muster area                 | a designated area where personnel gather for protection, instructions and final preparations before evacuation  
A muster area shall be protected from the immediate effects of an emergency, and the primary muster area is normally within the temporary refuge.                                                        |
| offshore installation       | A buoyant or non-buoyant construction engaged in offshore operations including drilling, production, storage or support functions, and which is designed and intended for use at a location for an extended period.  
This will also include Floating LNG terminals.                                                                                             |
| performance standard        | quantitative or qualitative definition of the functionality required of a system or item of equipment  
It relates to the purpose and performance of the system or item and can be expressed in terms of capacity, functionality, reliability, availability, survivability etc. |
Table 7 Definitions (Continued)

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>prevailing wind</td>
<td>wind direction, which has the highest probability of occurrence</td>
</tr>
<tr>
<td>processing area</td>
<td>area designated for separation, compression, treatment and disposal of reservoir fluids</td>
</tr>
<tr>
<td>riser area</td>
<td>area containing import and/or exports risers and includes the isolation valve on the riserSee also Turret area</td>
</tr>
<tr>
<td>safety assessment</td>
<td>systematic evaluation of safety involving identification and evaluation of hazards and events that could result in loss of life, property damage, environmental damage, or the need to evacuate</td>
</tr>
<tr>
<td>safety criteria</td>
<td>qualitative and quantitative criteria, which express the maximum tolerable risk to personnel, environment, safety functions etc.</td>
</tr>
<tr>
<td>safety systems</td>
<td>systems, including required utilities, which are provided to prevent, detect/ warn of an accidental event/abnormal conditions and/or mitigate its effects</td>
</tr>
<tr>
<td></td>
<td><strong>Interpretation:</strong></td>
</tr>
<tr>
<td></td>
<td>1) The following should be considered as safety systems:</td>
</tr>
<tr>
<td></td>
<td>— ESD, including blowdown where relevant</td>
</tr>
<tr>
<td></td>
<td>— PSD</td>
</tr>
<tr>
<td></td>
<td>— Fire &amp; gas detection</td>
</tr>
<tr>
<td></td>
<td>— PA/GA</td>
</tr>
<tr>
<td></td>
<td>— Fire-fighting systems</td>
</tr>
<tr>
<td></td>
<td>— BOP incl. control system</td>
</tr>
<tr>
<td></td>
<td>— Safety systems for essential or important services</td>
</tr>
<tr>
<td></td>
<td>2) Safety systems are normally considered as “on-demand” functions.</td>
</tr>
<tr>
<td></td>
<td>——————————————————— end of Interpretation ———————————————————</td>
</tr>
<tr>
<td>semi-enclosed location</td>
<td>locations where natural conditions of ventilation are notably different from those on open decks due to the presence of structures such as roofs, windbreaks and bulkheads and which are so arranged that dispersion of gas may be hindered</td>
</tr>
<tr>
<td>tank deck</td>
<td>deck, or part of a deck, which forms the top of a product storage tank</td>
</tr>
<tr>
<td>temporary refuge or shelter area</td>
<td>area provided to protect personnel from the effects of an emergency, which is beyond immediate control</td>
</tr>
<tr>
<td></td>
<td>Protection shall be sufficient to allow controlled muster, emergency assessment, incident evaluation, and implementation of control emergency procedures, and evacuation etc. The temporary refuge should be provided with adequate command communication facilities to address an emergency and organise safe evacuation if necessary.</td>
</tr>
<tr>
<td>turret area</td>
<td>area containing mooring equipment, which enables the unit to rotate relative to fixed facilities or pipelines on the seabed</td>
</tr>
<tr>
<td></td>
<td>Import and export risers are usually located within the turret area.</td>
</tr>
<tr>
<td>utility areas</td>
<td>areas for combustion equipment, power generation, switchboards, boiler, water injection facilities, workshops, storage areas, drilling utilities and general machinery</td>
</tr>
<tr>
<td></td>
<td>A utility area should not include production, drilling or wellhead equipment, and will not normally include release sources leading to designation as a significant hazardous area.</td>
</tr>
</tbody>
</table>
4.3 Abbreviations

The abbreviations in Table 8 are used.

**Table 8 Abbreviations**

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>In full</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALS</td>
<td>accidental limit states</td>
</tr>
<tr>
<td>API</td>
<td>American Petroleum Institute</td>
</tr>
<tr>
<td>AVS</td>
<td>abandon vessel shutdown</td>
</tr>
<tr>
<td>BOP</td>
<td>blow out preventer</td>
</tr>
<tr>
<td>CCR</td>
<td>centralised control room</td>
</tr>
<tr>
<td>CFD</td>
<td>computational flow dynamics</td>
</tr>
<tr>
<td>CG</td>
<td>class guideline</td>
</tr>
<tr>
<td>DAL</td>
<td>design accidental load</td>
</tr>
<tr>
<td>DP</td>
<td>dynamic positioning</td>
</tr>
<tr>
<td>ESD</td>
<td>emergency shutdown</td>
</tr>
<tr>
<td>FMEA</td>
<td>failure mode and effect analysis</td>
</tr>
<tr>
<td>HAZID</td>
<td>hazard identification</td>
</tr>
<tr>
<td>HAZOP</td>
<td>hazard and operability (study)</td>
</tr>
<tr>
<td>IACS</td>
<td>International Association of Classification Societies</td>
</tr>
<tr>
<td>IACS UI</td>
<td>Unified interpretation</td>
</tr>
<tr>
<td>IACS UR</td>
<td>Unified requirement</td>
</tr>
<tr>
<td>ICAO</td>
<td>International Civil Aviation Organisation</td>
</tr>
<tr>
<td>IEC</td>
<td>International Electrotechnical Commission</td>
</tr>
<tr>
<td>IMO</td>
<td>International Maritime Organization</td>
</tr>
<tr>
<td>ISO</td>
<td>International Organisation of Standardisation</td>
</tr>
<tr>
<td>KO</td>
<td>knock out</td>
</tr>
<tr>
<td>LEL</td>
<td>lower explosion limit</td>
</tr>
<tr>
<td>LER</td>
<td>local equipment room</td>
</tr>
<tr>
<td>LIR</td>
<td>local instrument room</td>
</tr>
<tr>
<td>LNG</td>
<td>liquefied natural gas</td>
</tr>
<tr>
<td>MAC</td>
<td>manually activated call point</td>
</tr>
<tr>
<td>MJ</td>
<td>Mega Joules</td>
</tr>
<tr>
<td>MODU</td>
<td>mobile offshore drilling unit</td>
</tr>
<tr>
<td>NDE</td>
<td>normally de-energised</td>
</tr>
<tr>
<td>NE</td>
<td>normally energised</td>
</tr>
<tr>
<td>OS</td>
<td>offshore standard</td>
</tr>
<tr>
<td>PA/GA</td>
<td>public address/general alarm</td>
</tr>
<tr>
<td>PSD</td>
<td>process shutdown</td>
</tr>
<tr>
<td>RP</td>
<td>recommended practice</td>
</tr>
<tr>
<td>SCSSSV</td>
<td>surface controlled subsea shutdown valve</td>
</tr>
<tr>
<td>SSIV</td>
<td>sub-surface isolation valve</td>
</tr>
<tr>
<td>STL</td>
<td>submerged turret loading</td>
</tr>
<tr>
<td>STP</td>
<td>submerged turret production</td>
</tr>
<tr>
<td>UEL</td>
<td>upper explosion limit</td>
</tr>
<tr>
<td>ULS</td>
<td>ultimate limit states</td>
</tr>
<tr>
<td>UPS</td>
<td>uninterruptible power supply</td>
</tr>
</tbody>
</table>
CHAPTER 2 TECHNICAL PROVISIONS

SECTION 1 DESIGN PRINCIPLES AND ACCIDENTAL LOADS

1 Introduction

1.1 Objective
Application of these design principles is intended to establish an acceptable level of safety, whilst promoting safety improvements through experience and available technology.

1.2 Application
The principles and requirements shall be applied throughout the project lifecycle, beginning in the concept phase, and reviewed and updated through detailed design and construction. The principles shall also be applied with respect to subsequent modifications.

2 Design principles

2.1 Main principles

2.1.1 The following general principles shall be applied throughout the concept and design phases of the mobile unit or offshore installation.

2.1.2 The mobile unit or offshore installation shall be designed and constructed with sufficient integrity to withstand operational and environmental loading throughout its lifecycle.

(Ref. MODU code 2.3)

2.1.3 Systems and structures shall be designed with suitable functionality and survivability for prevention of, or protection from, design accident events affecting the unit or installation. For structures see also DNV-RP-C204 Design Against Accidental Loads.

Guidance note:
Definitions of accidental loads are typically given as follow:
- Design Accidental Loads are loads that are actually applied in the design
- Dimensioning Accidental Loads are calculated loads that meet the acceptance criteria.

The difference between the Design and the Dimensioning loads is a safety margin as long as the Design load is higher than the Dimensioning load. A lower Design load is not acceptable.

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

2.1.4 Effective escape, shelter and evacuation facilities shall be provided to safeguard all personnel, as far as practicable, at all times when the unit or installation is manned.

2.1.5 The generic Design Accidental Loads in [3] can be used for standard, conventional designs. If these loads are too large for practical use, more refined analyses such as CFD analyses for fire and explosion loads, and probabilistic risk analyses may be carried out in order to set the DALs.

2.1.6 For complex or non-standard applications a more comprehensive safety assessment shall be carried out. App.B provides further information.

2.2 Additional requirements
In meeting the main design principles in [1], the following requirements shall be applied:

a) The design shall be sufficiently robust to tolerate at least one failure or operator error without resulting in a major hazard, or damage to the unit or installation.

b) Suitable measures shall be provided to enable timely detection, control and mitigation of hazards.

c) Escalation to plant and areas that are not affected by the initiating event shall be avoided.
2.3 Design for accidental loads

2.3.1 The provisions given in [3] and [3] are based on international practice, experience with offshore designs and results obtained by various risk assessments carried out on offshore units. For relatively standardised designs (e.g. typical drilling units) the prescriptive requirements given in these standards are intended to anticipate the most likely hazards which may be encountered.

2.3.2 Each project shall, however, consider the applicability of the generic load approach used in [3] with respect to the intended application and operation in order to identify, where applicable, hazards associated with non-standard design or application.

Guidance note:
For example generic collision load is based on a supply vessel size of 5000 tons. In applications where supply vessels are of much larger size this will need to be accounted for in defining the collision load.

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

2.3.3 The acceptance criteria shall be established prior to carrying out the safety assessment. The level of acceptance criteria shall follow normal industry practice, see App.B.

Guidance note:
One example of normal industry practice: The Offshore Technology Report 2001/63 Marine Risk Assessment issued by Health & Safety Executive (HSE) in UK.

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

3 Generic design accidental loads

3.1 General

3.1.1 The prescriptive requirements given here and elsewhere in DNV GL offshore standards are intended to take account of accidental events which have been identified through previous risk studies and through experience.

3.1.2 The requirements are based on consideration of the integrity of the following main safety functions:

— integrity of shelter areas
— integrity of main fire and explosion dividers (fire and blast walls, decks, safety gaps, etc.)
— usability of escape ways
— usability of means of evacuation
— global load bearing capacity.

3.1.3 The selection of relevant design accidental loads is dependent on a safety philosophy considered to give a satisfactory level of safety. The generic loads defined here represent the level of safety considered acceptable by DNV GL, and are generally based on accidental loads affecting safety functions which have an individual (per load type) frequency of occurrence in the order of $10^{-4}$ per year. This will normally correspond to an overall frequency of $5 \times 10^{-4}$ per year as the impairment frequency limit.

3.1.4 The most relevant design accidental loads are considered to be:

— impact loads, including dropped object loads and collision loads
— unintended flooding
— loads caused by extreme weather
— explosion loads
— heat loads from fires.

3.1.5 This standard is intended to address the above design accidental loads. Other additional relevant loads that may be identified for a specific design or application will need to be separately addressed.
3.2 Dropped objects

3.2.1 It is assumed that lifting arrangements comply with Sec.2 [4.2] with regard to location of cranes and lay down areas and with respect to lifting operations over pressurised equipment.

3.2.2 It is assumed that critical areas are designed for dropped object loads as defined in [3.2.3] and [3.2.4].

Guidance note:
Typical critical areas normally include: accommodation, workshops, storage areas for pressurised gas, areas with hydrocarbon equipment.

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

3.2.3 The weights of the dropped objects to be considered for design of the structure are normally taken as the operational hook loads in cranes.

3.2.4 The impact energy is normally not to be less than:

\[ E = M \cdot g \cdot h \quad (kJ) \]

\( M \) = mass of object (tonnes)
\( g \) = 9.81 m/s\(^2\)
\( h \) = drop height in air (m)

Interpretation:
The impact energy at sea level should normally not be taken less than 5 MJ for cranes with maximum capacity more than 30 tonnes. The impact energy below sea level is assumed to be equal to the energy at sea level.

------------- end of Interpretation -------------

3.3 Collision loads

3.3.1 The impact energy to be considered is to be based on typical size of supply vessels in the area of operation and normally not to be less than:

- 14 MJ (Mega Joule) for sideways collision
- 11 MJ for bow or stern collision

corresponding to a supply vessel of 5000 tonnes displacement with impact speed \( v = 2 \) m/s.

3.3.2 For vessels the impact energy is given as:

\[ E = \frac{1}{2}(M + a)v^2 \quad (kJ) \]

\( M \) = displacement of vessel (t)
\( a \) = added mass of vessel, normally assumed as 0.4 \( M \) for sideways collision and 0.1 \( M \) for bow or stern collision
\( v \) = impact speed (m/s).

3.3.3 It is assumed that the unit or installation is not operating in a shipping lane. In such case a more detailed assessment of relevant collision loads shall be carried out.

3.3.4 Where a unit is operating in tandem with a shuttle tanker, special precautions shall be taken to minimise possibility of collision, or the design is to take account of collision loads.
3.4 Unintended flooding

3.4.1 The design sea pressure on watertight subdivisions (bulkheads and decks with compartment flooded) shall for accidental damaged condition be taken as:

\[ p_d = 10 \cdot h_b \, (kN/m^2) \]

\( h_b \) = vertical distance in m from the load point to the damaged waterline.

3.5 Loads caused by extreme weather

3.5.1 Characteristic values of individual environmental loads are defined by an annual probability of exceedance equal to \( 10^{-2} \) (for Ultimate limit states, ULS) and \( 10^{-4} \) (for Accidental limit states, ALS).

3.6 Explosion loads

3.6.1 Requirements given in this standard are applicable to hydrocarbon gases. Where hydrogen, ethylene or acetylene is used in large quantities special consideration shall be given to explosion loads.

Guidance note:
The overpressure values quoted in this section are based on studies with ethane, propane, butane, condensate and crude oil vapour. Methane or evaporated LNG values may be slightly lower.

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

3.6.2 The recommended design process is to first evaluate and document all possibilities to make a safe design, and then second to set DAL loads accordingly. The overall approach to set explosion DAL is here split in the following sequence:

a) Evaluate and document the overall platform lay-out to minimize explosion and fire loads. Both distance to living quarters and evacuation means, and to provide good ventilation and venting of the hazardous areas shall be considered.

b) Evaluate and document protection strategies such as ventilation strategy, safety gaps and fire and blast dividers, grated and plated decks, and active mitigating measures such as flare, and shutdown and blowdown philosophies. At this point the different fire and explosion areas are defined.

c) Decide the explosion areas and calculate their volumes (called the explosion volume). Explosion area is defined in the guidance note below.

d) Find the curve letter in Table 1 based on congestion, operation, confinement and wind protection.

e) Read off the DAL pressure in Figure 1 using the explosion volume.

f) If the explosion volume is larger than 30 000 m³, the present DAL assessment is not applicable, and a detailed analysis must be performed, or the size of the explosion area must be reduced.

g) The pressure pulse duration varies between 0.05 and 0.2 s. The higher and lower DAL pressures have a shorter and longer duration within this range, respectively.

h) Drag DAL can be set to 1/3 of the pressure DAL.

Interpretation:

An explosion area is defined as an area where there is congestion and where a gas cloud can freely build up. The borders are solid walls, solid decks and border between the congested area and open air. The following conditions should be used to calculate the limiting borders of the explosion area. When the borders are decided, the volume, called the explosion volume should be calculated.

- The distance to the next well congested area should be more than 20 m in order to classify as a separate explosion area.

- Walls and decks that border to the neighbouring explosion area should be gas tight to a degree that is reasonable. Small openings like pipe penetrations that are not sealed and other small penetrations are acceptable as long as the total percentage opening area is less than 5% of the total area of the wall or deck.

- Decks that are solid, but not explosion and fire rated, can still be regarded as a border to the explosion area. The fire area can hence be larger than the explosion area.
- The border/limit where the process area borders open air (either to the side or up) should be the natural border where no more piping and equipment are placed. It is accepted that limited/open support structure and railing is outside this border. For the height of the explosion area where the process equipment heights varies largely along the area, an average height which has the same volume of open air below as the volume of congested piping and equipment above, should be used.

- The upper border in a drill deck area with a derrick above should be to the height of the weather cladding (if any). If there is no weather cladding, the upper border should be at the height where there are no more large equipment (7.5 to 10 m typically).

- The explosion DAL loads are found per fire area, not per explosion area. If the fire area contains more than one explosion area, the DAL pressure found for each explosion area need to be combined in order to set the DAL load for the fire area. E.g. if the DAL in the explosion areas is 0.5 barg each, and the fire area contains two explosion areas, then the combined DAL in the fire area can be set as the sum of the DALs in each explosion area. The DAL pressure on a common wall that goes across the two explosion areas will then have a DAL pressure of 1 barg.

- The above will ensure that the escalation out of a fire area occurs less frequent than once per 10 000 years. This is the acceptance criteria which is used as a basis when calculating the DAL pressures used in Explosion Risk Analyses that makes the foundation of the present section.

--- end of Interpretation ---

3.6.3 Explosion areas that consist of elevated modules on a main deck (production/process modules) should be separated from each other by safety gaps or fire/explosion walls. If separation between modules is not in place, the modules shall be considered as a common explosion area.

3.6.4 Design shall as far as possible aim to minimise the possibility of gas build up.

Interpretation:

1) Where a solid process deck is used, the location of possible leak sources below this deck should be minimized.

2) Similarly, for internal turret designs the number of leak sources within the enclosed sections should be minimized.

--- end of Interpretation ---

3.6.5 The following items shall be designed to withstand the specified design overpressure:

- protective walls
- structures capable of blocking escape ways
- safety systems (and control lines)
- structure supporting hydrocarbon containing equipment
- hydrocarbon piping and piping support that can lead to escalation of the incident (drag load).

Interpretation:

The drag load applies to piping and structure less than 1 m in diameter or cross section main dimension. For items with dimension larger than 1 m, the DAL pressure should be used.

--- end of Interpretation ---

3.6.6 In a naturally ventilated compartment the explosion load given by the explosion overpressure and duration is mainly determined by the volume of the compartment, fraction of the total compartment sides that is open to free air and the level of congestion.

Guidance note:
A naturally ventilated compartment is defined by a volume with sides that are either solid walls or decks, or bordering to free, fresh air. If the compartment is located far enough from a neighbouring compartment (typically 20 m) only then it can be regarded as a single, standalone compartment. The fraction of the total compartment side that is open to free air is called the relative ventilation area. E.g. for compartment volumes of approximately 1000 m³ and relative ventilation area of about 0.5 (can be a cubic compartment that is fully open on 3 of 6 equal sides), ignition for stoichiometric gas mixtures is expected to lead to pressures of approximately...
100 kPa (1 barg) in cases with medium level of congestion. High level of congestion may increase the pressure with a factor of 2 to 3. Larger volume also tends to increase the pressure.

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3.6.7 Regarding internal layout of naturally ventilated explosion areas. The large items such as large vessels and LER/LIR rooms, etc. should be located centrally in order to avoid blocking of air ventilation and explosion venting. If located along the edges of the process areas, vessels should be turned towards the inner parts of the process area to give minimum blockage along the borders.

It is assumed that the process plant is designed with a suitable blowdown system and deluge system in accordance with a recognised code (e.g. DNVGL-OS-E201), in order to avoid possible pressure vessel rupture.

Table 1  Categorization of naturally ventilated offshore oil and gas areas wrt explosion DAL pressures. The curve letter identifies to pressure curves in Figure 1 to be used.

<table>
<thead>
<tr>
<th>Congestion /density level</th>
<th>Operation</th>
<th>Confinement by blastwalls and solid decks</th>
<th>Typical unit type</th>
<th>DAL on</th>
<th>Weather cladding</th>
<th>Curve no.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Confinement level</td>
<td>Blastwalls and solid decks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High to normal</td>
<td>Production</td>
<td>Confined</td>
<td>1 or 2 blastwalls, open or solid deck 6 m or more above</td>
<td>FPSO, FLNG, Semi sub, fixed</td>
<td>Blastwall(s)</td>
<td>Windwalls more than 50%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Open</td>
<td>No blastwalls open or deck above (FPSO, FLNG)</td>
<td>FPSO, FLNG, Turrets</td>
<td>Deck</td>
<td>Windwalls more than 50%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Open</td>
<td>No blastwalls open or deck above</td>
<td>Drilling rig, Integrated prod/drill</td>
<td>Blastwall(s)</td>
<td>Windwalls more than 50%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Open</td>
<td>No blastwalls open or deck above</td>
<td>Drilling rig</td>
<td>Deck</td>
<td>Windwalls more than 50%</td>
</tr>
<tr>
<td>Less congested</td>
<td>Drilling</td>
<td>Confined</td>
<td>1 or 2 blastwalls, open or solid deck 6 m or more above</td>
<td>Tank decks (FPSO, FLNG)</td>
<td>Blastwall(s)</td>
<td>Windwalls more than 50%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Open</td>
<td>No blastwalls, plated deck above</td>
<td>Open area on tank deck</td>
<td>Deck</td>
<td>Windwalls more than 50%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Open</td>
<td>No blastwalls, plated deck above</td>
<td>Open area on tank deck</td>
<td>Deck</td>
<td>Windwalls more than 50%</td>
</tr>
</tbody>
</table>
3.6.8 The explosion DAL pressures in enclosed areas handling hydrocarbons (e.g. STP or STL rooms, internal moonpools and shale shaker rooms) considering bulkheads that need to remain intact after an explosion, e.g. towards storage tanks, shall be designed for an overpressure of 4 barg in case no venting panels are installed. A pulse duration of 1s should be used.

3.6.9 If venting panels are installed, they need to cover more than 20% of the surface area of the explosion volume. The relieving pressure of the venting panels (explosion panels) should be between 0.05 and 0.1 barg. The DAL pressure on the stronger walls and decks can then be set to 2 barg, with pulse duration of 0.3 s.

3.6.10 For compartments where the length to diameter ratio, L/D, is greater than 3, the long flame acceleration distance available tends to result in higher pressures than given in Figure 1. The diameter can be estimated as \( D = \sqrt[3]{A} \) where \( A \) is the smallest cross-sectional area. \( L \) is the greatest dimension of the compartment/explosion area. It could be either horizontal or vertical.

3.6.11 Where it is possible for an explosion to propagate from compartment to compartment and for tunnels and chutes where explosion venting can be foreseen at one end only, detailed investigations shall be carried out.

3.6.12 The following items shall be designed to withstand the specified design overpressure:

- protective walls
- structures capable of blocking escape ways
- safety systems (and control lines)
— structure supporting hydrocarbon containing equipment
— hydrocarbon piping and piping support that can lead to escalation of the incident (drag load).

Interpretation:
The drag load applies to piping and structure less than 0.5 m in diameter or cross section main dimension. For items with dimension larger than 0.5 m, the DAL pressure should be used.

--- end of Interpretation ---

3.6.13 Typical design values are summarised in Table 1 with associated Figure 1. This shall be read together with the reservations in the text of this subsection.

Guidance note:
Accurate predictions of explosion overpressures are dependent on numerous variables and therefore specific analysis with use of actual project details is recommended.

--- end of guidance note ---

3.7 Heat loads

3.7.1 Where the living quarters are exposed to a heat load below 100 kW/m² a passive fire protection rating of A-60 is considered sufficient for the surface facing the source of the heat load. For heat loads above 100 kW/m² H-rated protection shall be used.

Guidance note:
For standard design drilling units the passive fire protection requirements of the IMO MODU Code is considered as acceptable.

--- end of guidance note ---

Where radiation levels at lifeboat stations exceeds 4.7 kW/m², radiation protection shall be provided.

3.7.2 For drilling in water depths of 200 and 400 m the subsea gas blowout rate is reduced by 50% and 75% when reaching the surface, respectively. Potential effects of subsea blowouts shall be considered according to this.

3.7.3 For drilling and production units, heat loads in connection with ignition following loss of containment of hydrocarbons shall be taken as in Table 2, unless otherwise documented. These fires shall be used in areas as follow:

a) In areas with both gas containing and oil or condensate containing equipment, critical items shall be designed to withstand a two-phase jet fire for 30 minutes and a pool fire for the following 30 minutes.
b) In areas with only oil or condensate containing equipment, critical items shall be designed to withstand a pool fire for 60 minutes.
c) In areas with only gas containing equipment, critical items shall be designed to withstand a jet fire for 30 minutes.

Table 2 Fire DAL for different types of fires

<table>
<thead>
<tr>
<th></th>
<th>Global average heat load (kW/m²)</th>
<th>Local peak heat load (kW/m²)</th>
<th>Duration (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two-phase jet fire</td>
<td>100</td>
<td>350</td>
<td>30 + 30 pool</td>
</tr>
<tr>
<td>Gas jet fires</td>
<td>100</td>
<td>350</td>
<td>30</td>
</tr>
<tr>
<td>Pool fire</td>
<td>100</td>
<td>250</td>
<td>60</td>
</tr>
</tbody>
</table>

Guidance note:
Global average heat load represents the average heat load that exposes a significant part of the process segment or structure. The global average heat load provides the major part of the heat input to the process segment and/ or area and, hence, affects the pressure in the segment.

The local peak heat load exposes a small (local) area of the process segment where process segment can be the drill floor or of the structure to peak heat flux. The local peak heat load, with the highest flux, determines the rupture of different equipment and piping within the process segment.

--- end of guidance note ---
3.7.4 The following critical items shall be designed to withstand the specified design heat load:

- protective walls
- structures supporting hydrocarbon pressure vessels
- hydrocarbon piping and piping support that can lead to escalation of the incident
- structures capable of blocking escape ways
- safety systems
- main structure.
SECTION 2 ARRANGEMENT

1 Introduction

1.1 Objective

The provisions of this section aim to avoid or reduce the effects of hazards on the mobile unit or offshore installation, by means of safe general arrangement of structures, plants and facilities.

1.2 Application

The requirements of this section shall be applied to all mobile units and offshore installations. Additional, specific requirements for arrangement of different unit types are given as indicated in Table 1.

Table 1 Additional requirements

<table>
<thead>
<tr>
<th>Reference</th>
<th>Unit type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sec.6</td>
<td>Special provisions for drilling units and/or well intervention units</td>
</tr>
<tr>
<td>Sec.7</td>
<td>Special provisions for floating production and/or storage units</td>
</tr>
<tr>
<td>Sec.8</td>
<td>Special provisions for floating storage units</td>
</tr>
<tr>
<td>Sec.9</td>
<td>Special provisions for LNG import and export terminals and LNG production units</td>
</tr>
</tbody>
</table>

2 General arrangement

2.1 Segregation of areas

2.1.1 The mobile unit or offshore installation shall be divided into different areas according to the type of activities that will be carried out and the associated hazard potential. Areas of high risk potential shall be segregated from areas of low risk potential, and from areas containing important safety functions. Incident escalation between areas shall be avoided.

Interpretation:

The effect of prevailing winds and potential for segregation by less hazardous areas should also be considered for area protection. This is also vital for establishing an ESD philosophy.

2.1.2 The above implies that hazardous areas including drains shall be separated from non-hazardous areas including drains.

(Ref. MODU code 6.3.2)

2.1.3 Accommodation and other areas important for safety, such as control stations, shall be located in areas classified as non-hazardous by location, and as far as practicable away from hazardous areas for hydrocarbon processing, hydrocarbon storage, wellheads, risers and drilling.

(Ref. MODU code 9.3.1)

2.1.4 Use of firewalls, blast walls, cofferdams etc. shall be considered in cases where segregation by physical distance is not sufficient.

(Ref. MODU code 9.3.1)

2.2 Arrangement

2.2.1 Escape, muster and evacuation areas shall not be impaired by smoke or gas. With regard to the dominant operational wind conditions, the general arrangement shall support this aim.

2.2.2 Arrangement of functions and equipment shall take into account the following:

— safe escape from working areas
— efficient ventilation of hazardous areas
— minimal explosion overpressure in case of ignited gas release
— access for fire fighting and emergency response
— prevention of serious consequences from dropped objects
— minimal possibility for escalation of fires and other failures or accidents
— safe containment of accidental release of hazardous liquids
— planned simultaneous operations.

**Guidance note:**
ISO 13702 section 13 and Annex B provides useful principles to minimise the effect of explosions.

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

### 3 Location of plants and equipment

#### 3.1 Location of safety systems

**3.1.1** Safety systems shall be located such that they can remain operational during the defined accidental events. Controls for safety systems shall be located where they are accessible and available for safe, simultaneous use during an emergency.

**Interpretation:**

1) The above should include at least fire and gas detection, fire fighting systems, ESD and ballast systems as applicable.
2) Where redundant safety equipment is used, this should not be vulnerable to the same accidental events as the main system.
3) Where control stations or control of safety functions are located in Local Equipment/Instrument Rooms (LER/LIRs) outside the accommodation block/safe area, special precautions against gas ignition should be provided in the form of airlock, gas detection, ventilation and shutdown.

--------- end of Interpretation ---------

**3.1.2** The emergency and UPS systems and associated controls etc. shall be self-contained, and located such that they are not vulnerable to events that affect main power supply.

**3.1.3** The bridge of mobile installations or units intended for self-propelled transit shall be located and arranged to provide sufficient field of vision for safe navigation and manoeuvring. The requirements in SOLAS Regulation V/22 or MODU Code 14.8 apply.

**3.1.4** Field control panels and energy or actuation sources for well control equipment and accumulator operated ESD valves shall be protected from dimensioning accidental events (such as fire, explosion and mechanical impact) to ensure operation of the barrier as necessary.

#### 3.2 Location of air intakes and other openings

**3.2.1** Inlets are to be located in non-hazardous areas as high and as far away from any hazardous area as practicable.

(Ref. IACS UR D8.3.1)

**Interpretation:**

3 Meters is considered sufficient to cover this requirement.

--------- end of Interpretation ---------

**3.2.2** Air intakes for internal combustion engines shall be not less than 3 m (10 ft) from the hazardous areas as defined in Sec.3.

(Ref. IACS UR D9.11.3)
3.2.3 Exhausts from combustion equipment and ventilation systems shall be located to avoid cross contamination of air inlets.
(Ref. IACS UR D8.3.1)

3.2.4 Openings, such as windows, doors, and ventilation ducts, shall normally be avoided in boundaries between main areas. In particular this applies to openings in accommodation spaces, control stations and other areas important for safety which face areas for hydrocarbon processing, hydrocarbon storage, wellheads, risers or drilling.

3.2.5 Requirements for freeboard to prevent uncontrolled flooding through openings in watertight barriers are given in DNVGL-OS-C301.

3.3 Fired heaters, combustion engines and hot surfaces

3.3.1 Generally, combustion engines are not to be installed in hazardous areas. When this cannot be avoided, diesel engines are allowed in zone 1 and 2 provided special consideration shall be given to the arrangement.
(Ref. MODU code 6.7 and IACS UR D9.10.1)

Interpretation:

1) The special precautions should consider the following:
   — use of segregation and/or fire barriers
   — gas tight enclosures
   — overpressure ventilation
   — gas detection and automatic isolation
   — insulation or cooling of hot surfaces
   — a diesel engine protection in compliance with EN-1834-1

2) Similar considerations should also be given to diesel engines outside hazardous areas but left operational after gas has been detected.

3.3.2 Fired boilers are not to be installed in hazardous areas.
(Ref. IACS UR D9.10.2)

3.3.3 Other requirements for protection of hot surfaces are presented in DNVGL-OS-D101.

3.4 Location of flares and vents

3.4.1 Flares and/or burner booms shall be located to avoid ignition of normal or accidental gas releases. Use of dispersion calculations shall be considered.

3.4.2 The flare and vent systems shall comply with API Std. 521/ ISO 23521 or equivalent. The radiant heat intensities or emissions from flares and vent systems shall not exceed the following limits:
   — 6.3 kW/m² (2000 Btu/hr./ft²) in areas where emergency actions lasting up to one minute may be required by personnel without shielding but with appropriate clothing
   — 4.7 kW/m² (1500 Btu/hr./ft²) in areas where emergency actions lasting several minutes may be required by personnel without shielding but with appropriate clothing
   — 1.6 kW/m² (500 Btu/hr./ft²) at any location where personnel are continuously exposed
   — temperature rating of electrical and mechanical equipment
   — 50% LEL at any point on the installation where the gas plume from a vent could be ignited or personnel could get into contact with the gas. The most unfavourable weather and process conditions have to be taken into consideration when calculating heat radiation and dispersion.

The limits above also apply to abnormal conditions (e.g. flame out of flare system and accidental ignition of vent).
4 Dangerous goods and cranes

4.1 Storage of dangerous goods

4.1.1 Dangerous goods should be stored safely and appropriately according to the nature of the goods.

(Ref. MODU Code 14.4.1)

Interpretation:

1) Stores for hazardous substances should be segregated from, and located at a safe distance from accommodation spaces and control stations.
2) Areas for storage of flammable, radioactive, explosive or otherwise hazardous substances should be marked with appropriate warning signboards.

------------------ end of Interpretation ------------------

4.1.2 Flammable liquids which give off dangerous vapours and flammable gases should be stored in a well-ventilated space or on deck.

(Ref. MODU code 14.4.3)

Interpretation:

1) Indoor storage areas should have access from open deck.
2) Equipment for storage and handling of cryogenic liquids (e.g. liquid nitrogen) should be located in open areas with efficient natural ventilation. Equipment with potential for significant leakage should be located in a bounded area, which is constructed of materials suitable for sustaining low temperatures. Reference also Sec.9 dealing with LNG terminals. Since evaporating cryogenic gases are heavier than air, care should be taken to ensure that such gases do not contaminate lower modules.

------------------ end of Interpretation ------------------

4.2 Cranes and lay down areas

Cranes and lay down areas shall be located so as to minimise the risk of load handling or dropped object damage to systems and structures.

(Ref. MODU code 12.1.2)

Interpretation:

1) The need for load handling above pressurised hydrocarbon equipment, hazardous inventories, and equipment important for safety should be avoided as far as possible. Suitable impact protection should be provided where such lifting cannot be avoided.
2) Lay down areas should be provided with heavy-duty barriers to prevent damage to adjacent equipment.
3) On floating installations, necessary points for securing of deck loading should be provided.
4) Lay down areas should be located outside hazardous areas.

------------------ end of Interpretation ------------------

5 Other requirements

5.1 Asbestos

The principal means of ensuring that no materials containing asbestos are installed on board the vessel rests with the ship builder and the subcontractors by managing procedures for purchasing and installing asbestos free materials.

Builders are upon completion of the vessel to issue an Asbestos Free Declaration that includes structures and equipment on board that have been known to contain asbestos, Ref. also MODU Code 2.10.3.
Guidance note:
IACS UI SC 249 Annex 1 gives an indicative list of components that have been known to contain asbestos.

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5.2 Railings and barriers
Railings and other barriers shall be designed with sufficient strength, height and arrangement such that personnel are protected from falling either overboard or more than 0.8 m to a lower deck level. The guard rails shall have at least three courses so arranged that the lowest rail is not more than 230 mm above the deck or toe board and the highest rail not less than 1 m above the deck.

Every deck, gangway, stairway and opening from which an object could drop more than 2 m, shall, where practicable, be provided with a toe board of not less than 150 mm height.
SECTION 3  HAZARDOUS AREA CLASSIFICATION

1  Introduction

1.1  Objective and scope

1.1.1  Objective
The provisions of this section is to identify areas where there is the potential for release of flammable gas, vapours or liquids during normal operation, at the same time assess frequency of release and the type of gas/vapour/liquid that may be released. The resulting hazardous areas classification will in turn specify the requirements of the equipment acceptable to install in that area.

1.1.2  Scope
Release as a result of accidental events such as blowout or vessel rupture is not addressed by area classification as is addressed in this section, but shall be covered by emergency shut down as is addressed in Sec.4.

1.2  Application

1.2.1  This section applies to all offshore units and installations covered by this standard. For supplementary requirements applicable for special types and services, see Sec.6 to Sec.9.

1.2.2  The standards listed in Table 1 are referred to for basic or supplementary information. The code revision applicable is that valid at date of issue of this standard unless otherwise agreed.

1.2.3  Hazardous area classification shall be documented by drawings including location, of air inlets and exhausts.

1.2.4  A schedule of release sources shall be established.

Guidance note:
IEC 61892-7 paragraph 10.1 and Table C2 provide further information.

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

2  Basic principles

2.1  Definition of hazardous areas

2.1.1  Hazardous areas are all those areas in which explosive gas or air mixture may normally be expected to be present in quantities which can require special precautions for the construction and use of electrical equipment and machinery.

(Ref. IACS UR D8.1.2)

2.1.2  Hazardous areas are divided into zones depending upon the grade (frequency and duration) of release:

a) Zone 0: in which an explosive gas atmosphere is continuously present or present for long periods. (Typical for continuous grade source present for more than 1000 hours a year or that occurs frequently for short periods).

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---
b) Zone 1: in which an explosive gas atmosphere is likely to occur in normal operation. (Typical for primary grade source present between 10 and 1000 hours a year).

c) Zone 2: in which an explosive gas atmosphere is not likely to occur in normal operation, and if it does occur, is likely to do so infrequently and will exist for a short period only. (Typical for secondary grade source present for less than 10 hours per year and for short periods only).

(Ref. IACS UR D8.1.3)

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

2.1.3 Non-hazardous areas are areas which are not hazardous according to the definitions in [2.1.1] and [2.1.2], either by safe location, by overpressure or by dilution ventilation.

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

2.2 Hazardous fluids (sources)

2.2.1 The following fluids shall be considered as sources requiring area classification:

a) Flammable gas or vapour.

b) Flammable liquids which are handled at or above their flashpoint, or which could be heated to the flashpoint after release.

c) Flammable liquid that could form a flammable mist.

d) Fluids which satisfy the criteria in a), b) or c), and which are present periodically within the plant for 100 hours per year or more (e.g. during start-up).

e) Unclassified, flammable liquids containing residual, volatile materials and which are stored under confined, heated conditions give rise to limited area classification.

2.2.2 App.A gives guidance for general categorisation of sources of release based on definitions in [2.1].

2.3 General principles for area classification

2.3.1 Location of a continuous source within an enclosed area, or in open areas with significant obstructions to ventilation, shall be avoided.

2.3.2 The number and release rate of primary grade sources shall be minimised as far as practicable. Location of a primary grade source within an enclosed area shall as far as practicable be avoided.

2.3.3 It is not normally acceptable to locate open, non-hazardous areas (significantly) surrounded by hazardous areas.

2.3.4 Openings, penetrations or connections between areas of different hazardous area classification shall be avoided, e.g. through ventilation systems, air pipes or drain systems.

2.4 Extent of the hazardous zone

2.4.1 The extent of the hazardous area depends on the rate of release, fluid properties and actual ventilation conditions as influenced by use of windshields, ventilation arrangements, structural arrangements (e.g., low deck head), etc.

(Ref. IACS UR D8.1.4)

2.4.2 The extent of the hazardous area shall be based on one of the recognised standards listed in Table 1.

2.4.3 Where there is a potential for large releases in operational situations covered by hazardous area classification, e.g. process vents, the extent of the zone shall be larger than the boundary of 50% LEL concentration. This shall be determined by a dispersion analysis. The resulting zone will be defined as Zone 1 or Zone 2 depending on likelihood of release.
2.4.4 For additional requirements, see Sec.6 for drilling units and Sec.7 for production and storage units.

3 Openings, access and ventilation conditions

3.1 General

3.1.1 Adequate ventilation is required to ensure that releases are rapidly dispersed. The adequacy of ventilation conditions shall be justified and documented.

(Ref. MODU code 6.4.1)

**Interpretation:**

Adequacy of ventilation should prevent stagnant areas and achieve a minimum of 12 volumetric air changes per hour.

Open areas without significant obstructions are considered to have adequate ventilation if air velocities are rarely below 0.5 m/s and frequently above 2 m/s.

------------ end of Interpretation ------------

3.1.2 Any connection between hazardous areas of different classification and between hazardous and non-hazardous systems shall be designed to eliminate or control the risk of ingress of hazardous material from one system to the other due to incorrect operation or leaks.

(Ref. MODU code 6.3.2)

3.2 Openings and access

3.2.1 Except for operational reasons access doors or other openings shall not be provided between: a non-hazardous space and a hazardous zone; a Zone 2 space and a Zone 1 space.

(Ref. MODU code 6.3.1)

3.2.2 Where such access doors or other openings are provided, any enclosed space having a direct access to any Zone 1 location or Zone 2 location becomes the same zone as the location except that:

a) an enclosed space with direct access to any Zone 1 location can be considered as Zone 2 if:

i) the access is fitted with a gas-tight door opening into the Zone 2 space, and

ii) ventilation is such that the air flow with the door open is from the Zone 2 space into the Zone 1 location, and

iii) loss of ventilation is alarmed at a manned station;

b) and enclosed space with direct access to any Zone 2 location is not considered hazardous if:

i) the access is fitted with a self-closing gas-tight door that opens into the non-hazardous location, and

ii) ventilation is such that the air flow with the door open is from the non-hazardous space into the Zone 2 locations, and

iii) loss of ventilation is alarmed at a manned station;

c) an enclosed space with direct access to any Zone 1 location is not considered hazardous if:

i) the access is fitted with gas-tight self-closing doors forming an airlock, and

ii) the space has ventilation overpressure in relation to the hazardous space, and

iii) loss of ventilation overpressure is alarmed at a manned station.

(Ref. MODU code 6.3.1)
Interpretation:

1) Alarm delay of up to 30 seconds for loss of overpressure may be applied for the above cases to minimise spurious alarms when doors are intentionally opened.

2) Immediate remedial action to restore ventilation should be taken upon identified loss of mechanical ventilation.

3) Failure or loss of overpressure ventilation and coincident gas detection (in adjacent area, in HVAC inlets or next to any entrance doors) requires isolation of all non-Ex equipment inside the room as the enclosed space then is considered to be hazardous.

3.2.3 Airlocks

The requirements for airlocks below apply when they are installed to prevent smoke or gas ingress.

Airlocks shall consist of gas tight steel bulkheads and gas tight self-closing doors.

Airlocks between zone 1 and non-hazardous space shall be classified as zone 2 and shall be adequately ventilated.

(Ref. MODU code 6.2.4.8 and 6.4.1)

Interpretation:

Mechanically ventilated airlocks should have positive pressure against the adjacent hazardous area or outside atmosphere such that air flow is towards the most hazardous area.

3.2.4 Where ventilation arrangements of the intended safe space are sufficient to prevent any ingress of gas from the Zone 1 location, the two self-closing doors forming an airlock may be replaced by a single self-closing gas-tight door which opens into the non-hazardous location and has no hold-back device.

(Ref. MODU code 6.3.1/ IACS UR D8.2.4)

3.2.5 Hold-back devices

Hold-back devices shall not be used on self-closing gastight doors forming hazardous area boundaries.

(Ref. MODU code 6.3.3)

3.3 General requirements for mechanical ventilation systems

3.3.1 See DNVGL-OS-D101 for general requirements for ventilation systems (e.g. capacity, functionality, penetrations etc.).

3.3.2 See Sec.2 [3.2] for requirement for location of air intakes.

3.3.3 See DNVGL-OS-D301 for requirements for gas detection in ventilation air intakes and outlets.

3.3.4 Ventilation systems for hazardous areas shall be separate from ventilation systems for non-hazardous areas.

(Ref. IACS UR D8.3.1)

3.3.5 Hazardous enclosed spaces shall be ventilated with under-pressure in relation to adjacent less hazardous locations. Fans shall be interlocked to ensure outlet fan is engaged prior to inlet fan, and ventilation failure shall initiate alarm at a manned location. Fans shall have non-sparking blades and Ex certified motors.

(Ref. IACS UR D8.3.2)

3.3.6 Inlet and outlet ventilation openings shall be arranged to provide efficient ventilation in relation to the location of equipment and sources in the area.

(Ref. IACS UR D8.3.2)
3.3.7 Ventilation inlet ducts passing through a more hazardous area than the ventilated space shall be operated at overpressure in relation to the hazardous area.

(Ref. IACS UR D8.3.1)

3.3.8 The outlet air from hazardous spaces shall be routed through separate ducts to outdoor area which, in the absence of the considered exhaust, is of the same or lesser hazard than the ventilated space. The internal spaces of such ducts belong to the same Zone as the inlet space.

(Ref. IACS UR D8.3.2)

3.3.9 The outlet ducts and the area in vicinity of the discharge point shall have the same area classification as the ventilated space. The dimension of the hazardous zone at outlet shall not be less than the zone dimensions in open air for the largest single source within the enclosed space.

(Ref. IACS UR D8.3.1)

3.4 Ventilation conditions for overpressure protection of enclosed spaces

The ventilation system shall be suitable to:

— maintain at least 50 Pa overpressure with respect to the external hazardous area when all penetrations are closed
— maintain an outward air flow through all openings (single or multiple penetrations) of the enclosed space.

Guidance note:
The design of doors should take account of differential pressures between spaces, such that personnel can easily open doors without hazard.

3.5 Dilution ventilation

Enclosed areas with internal source(s) of release may be defined as non-hazardous provided that ventilation is sufficient to ensure that the release is immediately diluted below flammable limits.

Interpretation:

1) The ventilation rate should be based on calculation using the total release rate from all primary grade sources together with the rate from the largest secondary grade source. For turbine hoods a minimum of 90 air changes per hour will normally be sufficient.

2) The ventilation system providing dilution ventilation should be provided with 2 times 100% fan capacity. One fan should be driven from the emergency source of power, in areas containing ignition sources that cannot be removed instantaneously.

3) Emergency power supply for main turbine hood fans is not required if main power supply to the fans can be maintained from other turbine(s).

4) The ventilation system should be suitable to avoid stagnant areas, and flow of ventilation air should be continuously monitored.

5) Non-Ex-certified electrical equipment and other ignition sources should be isolated immediately upon failure of ventilation or upon gas detection unless such shutdown can cause escalation of the danger, in which case suitable alarms should be given in control room and other essential locations which may need to provide immediate action.

6) Gas detection levels for rooms with dilution ventilation should be as low as possible, and no higher than 10% LEL for alarm level and 25% LEL for shutdown level.

--------- end of Interpretation ---------

3.6 Ventilation of battery compartments

Ventilation arrangement for battery rooms shall be in accordance with DNVGL-OS-D201 Ch.2 Sec.2 [9.4.6].
4 Electrical installations in hazardous areas

4.1 Principle requirement
Electrical equipment and cables installed in hazardous areas shall be limited to that necessary for operational purposes.
(Ref. MODU code 6.6.1)

4.2 General requirements

4.2.1 All electrical installations in hazardous areas shall comply with the requirements of DNVGL-OS-D201 Ch.2 sec.11.

4.2.2 Electrical equipment with maximum surface temperature of 200°C shall be used when hydrocarbon gases give rise to hazardous areas.
SECTION 4 EMERGENCY SHUTDOWN

1 Introduction

1.1 Objective and scope

1.1.1 Objective
The purpose of the Emergency Shutdown (ESD) systems in the event of abnormal conditions is to minimise the escalation of events and to minimise the extent and duration of such events. This is achieved by a combination of actions including stopping of hydrocarbon flow and shutdown of equipment and systems to bring them to a predefined safe state. Where relevant the ESD system will also remove pressure and hydrocarbon from equipment by means of venting and flaring. The ESD system will carry out ignition source control by isolating any potential ignition sources before flammable gasses can reach them.

1.1.2 Scope
This section provides generic requirements applicable for all service types. Service type specific requirements are given Sec.6 to Sec.9.

1.2 Application

1.2.1 These requirements are applicable to all mobile units or offshore installations including mobile units without own gas hazards which are located adjacent to operational mobile unit or offshore installation which has potential for hydrocarbon release.

1.2.2 The requirements of DNVGL-OS-D202 apply to the emergency shutdown system.

1.3 Definition
An emergency shutdown system comprises:

— manual input devices (push buttons)
— field devices (e.g. level, pressure sensors)
— interfaces towards other safety systems as applicable, as e.g.:
  — fire detection system
  — gas detection system
  — alarm and communication systems
  — process shutdown system
  — drilling and well control system
  — fire fighting systems
  — ventilation systems.

— a central control unit receiving and evaluating signals from the manual input devices and the interfaced systems, and creating output signals to devices that shall be shut down or activated. The ESD central shall include a device providing visual indication of initiated inputs and activated outputs and a local audible alarm

— output actuators as e.g. relays, valves and dampers, including status indicators
— signal transfer lines between the ESD central and all input devices, interfaced systems and output actuators
— power supply.
2 Generic requirements

2.1 General

2.1.1 In order to meet the objective of ignition control in abnormal condition, an ESD system shall be provided to facilitate the selective disconnection or shutdown of:

1) ventilation systems, except fans necessary for supplying combustion air to prime movers for the production of electrical power;
2) main generator prime movers, including the ventilation systems for these;
3) emergency generator prime movers.

(Ref. MODU code 6.5.1)

Interpretation:

1) All HVAC inlets without dedicated gas detection should be automatically shutdown immediately upon gas detection anywhere. Shutdown of HVAC implies trip of HVAC fan and close of relevant dampers. Individual HVAC inlets provided with dedicated gas detection should be automatically shutdown immediately upon local gas detection.

2) Air inlets for prime movers for production of electricity do not need to be individually tripped if they supply combustion air to the prime mover only. Combined HVAC- and combustion inlets do not need to be tripped if branch take-off to room ventilation can be tripped.

2.1.2 Disconnection or shutdown shall be possible from at least two strategic locations, one of which shall be outside hazardous areas.

(Ref. MODU code 6.5.3)

Interpretation:

1) Additional automatic inputs will be accepted

2) Locations indicated in Table 1 should be applied as a basis with additional consideration given to installation-specific requirements given in Sec.6 to Sec.9.

Table 1 Location of push buttons for manual shutdown

<table>
<thead>
<tr>
<th>Shutdown level</th>
<th>Location of push-button</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abandon vessel (AVS)</td>
<td>— main and emergency control rooms, i.e. bridge and back-up control room</td>
</tr>
<tr>
<td></td>
<td>— muster stations, lifeboat stations and helicopter deck (not required for DP positioned mobile units)</td>
</tr>
<tr>
<td></td>
<td>— bridge connections between units/installations (if any)</td>
</tr>
<tr>
<td>Emergency shutdown (ESD)</td>
<td>As for AVS, plus (where applicable):</td>
</tr>
<tr>
<td></td>
<td>— process control room</td>
</tr>
<tr>
<td></td>
<td>— driller’s control cabin</td>
</tr>
<tr>
<td></td>
<td>— back up DP control</td>
</tr>
<tr>
<td></td>
<td>— exits and main escape routes from process, drilling, wellhead, riser areas etc</td>
</tr>
<tr>
<td>Manually activated call point (MAC)</td>
<td>Readily available for use in all normally manned areas (see DNVGL-OS-D301 Ch.2 Sec.4 [3])</td>
</tr>
</tbody>
</table>

2.1.3 Shutdown systems shall be so designed that the risk of unintentional stoppages caused by malfunction in a shutdown system and the risk of inadvertent operation of a shutdown are minimized.

(Ref. MODU code 6.5.4)
Interpretation:

1) The ESD system should be designed to allow testing without interrupting other systems onboard.
2) The ESD Operator Station/HMI unit should be located in a non-hazardous and continuously manned area.
3) The ESD control unit(s) shall have two power supplies; one from the main power system and one from a monitored uninterruptible power supply (UPS). This UPS shall be powered from the emergency power system and with battery back-up sufficient to operate the system for at least 30 minutes.
4) The ESD system should have continuous availability R0 as defined in DNVGL-OS-D202 Ch.2 Sec.1 [2.2] and be regarded as a safety system. This implies that the system is both redundant and not vulnerable to a single failure or fail-safe on instrumentation failure as is specified below. Components like valves and actuators, etc. are not required to be redundant.
5) Upon failure of the ESD system, all connected systems should default to the safest condition for the unit or installation. The safest conditions defined in Table 2 normally apply. The table is not intended to be comprehensive, so that other safety-related systems should also be considered in a similar way. Table 2 is primarily intended for systems shutdown/operations and not individual components within the system.
6) Failures to be considered for the shutdown system should include broken connections and short circuits on input and output circuits, loss of power supply and if relevant loss of communication with other systems. In this case, ‘circuit’ is defined as any signal transfer facility, e.g. electrical, pneumatic, hydraulic, optical or acoustic.

Table 2 Safest conditions and corresponding output circuit configuration

<table>
<thead>
<tr>
<th>System</th>
<th>Safest condition in case of failure to the shutdown system</th>
<th>Output circuit configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire pump drivers (start function)</td>
<td>Operational</td>
<td>NE</td>
</tr>
<tr>
<td>Electrical power generation, including required auxiliary systems, for units not dependent upon active position keeping</td>
<td>Shut down ¹)</td>
<td>NE</td>
</tr>
<tr>
<td>Electrical power generation, including required auxiliary systems, for units dependent upon active position keeping</td>
<td>Operational ¹)</td>
<td>NDE</td>
</tr>
<tr>
<td>Uninterruptible power supplies for power generation, control and safety systems</td>
<td>Operational ¹)</td>
<td>NDE</td>
</tr>
<tr>
<td>Propulsion and steering for units not dependent upon active position keeping</td>
<td>Shut down ¹)</td>
<td>NE</td>
</tr>
<tr>
<td>Propulsion and steering for units dependent upon active position keeping</td>
<td>Operational</td>
<td>NDE</td>
</tr>
<tr>
<td>Fire dampers ²)</td>
<td>Shut down</td>
<td>NE</td>
</tr>
<tr>
<td>Utility systems which do not affect safety functions</td>
<td>Shut down</td>
<td>NE</td>
</tr>
</tbody>
</table>

¹) Some installations may have multiple operational modes; e.g. storage units intended to transport crude oil to port. In such cases, the safest conditions for each operational mode shall be identified and implemented (e.g. through facilities for bypass of high level ESD trips during transit).
²) For units dependent upon active position keeping, fire dampers in ventilation inlets for combustion air may be NDE.

The above principles apply for offshore operating condition. However, for mobile units in transit the requirements in MODU Code sec. 14.8 or SOLAS Chapter II-1/43 apply. This may imply that relevant ESD actions have to be partially or completely disabled during transit.

NDE = normally de-energised, NE = normally energised

2.1.4 Equipment which is located in spaces other than enclosed spaces and which is capable of operation after shutdown shall be suitable for installation in zone 2 locations. Such equipment which is located in enclosed spaces shall be suitable for its intended operation (Ref. MODU code 6.5.5)
Interpretation:

1) The term ‘capable of operation after shutdown’ should be understood to mean ‘operational after initiation of selective disconnection’ described in [2.1.1].

2) It should be possible to isolate non-Ex equipment in naturally ventilated areas upon gas detection. The shutdown may be manual or automatic depending on the operational philosophy of the unit. Exemption is the equipment listed in [2.1.5].

3) Suitable equipment should be understood to be certified by an independent laboratory. If this is not possible, the suitability should be assessed on a case-by-case basis.

4) Rooms with safety critical non-Ex equipment should have at least two doors towards outside areas effectively forming a semi-airlock. Spaces with only one barrier against gas ingress should have only Ex-equipment. Typical living quarters design may meet this requirement, other enclosed spaces will be specially considered based on the above principles.

5) Unconfirmed gas detection should initiate alarm in the crane cabin. Non-operational cranes should be automatically de-energised if hydrocarbon gas is detected anywhere. Operational cranes should be subject to manual isolation of uncertified electrical equipment and other ignition sources after securing of load. Confirmed gas detection at the crane ventilation intake should initiate automatic isolation of the crane.

Guidance note:
This early warning to crane operator is to give the operator enough time to secure the load and avoid possible suspended load if power to crane is lost as a result of rapid escalation of the event.

For units with dedicated extract systems for shale shaker and mud tanks, gas detection from these systems does not require tripping of welding sockets in non-essential temporary equipment neither alarm to crane operator as specified in Interpretation 3) resp. 5). For guidance on ignition source control and the selection/location of electrical equipment, see App.C.

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2.1.5 At least the following facilities shall be operable after an emergency shutdown:

1) emergency lighting for half an hour;
2) general alarm system;
3) public address system; and
4) battery-supplied radio communication installations.

(Ref. MODU code 6.5.5)

Interpretation:

1) The safety critical systems listed may be non-Ex provided that the ventilation to the room where the equipment is located is shut down and the room is efficiently isolated against gas ingress.

2) The period of which the above facilities are available should be at least 30 min (based on the required availability for emergency lighting).
SECTION 5 ESCAPE AND COMMUNICATION

1 General

1.1 Objectives
The design of the mobile unit or offshore installation shall include adequate and effective facilities for safe and controlled emergency response during defined accidental events. This includes:

— routes which allow personnel to escape from the immediate effects of a hazardous event to a place of temporary refuge
— provision of temporary refuge for the time required for incident assessment and controlled evacuation
— rescue of injured personnel
— safe evacuation of the unit or installation.
(Ref. MODU code 9.4 and 10.4)

1.2 Application
1.2.1 Requirements for emergency response strategy, rescue and evacuation means and safety equipment are not included in this standard. Relevant flag state requirements for flagged units and/or coastal state requirements shall be applied.

1.2.2 The provisions of this section are provided as minimum requirements, and should be supplemented where appropriate, on the basis of an overall safety evaluation.

2 Escape routes

2.1 Principles
2.1.1 Safe, direct and unobstructed exits, access, and escape routes shall be provided from all regularly manned areas of the mobile unit or offshore installation to temporary refuge, muster areas and embarkation or evacuation points.
(Ref. MODU code 9.4.1 to .3)

Interpretation:
The escape routes should not be blocked by portable equipment, supplies or piping/valves etc. If obstructions exist, these should be clearly marked.

---------------------------------- end of Interpretation ----------------------------------

2.1.2 All regularly manned areas shall be provided with at least two exits and escape routes, separated as widely as practicable such that at least one exit and the connected escape route will be passable during an accidental event. Escape routes shall normally be provided on both sides of the mobile unit or offshore installation.
(Ref. MODU code 9.4.1.1)

Interpretation:

1) Two escape routes need not necessarily apply to infrequently manned areas or areas which require entry permit, e.g. which are subject to structural inspection only, where suitable arrangements can be made with temporary access facilities (e.g. scaffolding etc.). This is dependent on size of space and number of persons entering, etc. STP/STL spaces are not included in this exemption.

2) Single exits may be acceptable from small access platforms, rooms and cabins with low vulnerability to the location or room or the exit area.

---------------------------------- end of Interpretation ----------------------------------

Interpretation:
2.1.3 Dead ends greater than 7 m in length shall be avoided.
(Ref. MODU code 9.4.1.3)

2.2 Sizing

2.2.1 Escape routes shall be of suitable size to enable quick and efficient movement of the maximum number of personnel who may require using them, and for easy manoeuvring of fire-fighting equipment and use of stretchers.

Interpretation:
Typical values for width of escape routes would be 1 m for main escape routes, and 0.7 m for secondary escape routes. Main and secondary escape routes are expected to be addressed in the evacuation study.

2.2.2 For access and escape behind switchboards, reference is made to requirements in DNVGL-OS-D201 Ch.2 Sec.2 [9.2.3].

2.3 Walkways, stairs, ladders and lifts

2.3.1 Any necessary changes in elevation along escape routes shall be by stairs. Ladders may only be accepted where it is clearly not practicable to install stairs, and only for use by a very limited number of personnel in an emergency.
(Ref. MODU code 9.4.1.2)

2.3.2 Lifts shall not be considered as an emergency means of escape.
(Ref. MODU code 9.4.4)

2.3.3 All escape route doors shall be readily operable in the main direction of escape and shall not be a hazard to personnel using the escape route outside. Doors from cabins and small offices are excluded from this requirement.

Guidance note:
There are cases where the main direction of escape is in conflict with opening directions of the door required for other reasons, e.g. stability, water/weather tightness, hazardous areas adjacent to safe areas. In such cases it is accepted that these doors open in opposite direction.

2.3.4 The surfaces of decks, walkways, platforms, stairs and ladder rungs etc. shall be non-slip, and designed for drainage and easy cleaning of contaminants like mud and oil, where relevant

2.4 Escape from machinery spaces category A

2.4.1 Two means of escape shall be provided from every machinery space of category A.

2.4.2 In case ladders are part of the escape ways as required in [2.4.1], these shall be of steel or other equivalent material. In particular, one of the following provisions shall be complied with:

a) Two sets of ladders, as widely separated as possible, leading to doors in the upper part of the space, similarly separated and from which access is provided to the open deck. One of these ladders should be located within a protected enclosure that satisfies tables 1-3 and 1-4 in DNVGL-OS-D301 Ch.2 Sec.1 [3], category (4), from the lower part of the space it serves to a safe position outside the space. Self-closing fire doors of the same fire integrity standards should be fitted in the enclosure. The ladder should be fixed in such a way that heat is not transferred into the enclosure through non-insulated fixing points. The enclosure should have minimum internal dimensions of at least 800 mm by 800 mm, and should have emergency lighting provisions; or

b) One ladder leading to a door in the upper part of the space from which access is provided to the open deck. Additionally, in the lower part of the space, in a position well separated from the ladder referred
to, a steel door capable of being operated from each side shall be provided with access to a safe escape route from the lower part of the space to the open deck.

(Ref. MODU code 9.4.2)

2.5 Helicopter decks
A helideck shall be provided with both a main and an emergency means of escape and access for fire fighting and rescue personnel. These shall be located as far apart from each other as is practicable and preferably on opposite sides of the helideck.

(Ref. MODU Code 9.16.3)

3 Muster areas and lighting

3.1 Muster areas

3.1.1 Easily accessible muster areas shall be clearly defined on the mobile unit or offshore installation. All muster areas shall be located with direct and ready access to survival craft or other life-saving appliances.

3.1.2 Each muster station shall have sufficient space to accommodate all persons assigned to muster at that station, but at least 0.35 m² per person.

(Ref. MODU code 10.4.1)

3.1.3 Muster areas shall be provided with suitable protection and facilities, including emergency lighting and communications, for use in design accidental events.

(Ref. MODU code 10.4)

4 Emergency lighting

4.1 Specific requirement

4.1.1 All regularly manned areas on the mobile unit or offshore installation shall be equipped with emergency lighting, which is supplied from the emergency source of power. The illumination level shall be sufficient to ensure that necessary emergency response actions, including reading of signs and layouts, can take place efficiently.

4.1.2 Escape routes, access routes and exit points shall be illuminated so they are readily identifiable in an emergency.

(Ref. MODU code 9.4.1.4)

4.1.3 Muster areas, embarkation areas, launching arrangements, the sea below lifesaving appliances and locations for emergency towing connections shall be adequately illuminated by emergency lighting.

(Ref. MODU code 10.4.4)

4.1.4 For capacity and duration requirements reference is made to DNVGL-OS-D201 Ch.2 Sec.2 [3.1] including Table 2-1 and [6.2].

**Guidance note:**
For availability of emergency lighting requirements after ESD see [Sec.4 [2.1.5]].

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

5 Marking and warning signboards

5.1 General

5.1.1 The escape way shall be provided with marking, enabling personnel to identify the routes of escape and readily identify the escape exits.

(Ref. MODU code 9.4.1.4)
5.1.2 Fire fighting equipment shall be marked as required in DNVGL-OS-D301.

5.2 Safety plans and warning signboards

5.2.1 Orientation and safety plans shall be strategically located at major circulation points on the mobile unit or offshore installation (e.g. near the main stairways). The safety plans shall contain the following information:

— plan view of each level of the unit or installation
— escape routes and muster areas
— embarkation areas and means of evacuation
— means of escape, life rafts, ladders etc.
— location or personal protective equipment
— location of push-buttons for alarm and shutdown.

5.2.2 Entrances to enclosed spaces where there is a danger of asphyxiating or toxic atmosphere shall be marked with appropriate warning signs.

5.2.3 Self-closing doors between areas with different area classification shall be fitted with signboards. See IEC 61892-7, paragraph 4.10.5 for details.

5.2.4 Internal openings fitted with appliances to ensure watertight integrity shall be fitted with a signboard indicating that the opening is always to be kept closed while afloat.

(Ref. IACS UR D7.4.2)

6 Communications and alarms

6.1 Introduction

6.1.1 Objective
Communication and alarm systems shall be provided to alert all personnel on board, at any location, of an emergency. The systems shall be suitable to provide instructions for emergency response.

6.1.2 Scope
This sub section provides requirements for internal communication and emergency alarms. Requirements for alarms related to safety- and control systems are given in DNVGL-OS-D202.

Requirements for alarms in connection with watertight doors and release of hazardous fire extinguishing medium are given in DNVGL-OS-C301 and DNVGL-OS-D301.

6.1.3 The emergency alarm system comprises:

— manual alarm input devices
— input lines from detector and shutdown systems
— alarm central unit receiving and evaluating input signals and creating output signals to alarm sounding devices
— alarm sounding devices such as bells, flashing lights and/or loudspeakers
— power supply.
6.2 General requirements

6.2.1 The following distinctive alarms shall be provided where relevant:
- abandon unit
- general emergency/muster covering fire and hydrocarbon gas detection
- toxic gas (e.g. hydrogen sulphide) detection.

(Ref. MODU code 5.7.2, IACS UR D11.5.1 and ISO 13702, B7)

6.2.2 The internal communication extensions at control stations and the navigation bridge shall have priority.

6.2.3 The required internal communication and alarm systems shall be powered from the main power system and from a monitored Uninterruptible Power Supply (UPS) for continuous operation on loss of main power. The UPS shall be powered from the emergency power system for a period of at least 18 hours and have a capacity as a stand-by power sufficient to operate the system for at least 30 minutes.

(Ref. MODU code 5.4.6.4 and 5.4.10)

6.2.4 The alarms shall be clearly audible at all locations on the unit or installation, and shall be easily distinguishable. If noise in an area prevents the audible alarm being heard a visible means of alarm shall be provided.

(Ref. MODU code 5.7.2 and IMO Res. A.1021, 4.2)

Guidance note:
Alarm to areas which are not regularly manned (e.g. cofferdams, tanks) may be covered by procedural precautions, e.g. using portable radios.

FSS code Ch. 9.2.5.1.9 details the above requirement to a sound pressure levels at the sleeping positions in the cabins and 1 m from the source shall be at least 75 dB(A) and at least 10 dB(A) above ambient noise levels existing during normal operations. The sound pressure level should be in the 1/3 octave band about the fundamental frequency. Audible alarm signals shall not exceed 120 dB(A).

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

6.2.5 The mobile unit or offshore installation shall be equipped with a public address system at any spaces which are normally accessible to personnel during routine operations.

(Ref. MODU code 5.7.3)

6.2.6 The alarm system may be combined with the public address system, provided that:
- alarms automatically override any other input (emergency announcements are allowed to mute the alarm)
- volume controls are automatically set for alarm sounding
- all parts of the public address system (e.g. amplifiers, signal cables and loudspeakers) are made redundant
- redundant parts are located or routed separately
- all loudspeakers are protected with fuses against short circuits.

6.2.7 Activation of the general alarm shall be possible from the main control stations, including at least, the navigation bridge or radio room, drilling console (if any) and fire control station.

(Ref. IACS UR D11.5.1)

6.2.8 Internal means of communication shall be available for transfer of information between all spaces where action may be necessary in case of an emergency.

(MODU code 5.7.5)

6.2.9 Provision shall be made for functionally testing required alerts and indicators.

(Ref. IMO Res. A1021(26), 4.12)

6.2.10 The public address and alarm system shall be powered as required by DNVGL-OS-D201 Ch.2 Sec.2, including an transitional source of power/ UPS.
SECTION 6 SPECIAL PROVISIONS FOR DRILLING AND/OR WELL INTERVENTION UNITS

1 Introduction
In addition to the provisions given in Sec.1 to Sec.5 of this chapter, the following requirements apply specially for mobile drilling units and well intervention units with return of hydrocarbon fluids.

Guidance note:
One can read ‘well intervention’ for all instances of ‘drilling’ in the section’s text.

2 Arrangement

2.1 General
Design and location of equipment shall take account of motion of the unit and the possible effects of green sea.

2.2 Mooring systems
2.2.1 Mooring systems, including winches, tensioners, chain stoppers etc. should be located in open, non-hazardous areas. Where this is not practicable, special precautions shall be taken to ensure that such items do not become a source of ignition also during emergency release.

2.2.2 Chain lockers and chain pipes should be arranged in a non-hazardous area. Where such location is not practicable, permanent facilities for gas freeing (e.g. flushing or purging) the chain lockers and chain pipes shall be provided.

2.3 Moonpools
2.3.1 Moonpools shall have adequate scantling and stiffening to avoid damage from impact from load handling.

2.3.2 For ship shaped drilling units, the moonpool for drilling shall be surrounded by a cofferdam. However, cofferdams may be omitted in areas with an equivalent arrangement of ballast water tanks, drill water tanks etc., which are easily accessible for inspection immediately after being pumped out.

2.4 Production and well testing
2.4.1 Drilling units intending to utilise facilities for storage and offloading of crude oil are to satisfy relevant requirements for production and storage units as given in Sec.7. Specifically is referred to the protection systems and shutdown logic principles of Sec.7 [4] as applicable for the ESD.

2.4.2 The arrangement of functions and equipment shall facilitate well operations and control in normal and emergency situations, taking into account the elements as listed in Sec.2 [2.2.2].

2.4.3 Arrangement of burner booms shall be in line with Sec.2 [3.4] regarding location requirements and Sec.3 [3] for the extent of hazardous areas.

2.4.4 Flow lines shall be located to avoid damage e.g. by fire, explosion or impact from dropped objects.

2.4.5 Flow lines ESD valves shall be located in easily accessible, well-ventilated areas, to avoid damage from dimensioning accidental events such as fire, explosion and mechanical impact.

2.5 Control station
2.5.1 At least two control stations shall be provided. One of the stations shall be located in the drilling control room and a second station shall be at a suitable manned location outside the hazardous areas, normally on the bridge/CCR.
2.5.2 The control stations are to be provided with:

— manually operated push-buttons for actuating the general alarm system.
— an efficient means of communication between these stations and all manned locations vital to the safety of the vessel.
— emergency shutdown facilities.

2.5.3 At least two BOP control panels shall be provided. One panel shall be located in the drilling control room and one panel shall be on the bridge/CCR or in the toolpusher’s office. For panels located outside the bridge/CCR, efficient means of communication between these locations and all manned locations vital to the safety of the vessel shall be provided.

3 Hazardous area classification

3.1 General

3.1.1 These requirements are supplementary to general requirements given in Sec.3.

3.1.2 Hazardous areas are all those areas where, due to the possible presence of a flammable atmosphere arising from the drilling operations, the use without proper consideration of machinery or electrical equipment may lead to fire hazard or explosion.

(Ref. IACS UR D8.1.2)

Interpretation:

1) Drilling fluid should be considered as hazardous also after final degassing discharge when it is flammable and is handled at temperatures above flash point, e.g. due to high formation temperatures.

2) Where a cementing unit is used for well control (kill) operations and may use active mud, the space containing the cementing unit should be considered.

3) Outlets from drilling diverter line and overboard line from kill and choke manifold should be located at a safe distance from potential sources of ignition.

4) If data on expected flow rate is available, dispersion calculations should be applied to identify the actual size of the gas plume.

------------------------------------------------- end of Interpretation -------------------------------------------------

3.1.3 Areas containing well test equipment and associated flowlines and burner arrangements shall be classified in accordance with the same general principles as for equivalent production equipment.

3.1.4 The dedicated area for well test equipment and associated piping shall be indicated on area classification drawings that shall include temporary test equipment.

3.1.5 Typical drilling plants shall be classified in accordance with requirements of one of the reference documents as listed in Sec.3 Table 1 taking into account the minimum requirements as given in [3.2].

Guidance note:
The flag or other authorities may enforce compliance to the hazardous area classification as specified in the MODU code.

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

3.2 Drilling plant/well intervention plant

3.2.1 Hazardous areas Zone 0 include the internal spaces of closed tanks and pipes for active drilling mud, as well as oil and gas products, for example escape gas outlet pipes, or spaces in which an oil/gas/air mixture is continuously present or present for long periods.

(Ref. IEC 61892-7, sec. 4.6.1)
3.2.2 Hazardous areas Zone 1 include:

i) Enclosed spaces containing any part of the mud-circulating system that has an opening into the spaces and is between the well and the final degassing discharge.

ii) In outdoor or semi-enclosed locations except as provided for in (iv), the area within 1.5 m (5 ft) of the boundaries of any openings to equipment which is part of the mud system as specified in (i), any ventilation outlets of Zone 1 spaces, or any access to Zone 1 spaces.

iii) Pits, ducts or similar structures in locations which otherwise would be Zone 2 but which are arranged so that the dispersion of gas may not occur

iv) Enclosed spaces or semi-enclosed locations that are below the drill floor and contain a possible source of release such as the top of a drilling nipple.

v) Enclosed spaces that are on the drill floor and which are not separated by a solid floor from the spaces in (iv).

(Ref. IACS UR D8.2.2)

3.2.3 Hazardous areas Zone 2 include:

i) Outdoor locations within the boundaries of the drilling derrick up to a height of 3 m above the drill floor.

ii) Semi-enclosed derricks to the extent of their enclosures above the drill floor or to a height of 3 m above the drill floor, whichever is greater.

iii) Semi-enclosed locations below and contiguous with the drill floor and to the boundaries of the derrick or to the extent of any enclosure which is liable to trap gases.

iv) Outdoor locations below the drill floor and within a radius of 3 m from a possible source or release such as the top of a drilling nipple.

v) The areas 1.5 m beyond the Zone 1 areas specified in [3.2.2](ii) and beyond the semi-enclosed locations specified in [3.2.2](iv).

vi) Outdoor spaces within 1.5 m of the boundaries of any ventilation outlet from or access to a Zone 2 space unless Sec.2 [3.2.1] is applicable.

(Ref. IACS UR D8.2.3)

3.3 Electrical installations in hazardous areas

Electrical equipment and wiring installed in hazardous areas shall be limited to that necessary for operational purposes.

(Ref. MODU code 6.6.1)

Interpretation:

Electrical cables should as far as possible to be routed outside areas containing drilling mud.

----------------- end of Interpretation -----------------

4 Emergency shutdown

4.1 Introduction

4.1.1 These requirements are supplementary to the requirements in Sec.4.

4.1.2 The requirements are split between basic provisions in [4.2] and requirements for an enhanced ESD system in [4.3].

4.1.3 Objective

The basic provisions describe an ESD system with a simplified shutdown hierarchy aligned and in compliance with international regulations.

The enhanced ESD system requires a safety and shutdown philosophy on which a shutdown logic is to be based. The required implementation of this logic together with additional technical requirements as listed, aim for a more robust system.
4.1.4 Scope
The basis provisions cover the MODU code requirements specific for a drilling unit, completed with DNV GL Interpretations.

The Enhanced ESD requirements include in addition:

— Safety and shutdown philosophy
— Shutdown logic
— Automatic and manual shutdown
— Additional provisions.

4.1.5 Application
For classification purposes, the requirements for Enhanced ESD are only applicable for vessels with the voluntary class notation ES. See Ch.3.

4.2 Basic provisions
4.2.1 In the case of units using dynamic positioning systems as a sole means of position keeping, special consideration shall be given to the selective disconnection or shutdown of machinery and equipment associated with maintaining the operability of the dynamic positioning system in order to preserve the integrity of the well.

(Ref. MODU code 6.5.2)
Interpretation:

1) For units with DP as position keeping system the combustion air inlet should be maintained while the room ventilation is shut-off.
2) Special consideration should also be given to thruster assisted mooring systems.

4.2.2 Shutdown systems shall be so designed that the risk of unintentional stoppages caused by malfunction in a shutdown system and the risk of inadvertent operation of a shutdown are minimized.

(Ref. MODU code 6.5.4)
Interpretation:

In addition to conditions as listed in Table 2, the conditions of the table below should normally apply.

<table>
<thead>
<tr>
<th>System</th>
<th>Safest condition in case of failure to the shutdown system</th>
<th>Output circuit configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drilling system</td>
<td>Operational 1)</td>
<td>NDE</td>
</tr>
</tbody>
</table>

1) See DNVGL-OS-E101 for further details
NDE = normally de-energised NE = normally energised

4.2.3 In addition to the facilities as listed at Sec.4 [2.1.5], the blow out preventer shall be operable after an emergency shutdown.

(Ref. MODU code 6.5.5.2)
4.3 Enhanced ESD

4.3.1 General
The requirements in this section are only applicable for vessels with the voluntary class notation ES.

4.3.2 Safety and Shutdown Philosophy
A safety and shutdown philosophy shall be established, comprising functional requirements for the safety systems upon detection of an abnormal condition. The fail-safe functionality for the safety systems shall be included.

4.3.3 The philosophy shall take due notice of which position keeping means the unit is based. The philosophy document shall describe the principles for the actions to:

— limit the duration and severity of the incident
— maximise the ignition control related to the incident (e.g. ventilation/dampers, ignition sources)
— protect personnel exposed to the incident
— limit environmental impact
— facilitate escape, muster and evacuation, as necessary.

4.3.4 Inter-relationships and requirements for the following systems, if installed on the installation or unit, shall be addressed:

— emergency shutdown (ESD) system
— fire and gas detection system
— process shutdown system
— drilling and well control systems
— alarm and communication systems
— active fire fighting systems
— ventilation systems
— energy sources and associated utilities required to drive essential and emergency functions.

4.3.5 Shutdown Logic
Shutdown shall be executed in a pre-determined, logical manner to meet the objectives defined in Sec.4 [1.1]. Definition of the logic and required response time shall include consideration of interactions between systems and dynamic effects.

A shutdown logic shall be implemented to determine the response to different degrees of emergency conditions. The shutdown logic shall be as simple as possible. The shutdown logic given in Figure 1 and Figure 2 shall be applied as basis with additional due recognition of installation specific requirements.

4.3.6 Drilling units with multiple position keeping systems shall have a shutdown logic implemented with clear identification of and due consideration of the change between the various position keeping systems.

4.3.7 Shutdown shall not require unrealistically quick or complex intervention by the operator.

4.3.8 Shutdown shall initiate alarm at the control station. The initiating device of the shutdown shall be indicated at the control station. For shutdown actions, status shall be available and an additional alarm shall be given by the ESD system when actions have not reached intended position.

The status of other safety systems shall be indicated at the control station.

4.3.9 Upon confirmed gas detection automatic actions to ensure ignition control shall be implemented. This implies:

— Tripping of electrical equipment
— Tripping of HVAC fans for room cooling and closing of firing dampers

4.3.10 Personnel lifts, work platforms and other man-riding equipment shall be designed to enable safe escape after an emergency shutdown, e.g. by controlled descent to an access point on a lower level.
4.3.11 Systems which are not permanently attended during operation, and which could endanger safety if they fail, shall be provided with automatic safety control, alert and alarm systems.

4.3.12 Plants that are protected by automatic safety systems shall have pre-alarms to alert when operating parameters are exceeding normal levels.

4.3.13 The shutdown command shall not be automatically reset.

4.3.14 Automatic and Manual Shutdown

Shutters shall normally be automatically initiated (in line with [4.3.10]), however solely manually initiated actions may be provided where automatic action could be detrimental to safety, e.g. for dynamic positioning and draw works.

4.3.15 Alarm for manual initiation shall be clear, and shall be readily identifiable at a permanently manned control station. The operator must have sufficient time to acknowledge and execute shutdown before an incident escalates. Manual activation shall be simple and quick to operate. Ref. also Sec.4 [2.1.1].

4.3.16 In all shutdown systems, it shall be possible to manually activate all levels of shutdown at the main control station.

4.3.17 Additional provisions

The ESD operator station/ HMI units shall be located in an area safe by location and continuously manned.

4.3.18 The logic solver(s) shall be located in an area safe by location, normally in accommodation or similar.

4.3.19 If the logic solvers are distributed to more than one location, it shall be demonstrated that the integrity, including communication between logic solvers, is equivalent to that of a centralised system.

4.3.20 The actions required for ESD shall be independent of systems other than safety systems.

4.3.21 When a risk assessment assumes relocation of the unit, system design shall support safe emergency relocation including disconnection from the well and release of mooring lines as applicable.

Guidance note:
If position keeping lines need to be released, adequate protection to avoid sparking is expected to be part of the design.

---e-n-d-o-f---g-u-i-d-a-n-c-e-n-o-t-e---
Figure 1 Outline ESD logic for an anchored drilling unit

Abandon Vessel Shutdown

- Initiate AVS alarm
- Confirmed gas detection in air inlet to non-hazardous area
- Manual ESD Push Button
  - Gas detection in hazardous area
  - Fire detection in hazardous area
  - MAC
  - Start fire pumps
- Trip affected ventilation system(s)
- Start Emergency Generator (0-voltage relay in emergency s/b)
- Activate Quick Disconnect
- Trip ventilation to areas with main and auxiliary power.
- Shut down main and auxiliary power generation
- Trip all potential ignition sources in hazardous areas (e.g. normal lighting, non-critical Ex-equipment)
- Isolate uncertified ignition sources (Welding sockets, temporary equipment etc. shall be isolated on unconfirmed, low level gas detection) (Alarm to crane operator shall be given on unconfirmed gas detection)
- Isolate well test plant
- Trip all non-important ventilation intakes (not related to main power and safety critical systems) including any ventilation system not monitored by gas detection

ESD High Level

- Manual ESD Push Button to initiate evacuation
- Manual AVS Push Button to initiate evacuation
- Manual Push Button. Trip to override shutdown timer
- Timer based shutdown of:
  - BOP control system
  - Fire and Gas systems
  - ESD system
  - Alarm and Communication Systems
  - VDR (Voyage Data Recorder)
- Start fire pumps
- Trip affected ventilation system(s)
- Isolate uncertified ignition sources

ESD Low Level

- Initiate ESD/PAGA alarm
- Activate blow down well test plant
- Isolate well test plant
- Trip all non-important ventilation intakes (not related to main power and safety critical systems) including any ventilation system not monitored by gas detection

Systems that remain active after AVS are:
- Navigation aids (marking lights with batteries)
- Emergency lights with batteries
- Fire pumps (if running) and no stability issues will result

DNV GL AS
Figure 2 Outline ESD logic for a dynamic positioned drilling unit

1 If safety philosophy requires relocation, these actions to take place. Separate manual ESD pushbutton to be installed. Activate ESD on loss of power.
2 Preferably automatic
3 A requirement for all drilling and well intervention units
5 Escape, evacuation and communications

5.1 General
Siting of superstructures and deckhouses shall be arranged such that in the event of fire at the drill floor at least one escape route to the embarkation position and survival craft is protected against radiation effects of that fire as far as practicable.

(Ref. MODU code 9.4.5)

Interpretation:
At least one escape route from the drilling derrick should lead directly to a safe place without requiring personnel entry to the drill floor area.

5.2 Alarm
A suitable audible and visual alarm to indicate significant increase or decrease in the level of the contents of the mud pit is to be provided at the control station for drilling operations and at the mud pit. Equivalent means to indicate possible abnormal conditions in the drilling system may be considered by the Society.

(Ref. IACS D11.5.2)
SECTION 7 SPECIAL PROVISIONS FOR FLOATING PRODUCTION AND STORAGE UNITS

1 Introduction
In addition to the provisions given elsewhere in this standard, the following requirements apply specially for floating production and storage units (FPSO's).

For general arrangements of ship shaped units, see DNV Rules for ships Pt.5 Ch.3. The following areas are covered by this reference:

— arrangement of access and openings to spaces and tanks
— guard rails and bulwarks
— cofferdams and pipe tunnels
— equipment in tanks and cofferdams
— crude oil washing arrangements.

2 Arrangement

2.1 General
2.1.1 The mobile unit or offshore installation shall be oriented to provide efficient natural ventilation of hazardous areas, and safeguard areas important to safety.

2.1.2 The production plant shall be located and protected such that an incident within the process area will not escalate to the product storage tanks, e.g. located outside the storage tank area, or on a deck elevated above the cargo tank deck.

2.1.3 Pressurised processing plant shall normally not be located within the main hull.

2.1.4 Design and location of structures, equipment and controls shall take account of the motion of the unit and the possibility of green sea.

2.1.5 If hydrocarbon containment and connections to such are located in the lower hull of a unit or installation, the design shall be examined by a safety assessment.

Guidance note:
Typical methods would include HAZOP, FMEA, SWIFT (Structured What If Technique), or similar. Standard fuel oil and lube oil storage need not be subject to special assessment.

This is in general meant to include internal turrets or other locations below main deck.

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

2.1.6 For arrangement of access and openings to tanks see DNV Rules for ships Pt.5 Ch.3 Sec.3 D.

2.2 Process/utility and storage tank decks
2.2.1 The space between process/utility deck and storage tank deck shall be designed to allow easy access for operation, inspection and maintenance, and shall be sufficiently open to allow efficient natural ventilation and possibility of fire fighting. This normally implies an elevation of 3 m or more above storage tank deck.

2.2.2 The process deck shall be provided with suitable process drainage and bunding for operational and accidental spillage collection. Drainage shall prevent large oil spills, i.e. as created by rupture of the largest pressure vessel, and firewater from impairing escape routes or spreading to storage tank deck.

Interpretation:
The dimension of the drainage should be based on the oil spill as created by rupture of the largest pressure vessel and by the firewater resulting from activation of the deluge system,

--------- end of Interpretation --------
2.2.3 The storage tank deck should not be used as a laydown area. In cases where this limitation is not practicable, the tank deck shall be provided with adequate impact protection against dropped objects. Precautions shall also be taken to avoid spark generation in gas hazardous area.

2.3 Risers and piping

2.3.1 Where practicable, high-pressure hydrocarbon piping shall be routed such that jet or spray fires will not impinge directly onto the storage tank deck. Where necessary, the storage tank deck shall be adequately protected against such fires.

2.3.2 Risers shall be located to avoid impairment from mechanical damage, fire and explosion. This can be achieved by locating risers within main structures or by provision of protection structures, riser guide pipes etc.

2.3.3 Riser ESD valves shall be located in easily accessible, well-ventilated areas, to avoid damage from wave impact and dimensioning accidental events such as fire, explosion and mechanical impact.

2.3.4 Pig launchers and receivers shall be located in open, well-ventilated areas with the opening directed outboard, away from pressurised or other critical equipment, where practicable.

Interpretation:

Special consideration should be given where design involves a submerged turret production (STP) type solution, where pig launcher or receiver and ESD valves may be located in an enclosed space.

2.3.5 Offloading systems shall be located at a safe distance from accommodation spaces, air inlets, and equipment important for safety. Special consideration shall be given to protection of systems important for safety in the event of collision with shuttle tanker.

2.4 Entrances and openings

2.4.1 Entrances and openings to accommodation spaces, machinery spaces, service spaces and control stations shall be fitted with airlocks, where they are on the bulkhead facing the hazardous area, an adjacent bulkhead within 3 m of a facing bulkhead, or within hazardous area.

2.4.2 The following apply to boundaries facing the tank area:

a) Gas tight, bolted plates for removal of machinery may be fitted in such boundaries. Signboards giving instruction that such plates shall be kept closed unless the unit is gas-free shall be posted nearby.

b) Windows in the navigation bridge, if the bridge contains control function for the operation of FPSO and the window is not designed to withstand the possible fire load, may be accepted on the conditions that the windows are of non-opening type and provided with inner steel covers, or alternatively rated to the same fire and explosion rating as the boundary.

2.5 Crude oil storage area and cofferdams

2.5.1 Crude oil storage tanks shall not have a common boundary with machinery spaces.

2.5.2 The oil in the crude tanks shall be stabilised and with limited gas content to avoid excessive venting of gas to tank deck.

2.5.3 Cofferdams shall be provided between crude oil tanks, slop tanks and adjacent non-hazardous areas (e.g. machinery spaces and accommodation spaces). Cargo and ballast pump rooms and ballast tanks can be accepted as cofferdams. Access to the pump room entrances shall be from open deck.

2.5.4 Cofferdams shall be of sufficient size for easy access and shall cover the entire adjacent tank bulkhead. Minimum distance between bulkheads shall be 600 mm.

2.5.5 Crude oil tanks, slop tanks and enclosed spaces adjacent to these tanks shall be arranged with suitable access for inspection of structural elements.
2.5.6 Where a non-hazardous space and a crude oil tank meet in a “corner to corner” configuration, a diagonal plate or an angle across the corner may be accepted as cofferdam. Such cofferdams shall be:

— ventilated if accessible
— filled with a suitable compound if not accessible.

2.5.7 Fuel oil bunker tanks shall not normally be located within the cargo tank area. Such tanks may, however, be located at forward and aft end of tank area instead of cofferdams. Fuel oil bunker in double bottom tanks situated under crude oil tanks is not permitted.

2.5.8 Hatches, openings for ventilation, ullage plugs or other deck openings for crude oil tanks shall not be arranged in enclosed compartments.

2.5.9 The closing of deck openings for scaffolding wire connections may be done by use of screwed plugs of metal or a suitable synthetic material.

2.5.10 Anodes, tank washing machines and other permanently attached equipment units in tanks and cofferdams shall be securely fastened to the structure. The units and their supports shall be able to withstand sloshing in the tanks, vibration and other operational loads.

2.5.11 Selection of materials for moving parts or attachments in tanks and cofferdams shall include due consideration to avoiding spark-production in case of impact.

2.6 Slop tanks

2.6.1 At least two slop tanks shall be provided for collection of oil contaminated water, primarily from water washing of oil storage tanks.

2.6.2 Slop tanks shall be designed particularly with respect to separation of water, oil and solids. Inlets, outlets, baffles or weirs shall be arranged to avoid excessive turbulence and entrainment of oil or emulsion with the water.

2.6.3 The slop tanks may be used as drain tanks for open and closed hazardous drains from the processing area. The liquids shall be collected in an intermediate tank and pumped in closed piping to the slop tanks. Where an intermediate tank is not practicable, vent systems shall be designed to accommodate the maximum gas release rate.

2.6.4 Back flow of inert gas from slop tanks to open hazardous drain boxes shall be prevented by effective and reliable means (e.g. double barriers including a water seal and level alarm).

2.6.5 Slop tanks or intermediate collection tanks shall be designed to collect the maximum volume of liquid in any process segment that may be encountered by open or closed drain system in addition to any other requirements give in this sub-section.

2.7 Crude oil pump rooms and pipe tunnels

2.7.1 Submerged (deep well) crude pumps shall be used where practicable, in order to limit risk of hydrocarbon leaks in confined spaces. The requirements in [2.7.2] to [2.7.5] apply where use of deep well pumps is not practicable.

2.7.2 The lower portion of the pump room may be recessed into machinery and boiler spaces to accommodate the pumps. Deck head of the recess is, in general, not to exceed one-third of the moulded depth above the keel. In ship shaped units of less than 25 000 tons deadweight, where it can be demonstrated that this height does not allow satisfactory access and piping arrangements, a recess up to one half of the moulded depth above the keel may be acceptable.

2.7.3 Pipe tunnels are to have ample space for inspection of the pipes.

2.7.4 The pipes in pipe tunnels shall be situated as high as possible above the unit bottom. There shall be no connection between a pipe tunnel and the engine room (e.g. through pipes or manholes).

2.7.5 Access to pipe tunnels is normally to be arranged from the pump room, a similar hazardous space or from open deck. Access opening from the cargo pump room shall be provided with watertight closures.
2.8 Mooring systems

2.8.1 Mooring systems, including winches, tensioners, chain stoppers etc. should be located in open, non-hazardous areas. Where this is not practicable, special precautions shall be taken to ensure that such items do not become a source of ignition also during emergency release.

2.8.2 Chain lockers and chain pipes should be arranged in a non-hazardous area. Where such location is not practicable, permanent facilities for gas freeing (e.g. flushing or purging) the chain lockers and chain pipes shall be provided.

2.8.3 The mooring system shall be arranged to minimise the potential for damage to risers in case of failure during normal operations or maintenance.

3 Hazardous area classification

3.1 General
These requirements are supplementary to general requirements given in Sec.3.

3.2 Product storage tank areas

3.2.1 The hazardous area classification of product storage tank areas shall follow a recognised code, see Sec.3 Table 1.

3.2.2 Pipe tunnels carrying hydrocarbons or with a common boundary with product storage tanks shall be classified as Zone 1.

3.2.3 Gas venting systems connected to cargo tanks will give rise to hazardous area, and the zone number shall be based on consideration of the frequency of release. In general, the following principles shall apply:

— the tank venting system used during loading or unloading shall be classified according to a recognised code, see Sec.3 Table 1
— the venting system used for thermal breathing (small capacity pressure or vacuum valves) is the source of a spherical hazardous Zone 1 with a radius of 5 m
— for unconventional designs, the extent of hazardous areas from cargo tank vent systems shall be based on the boundaries of 50% LEL concentration.

Guidance note: Consideration should be given to location of cargo tank vents with respect to releases that may activate gas detectors, be a hazard to personnel in the area or be too close to the flare with risk of ignition.

3.3 Equipment and cables in hazardous areas

3.3.1 Except for small spaces such as airlocks, paint stores, battery rooms, etc. the lighting installation in hazardous enclosed spaces is to be divided between at least two independent circuits. One of the circuits may be emergency lights.

3.3.2 Electrical equipment in cofferdams, ballast tanks and other spaces adjacent to crude oil tanks and pipe ducts for crude oil is to be limited to that necessary for operational reasons only.

4 Emergency shutdown principles

4.1 General requirements

4.1.1 The ESD system shall also comprise interface to other safety systems like the process shutdown and well control system. These interfaces are also part of the definition of the ESD system.

4.1.2 These requirements are supplementary to the requirements in Sec.4. The requirements given in Sec.4 [2.1.4] do not apply for units covered by this section.
4.1.3 In cases where drilling is also part of the unit the ESD system shall also comprise interface to other safety system like drilling control system.

4.2 Safety and shutdown philosophy

4.2.1 A safety and shutdown philosophy shall be established, comprising functional requirements for the safety systems upon detection of an abnormal condition. The fail-safe functionality for the safety systems shall be included.

4.2.2 The philosophy document shall describe the principles for the actions to:

— limit the duration and severity of the incident
— maximise the ignition control related to the incident (e.g. ventilation/dampers, ignition sources)
— protect personnel exposed to the incident
— limit environmental impact
— facilitate escape, muster and evacuation, as necessary.

4.2.3 Inter-relationships and requirements for the following systems, if installed on the installation or unit, shall be addressed:

— emergency shutdown system
— fire and gas detection system
— process shutdown system
— drilling and well control systems
— alarm and communication systems
— active fire fighting systems
— ventilation systems
— energy sources and associated utilities required to drive essential and emergency functions.

4.3 Fail-safe functionality

Shutdown systems that are provided to comply with Sec.4 [2.1.1] shall be so designed that the risk of unintentional stoppages caused by malfunction in a shutdown system and the risk of inadvertent operation of a shutdown are minimized.

(Ref. MODU code 6.5.4)

Interpretation:

In addition to conditions as listed in Table 2, the conditions of Table 1 should normally apply. Deviations from the requirements of table should be justified. This is primarily intended for systems shutdown/operations and not individual components within the system.

Table 1  Safest conditions and corresponding output circuit configuration

<table>
<thead>
<tr>
<th>System</th>
<th>Safest condition in case of failure to the shutdown system</th>
<th>Output circuit configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process plant including associated utilities</td>
<td>Shutdown</td>
<td>NE</td>
</tr>
<tr>
<td>Turret locking and turning system 1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drilling system 2)</td>
<td>Operational 3)</td>
<td>NDE</td>
</tr>
</tbody>
</table>

1) A detailed study of the different failure modes shall be required for installations that depend on the ability to release or rotate turret. Effects of torque from mooring lines, friction, design limitations on fluid transfer system and fairleads etc. will need to be addressed.

2) If drilling is part of the unit.

3) See DNVGL-OS-E101 for further details.

NDE = normally de-energised, NE = normally energised

---------- end of Interpretation ----------
4.4 Shutdown logic

4.4.1 Shutdown shall be executed in a pre-determined, logical manner to meet the objectives defined in [4.1.1] and supplemented with this section. Definition of the logic and required response time shall include consideration of interactions between systems and dynamic effects, e.g. for the process plant.

4.4.2 The shutdown system shall be designed to ensure that any ongoing operations can be terminated safely when a shutdown is activated.

4.4.3 A shutdown logic shall be implemented to determine the response to different degrees of emergency or upset conditions taking due account of the position keeping system of the installation or unit.

4.4.4 The shutdown logic shall be as simple as possible. The shutdown logic given in Figure 1 and Figure 2 depending on position keeping being applied, shall be applied as a basis with additional due recognition of installation specific requirements.

4.4.5 Units with multiple position keeping systems shall have a shutdown logic implemented with clear identification of and due consideration of the change between the various position keeping systems.

4.4.6 Shutdown shall not require unrealistically quick, undependable or complex intervention by the operator.

4.4.7 Shutdown shall initiate alarm at the control station. The initiating device and operating status of devices affected by the shutdown action shall be indicated at the control station, (e.g. valve position, unit tripped, etc.). For alarm and status, see Sec.5 [6].

Guidance note:
The above includes status of boundary barriers of hydrocarbon systems. Status of other equipment not part of a safety system but activated by such, may be given in a control system.

4.4.8 Shutdown on a hierarchical level shall automatically include shutdowns on lower levels.

4.4.9 It is assumed that the process protection system and shutdown logic have been based on guidance given in API RP 14C or ISO 10418.

4.4.10 Definition of the shutdown logic and required response time shall include consideration of interactions between systems and dynamic effects.

4.4.11 Upon confirmed detection of hydrocarbon gas or fire in the area of turret, production facilities and crude oil tanks area, the wellhead valves and oil production facilities are to be automatically shut down. See also Sec.4 and Sec.6. The alarm is also to sound without delay in outside areas.

4.4.12 The shutdown command shall not be automatically reset. Significant shutdown devices, (e.g. wellhead valves, riser ESD valves) shall be reset locally following recognition and reset at the main control station.

4.4.13 Plants that are protected by automatic safety systems shall have pre-alarms to alert when operating parameters are exceeding normal levels.

4.4.14 When a risk assessment assumes relocation of the unit, system design shall support safe emergency relocation including disconnection from the well and release of mooring lines as applicable.

Guidance note:
If position keeping lines need to be released, adequate protection to avoid sparking is expected to be part of the design.

4.4.15 Blowdown shall preferably be carried out automatically on fire detection in hazardous areas. If manual blowdown is chosen, activation shall initiate ESD low level, and blowdown must also be activated directly from highest level of ESD, AVS.
4.5 Automatic and manual shutdown

4.5.1 Shutdowns shall normally be automatically initiated, however solely manually initiated actions may be provided where automatic action could be detrimental to safety, e.g. for dynamic positioning.

4.5.2 Alarm for manual initiation shall be clear, and shall be readily identifiable at a permanently manned control station. The operator must have sufficient time to acknowledge and execute shutdown before an incident escalates. Manual activation shall be simple and quick to operate. Ref. also Sec.4 [2.1.1].

4.5.3 In all shutdown systems, it shall be possible to manually activate all levels of shutdown at the main control station.

4.6 Additional provisions

4.6.1 The ESD operator station/ HMI units shall be located in an area safe by location and continuously manned.

4.6.2 The logic solver(s) shall be located in an area safe by location, normally in accommodation or similar.

4.6.3 If the logic solvers are distributed to more than one location, it shall be demonstrated that the integrity, including communication between logic solvers, is equivalent to that of a centralised system.

4.6.4 The actions required for ESD shall be independent of systems other than safety systems.
### Safety principles and arrangements

#### Abandon Vessel Shutdown

- **Initiate AVS alarm**
- **Confirmed gas detection in non-hazardous areas including air inlets**
  - **Manual ESD Push Button**
- **Gas detection in cooling or heating medium system**
  - **Manual ESD Push Button**
- **Fire detection in hazardous area**
  - **MAC**
- **Start fire pumps**
- **Activate fire protection systems**
- **ESD Low Level**
  - **Initiate ESD/PAGA alarm**
- **Activate blow down**
  - *Surface controlled subsea shutdown valve
  - Preferably automatic

#### ESD High Level

- **Trip emergency generator**
- **Close SCSSSV* Initiate process blowdown**
- **Timer based shutdown of:**
  - ESD, PSD (and BOP control system if relevant)
  - Fire and gas systems
  - Alarm and Communication Systems
  - VDR (Voyage Data Recorder)
- **Manual ESD Push Button**
- **Confirmed gas detection in non-hazardous areas including air inlets**
- **Manual AVS Push Button to initiate evacuation**
- **Manual Push Button. Trip to override shutdown timer**

#### ESD Low Level

- **Start Emergency Generator (0-voltage relay on emergency s/b)**
- **Trip ventilation in areas affected by gas.**
- **Shut down main and auxiliary power generation**
- **Trip any ventilation system not monitored by gas detection**
  - **Close SCSSSV**
  - **Initiate process blowdown**
  - **Start fire pumps**
  - **MAC**

#### Total Process Shutdown

- **Shutdown fuel gas supply, switch to liquid fuel**
  - **Close ESD valves**
  - **Close X-mas tree valves**
  - **Stop offloading, alarm shuttle tanker**
  - **Trip all potential ignition sources in hazardous areas**
    - (e.g. normal lighting, non-critical Ex equipment)
- **Isolate uncertified (non-Ex) ignition sources**
  - (Welding sockets, temporary equipment etc. shall be isolated on unconfirmed, low level gas detection)
  - (Alarm to crane operator shall be given on unconfirmed gas detection)

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**Figure 1** Outline ESD logic for an anchored FPSO
Figure 2 Outline ESD logic for an dynamic positioned FPSO

Abandon Vessel Shutdown

Initiate AVS alarm

Confirmed gas detection in non-hazardous areas including air inlets

Manual ESD Push Button

When ESD is initiated:

Manual AVS Push Button to initiate evacuation

Manual Push Button. Trip to override shutdown timer

Trip emergency generator

Trip main and auxiliary power

Close SCSSSV*

Initiate process blow down

Timer based shutdown of:
- ESD, PSD (and BOP control system if relevant)
- Fire and gas systems
- Alarm and communication systems
- VDR (Voyage Data Recorder)

ESD High Level/relocation

Gas detection in cooling or heating medium system

Manual ESD Push Button

Gas detection in hazardous area

Fire detection in hazardous area

Start fire pumps

Activate fire protection systems

ESD Low Level

Initiate ESD/PAGA alarm

Activate blow down

*Surface controlled subsea safety valve

Preferably automatic

If safety philosophy requires relocation these actions to take place, and separate manual ESD pushbutton to be installed. Activation of quick disconnect if loss of main power.

Total Process Shutdown

Shutdown fuel gas supply, switch to liquid fuel

Close ESD valves

Close X-mas tree valves

Stop offloading, alarm shuttle tanker

Trip all potential ignition sources in hazardous areas (e.g. normal lighting, non-critical Ex-equipment)

Isolate uncertified (non-Ex) ignition sources (Welding sockets, temporary equipment etc. shall be isolated on unconfirmed, low level gas detection)

(Alarm to crane operator shall be given on unconfirmed gas detection)
5 Inert and vent systems for cargo tanks

5.1 General

5.1.1 The following requirements are applicable to units intended to perform in-service inspections of cargo tanks. For units where all cargo tanks will be emptied and inerted prior to gas freeing and inspection i.e. no simultaneous production, DNV Rules for ships Pt.5 Ch.3 can be applied.

5.1.2 The following safety barriers shall be in place and maintained throughout all stages of the operations:

- Protection against over-/under- pressure, see [5.2].
- Protection against explosive atmospheres during inerting, cleaning, gas-freeing and re-inerting of cargo tanks, see [5.3].
- Protection of personnel during tank entry, i.e. double barrier against hydrocarbon sources, ref. [5.4].

5.1.3 A procedure, or similar, shall be developed to demonstrate that above safety barriers are in place throughout all operational modes. The procedure shall include a general system description, clearly define which operations are to be carried out simultaneously, and demonstrate which safety barriers are in place throughout all operations. The procedure shall also include illustrative functional diagrams/sketches of the system. The diagrams/sketches need not have a high detailing level but shall as a minimum show:

- Relevant tanks and connections e.g. IG/Vent system, drop lines, cargo lines, stripping lines etc.
- Indicate position of barriers for all operations (blanks, valves, spades etc.).
- Details of key lock or key inter-lock systems, if any.

Guidance note:
“Relevant tanks and connections” means the number of tanks necessary to adequately illustrate all safety aspects of the operation. As such the required number will depend on how many simultaneous operations will be carried out. 3 tanks is sufficient if the operation is limited to simultaneous production and tank entry; i.e. one tank being produced into, one tank being made ready for inspection and one tank breathing.

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5.2 Over- /under – pressure protection of cargo tanks

5.2.1 Two barriers against over- and under- pressure shall be provided at all times (during all operations). The barriers shall be capable of handling 125% of the design flow. In addition, pressure monitoring, with high and low alarms shall be available at all times.

Guidance note:
Over-pressure
For an FPSO/FSO the dimensioning flow rate could be 125% of: the production rate, the capacity of the inert gas system, gas blow-by from the process plant or tank-tank transfer using the cargo pumps, whichever is greater. The primary protection is normally the vent through the open vent mast. The secondary protection is normally the Pressure-Vacuum Breaker/Valve.

Under-pressure
Similarly the vent system shall also provide primary and secondary protection from under-pressure with the same 125% capacity requirement. The dimensioning case is normally offloading. The primary barrier to avoid under-pressure is normally the inert gas system. The secondary barrier is normally the P/V breaker.

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5.2.2 Block valves installed in lines between the tank and the pressure protection device shall be interlocked or locked open to ensure that the tank is always protected.

5.2.3 For the tank subject to the tank entry operation the 2 barriers may be achieved by one physical protection device (e.g. P/V breaker, P/V valve or connected to the open mast) and one instrumented safety device (e.g. pressure alarm with shutdown).

Guidance note:
For pressure protection on FPSO/FSO it is normally not desired to locate vents from P/V valves on the individual tanks as release from these vent points causes gas detection and ESD shutdown. The designer therefore usually locates both the vent points in a "safe area" where small releases do not interfere with production. This also means that there is a potential to isolate the tank completely from all pressure protection devices.

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5.3 Protection against explosive atmospheres

5.3.1 It shall not be possible to contaminate inert gas used for tank purging/re-inerting, or air used for gas-freeing, with hydrocarbon gas (this means gas from other tanks or from the process plant). Single barrier is required. For cases where hydrocarbon blanket gas is used, special considerations must be made, e.g. use of double barriers and inerting with inert gas before the hydrocarbon blanket gas is being introduced into the tank.

5.3.2 Cargo bottom lines and cargo drop lines shall not be used for purging and/or re-inerting of tank.

5.3.3 During purging, gas-freeing and re-inerting operations, the tank atmosphere shall be routed to a suitable vent mast.

5.3.4 Purging using portable fans suitable for use in Zone 2 is acceptable provided that the air is taken from a non-hazardous area and the connection to the tank is through a suitable connection with valve.

5.4 Protection of personnel during tank entry

5.4.1 Positive isolation prior to tank entry is required (double barrier).

5.4.2 For lines with manual operated block valves the double barrier may be achieved by a locked closed valve and a blank (meaning either spectable, spade or removable spool).

5.4.3 For lines with actuated block valves, the positive isolation may be achieved by two block valves. Measures to ensure that these block valves do not open, due to maloperation, control system failure, power failure, etc. shall be in place.
SECTION 8 SPECIAL PROVISIONS FOR FLOATING STORAGE UNITS

1 Introduction
In addition to the provisions given elsewhere in this standard, the following requirements apply specially for Floating Storage Units (FSU’s).

For general arrangements of ship shaped units, see DNV Rules for ships Pt.5 Ch.3. The following areas are covered by this reference:
- arrangement of access and openings to spaces and tanks
- guard rails and bulwarks
- cofferdams and pipe tunnels
- equipment in tanks and cofferdams
- crude oil washing arrangements.

2 Arrangement

2.1 General

2.1.1 The mobile unit or offshore installation shall be oriented to provide efficient natural ventilation of hazardous areas, and safeguard areas important to safety.

2.1.2 The VOC plant/metering skid, etc shall be located and protected such that an incident within this area will not escalate to the product storage tanks, e.g. located outside the cargo area, or on a deck elevated above the cargo tank deck.

2.1.3 Design and location of structures, equipment and controls shall take account of the motion of the unit and the possibility of green sea.

2.1.4 If hydrocarbon containment and connections to such are located in the lower hull of a unit or installation, the design shall be examined by a safety assessment.

Guidance note:
Typical methods would include HAZOP, FMEA, SWIFT (Structured What If Technique), or similar. Standard fuel oil and lube oil storage need not be subject to special assessment.

This is in general meant to include internal turrets or other locations below main deck.

2.1.5 For arrangement of access and openings to tanks see DNV Rules for ships Pt.5 Ch.3 Sec.3 D.

2.2 Cargo area

2.2.1 Equipment/systems shall normally not be installed above the cargo area of a floating storage unit. Should there be a requirement for such installations they shall be designed to allow easy access for operation, inspection and maintenance, and shall be sufficiently open to allow efficient natural ventilation and possibility of firefighting. This normally implies an elevation of 3 m or more above storage tank deck.

2.2.2 Elevated decks above cargo area shall be provided with suitable drainage and bunding for operational and accidental spillage collection.

2.2.3 The dimension of the drainage should be based on the oil spill as created by rupture and by the firewater resulting from activation of the deluge system,

2.2.4 The cargo area should not be used as a laydown area. In cases where this limitation is not practicable, the tank deck shall be provided with adequate impact protection against dropped objects. Precautions shall also be taken to avoid spark generation in gas hazardous area.
2.3 Piping

2.3.1 Import/export valves shall be located in easily accessible, well-ventilated areas, to avoid damage from wave impact and dimensioning accidental events such as fire, explosion and mechanical impact.

2.3.2 Pig launchers and receivers shall be located in open, well-ventilated areas with the opening directed outboard, away from pressurised or other critical equipment, where practicable.

Interpretation:

Special consideration should be given where design involves a submerged turret production (STP) type solution, where pig launcher or receiver and ESD valves may be located in an encased space.

2.3.3 Offloading systems shall be located at a safe distance from accommodation spaces, air inlets, and equipment important for safety. Special consideration shall be given to protection of systems important for safety in the event of collision with shuttle tanker.

2.4 Entrances and openings

2.4.1 Entrances and openings to accommodation spaces, machinery spaces, service spaces and control stations shall be fitted with airlocks, where they are on the bulkhead facing the hazardous area, an adjacent bulkhead within 3 m of a facing bulkhead, or within hazardous area.

2.4.2 The following apply to boundaries facing the tank area:

a) Gas tight, bolted plates for removal of machinery may be fitted in such boundaries. Signboards giving instruction that such plates shall be kept closed unless the unit is gas-free shall be posted nearby.

b) Windows and side scuttles shall be of the fixed (non-opening) type. Such windows and side scuttles except wheelhouse windows, shall be constructed to A-60 class standard.

2.5 Crude oil storage area and cofferdams

Reference is made to Sec.7 [2.5].

2.6 Slop tanks

For requirements to slop tanks see DNV Rules for ships Pt.5 Ch.3 Sec.2 C300

2.7 Crude oil pump rooms and pipe tunnels

2.7.1 The lower portion of the pump room may be recessed into machinery and boiler spaces to accommodate the pumps. Deck head of the recess is, in general, not to exceed one-third of the moulded depth above the keel. In ship shaped units of less than 25 000 tons deadweight, where it can be demonstrated that this height does not allow satisfactory access and piping arrangements, a recess up to one half of the moulded depth above the keel may be acceptable.

2.7.2 Pipe tunnels are to have ample space for inspection of the pipes.

2.7.3 The pipes in pipe tunnels shall be situated as high as possible above the unit bottom. There shall be no connection between a pipe tunnel and the engine room (e.g. through pipes or manholes).

2.7.4 Access to pipe tunnels is normally to be arranged from the pump room, a similar hazardous space or from open deck. Access opening from the cargo pump room shall be provided with watertight closures.

2.8 Mooring systems

2.8.1 Mooring systems, including winches, tensioners, chain stoppers etc. should be located in open, non-hazardous areas.

2.8.2 Chain lockers and chain pipes should be arranged in a non-hazardous area. Where such location is not practicable, permanent facilities for gas freeing (e.g. flushing or purging) the chain lockers and chain pipes shall be provided.
2.8.3 The mooring system shall be arranged to minimise the potential for damage to risers in case of failure during normal operations or maintenance.

3 Hazardous area classification
Reference is made to Sec.3.

4 Emergency shutdown principles

4.1 General requirements

4.1.1 The requirements to ESD systems are different for storage units with hydro carbon blanket gas and units with a conventional inert plant.

For conventional inert plants an ESD system with a simplified shutdown hierarchy aligned and in compliance with the MODU code requirements completed with DNV GL Interpretations is acceptable.

Units with hydro carbon blanketing require a safety and shutdown philosophy on which shutdown logic is to be based. The required implementation of this logic together with additional technical requirements as listed, aim for a more robust system with the following additions:

— safety and shutdown philosophy
— shutdown logic
— automatic and manual shutdown
— additional provisions.

4.1.2 These requirements are supplementary to the requirements in Sec.4. The requirements given in Sec.4 [2.1.4] do not apply for units covered by this section.

4.1.3 In cases where drilling is also part of the unit the ESD system shall also comprise interface to other safety system like drilling control system.

4.2 Safety and shutdown philosophy

4.2.1 A safety and shutdown philosophy shall be established, comprising functional requirements for the safety systems upon detection of an abnormal condition. The fail-safe functionality for the safety systems shall be included.

4.2.2 The philosophy document shall describe the principles for the actions to:

— limit the duration and severity of the incident
— maximise the ignition control related to the incident (e.g. ventilation/dampers, ignition sources)
— protect personnel exposed to the incident
— limit environmental impact
— facilitate escape, muster and evacuation, as necessary.

4.2.3 Inter-relationships and requirements for the following systems, if installed on the installation or unit, shall be addressed:

— emergency shutdown system
— fire and gas detection system
— active fire fighting systems
— ventilation systems
— energy sources and associated utilities required to drive essential and emergency functions.
4.3 Fail-safe functionality

Shutdown systems that are provided to comply with Sec.4 [2.1.1] shall be so designed that the risk of unintentional stoppages caused by malfunction in a shutdown system and the risk of inadvertent operation of a shutdown are minimized.

(Ref. MODU code 6.5.4)

Interpretation:

A detailed study of the different failure modes shall be required for installations that depend on the ability to release or rotate a turret. Effects of torque from mooring lines, friction, design limitations on fluid transfer system and fairleads etc. will need to be addressed.

------------- end of Interpretation -------------

4.4 Shutdown logic for units with HC blanketing

4.4.1 Shutdown shall be executed in a pre-determined, logical manner to meet the objectives defined in [4.1.1] and supplemented with this section. Definition of the logic and required response time shall include consideration of interactions between systems and dynamic effects.

4.4.2 The shutdown system shall be designed to ensure that any ongoing operations can be terminated safely when a shutdown is activated.

4.4.3 A shutdown logic shall be implemented to determine the response to different degrees of emergency taking due account of the position keeping system of the installation or unit.

4.4.4 The shutdown logic shall be as simple as possible. The shutdown logic given in Figure xxx shall be applied as a basis with additional due recognition of installation specific requirements.

4.4.5 Shutdown shall not require unrealistically quick, undependable or complex intervention by the operator.

4.4.6 Shutdown shall initiate alarm at the control station. The initiating device and operating status of devices affected by the shutdown action shall be indicated at the control station, (e.g. valve position, unit tripped, etc.). For alarm and status, see Sec.5 [6].

Guidance note:
The above includes status of boundary barriers of hydrocarbon systems. Status of other equipment not part of a safety system but activated by such, may be given in a control system.

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4.4.7 Shutdown on a hierarchical level shall automatically include shutdowns on lower levels.

4.5 Automatic and manual shutdown

4.5.1 Shutdowns shall normally be automatically initiated, however solely manually initiated actions may be provided where automatic action could be detrimental to safety, e.g. for dynamic positioning.

4.5.2 Alarm for manual initiation shall be clear, and shall be readily identifiable at a permanently manned control station. The operator must have sufficient time to acknowledge and execute shutdown before an incident escalates. Manual activation shall be simple and quick to operate. See also Sec.4 [2.1.1].

4.5.3 In all shutdown systems, it shall be possible to manually activate all levels of shutdown at the main control station.

4.6 Additional provisions

Additional provisions shall be made in accordance to Sec.7 [4.6].

5 Inert and vent systems for cargo tanks

The inert and ventilations systems for cargo tanks shall comply to Sec.5.
SECTION 9 SPECIAL PROVISIONS FOR LIQUEFIED NATURAL GAS IMPORT AND EXPORT TERMINALS AND PRODUCTION UNITS

1 General
The following requirements apply specifically to Liquefied Natural Gas (LNG) terminals. They will be applicable to both floating and fixed installations.

These requirements shall be considered as supplementary to the requirements given in the main body of this document.

2 Risk assessment

2.1 General
With reference to Sec.1 [2.1.6], an LNG gas terminal will be regarded as a complex and non-standard installation and therefore will require a comprehensive safety assessment as outlined in App.B.

2.2 Hazards
2.2.1 The assessment shall, as a minimum, focus on hazards that could directly, or indirectly, result in:
- loss of life
- major fire or explosion
- loss of structural integrity or control
- the need for escape or evacuation
- environmental impact.

2.2.2 The following generic hazards listed in App.B [1.5] shall be considered,
- loss of well containment (for LNG production installations)
- gas release into confined space
- release of toxic or other hazardous substance
- collisions
- helicopter crash
- structural and/or foundation failure
- stability and buoyancy hazards for floating installations
- dropped objects
- loss of mooring, propulsion, or station keeping for floating installations.

2.2.3 In addition to the above hazards the following specific hazards shall be considered:
- release of cryogenic liquids
- leakage of LNG onto water and possible Rapid Phase Transition effects
- loss of primary LNG containment
- spread of fire that may threaten storage tank integrity
- relative proximity of LNG process to storage
- hazards associated with venting/flaring
- hazards associated with LNG transfer
- hazards associated with docking of gas carriers
- hazards associated with gas carrier alongside.

2.2.4 Any additional hazards identified by the assessment shall also be addressed.

2.2.5 It may be necessary to carry out additional engineering studies in order to determine the effects of accidental loads on the installation. (e.g. collision analysis, blast study, ventilation under fire conditions).
3 Arrangement

3.1 General

3.1.1 The LNG storage area, LNG processing area and the vent/flare system shall be arranged in order to minimize the possibility of an accidental event in one area impinging on another area or on the Living Quarters, or of affecting escape and evacuation.

3.1.2 Safe separation may be achieved by ensuring sufficient distance between areas or by installation of physical barriers (e.g. fire/blast walls) to prevent escalation from one area to another.

3.1.3 Where a firewall is required to perform its function following an explosion, it shall retain its fire technical properties. Its ability to do so shall be documented by reference to test results.

3.1.4 For floating installations arrangements common for gas carriers may be used. Additional requirements due to the presence of gas processing plant may also need to be specified.

3.1.5 For floating installations, ventilation inlets and outlets for rooms with essential equipment shall be located in such positions that closing devices to ensure watertight integrity will not be necessary. This includes such rooms as: fire pump room, emergency generator room, emergency switchboard rooms and control stations.

3.2 Location of equipment

3.2.1 On floating installations consideration shall be given to design of equipment and control systems to accommodate vessel motions. This may for example involve location of tall equipment close to the centreline of the floating installation.

3.2.2 Where an installation may be exposed to green seas, protection of safety systems, safety equipment and control lines shall be considered in addition to structural design aspects.

3.2.3 Location of equipment shall take account of the predominant wind direction and dispersion characteristics of potential leaks, in order to safeguard areas of importance for safety.

3.2.4 Equipment shall be located or oriented in such a way as to minimize congestion and confinement that could increase potential overpressure in the event of an explosion.

3.2.5 Equipment with potential for high energy failure (e.g. gas turbines) shall be located such that possible damage or escalation effects will be minimized.

3.2.6 Pressurised equipment for processing of gas/LNG shall normally not be located within the structure critical for floatability of floating installations.

3.2.7 If equipment is to be placed above storage tanks, the possible hazards associated with leakage, fire, explosion, and physical collapse as a result of an accidental event in either one of the areas shall be considered.

3.2.8 Where a process deck is provided above a storage area, sufficient space shall be provided to permit access for inspection and maintenance, to permit access for fire fighting, and to provide for sufficient ventilation to prevent any confinement of a gas leak.

3.3 Location of risers and ESD valves

3.3.1 Risers shall be located to avoid damage e.g. by fire, explosion or impact from dropped objects.

3.3.2 Riser ESD valves shall be located in easily accessible, well-ventilated areas, to avoid damage from wave impact and dimensioning accidental events such as fire, explosion and mechanical impact.
3.4 Location of storage tanks

3.4.1 Storage tank location shall consider safety with respect to possible accidental loads. These loads may include collision with subsequent penetration of the external hull, or fire and explosion elsewhere on the installation.

Interpretation:

The extent of damage and penetration in the event of a collision should be determined by a collision analysis. If collision requirements specified in international codes (e.g. IGC) are employed these should be justified with respect to actual traffic at the terminal location.

3.4.2 The storage tank deck shall not be used as a laydown area. In cases where this limitation is not practicable, adequate impact protection against dropped objects shall be provided.

3.5 Piping

3.5.1 Where practicable, high-pressure hydrocarbon piping shall be routed such that jet or spray fires will not impinge directly onto the storage tank deck. Where necessary, the storage tank deck shall be adequately protected against such fires.

3.5.2 Import and export risers and pipelines shall be located to avoid impairment from mechanical damage, fire and explosion. This can be achieved by locating these within main structures or by provision of protection structures, riser guide pipes etc.

3.5.3 Loading/Offloading systems shall be located at a safe distance from accommodation spaces, air inlets, and equipment important for safety. Special consideration shall be given to protection of systems important for safety in the event of collision with a shuttle tanker.

3.5.4 Any piping system which may contain LNG or hydrocarbon vapour is to be arranged so that:

— it is segregated from other piping systems, except where inter-connections are required for storage related operations, such as purging, gas freeing or inerting. In such cases precautions are to be taken to ensure that LNG or vapour cannot enter such other piping systems through the inter-connections
— it shall not normally pass through any accommodation space, service space or control station or through a machinery space other than a pump room or compressor space
— it is connected into the LNG containment system directly from the open deck, except that the pipes installed in a vertical trunkway or equivalent may be used to traverse void spaces above a containment system, and except that pipes for drainage, venting or purging may traverse cofferdams.

Where double piping is used as a safety measure the outer piping shall have sufficient rating to accommodate any pressure build up.

3.6 Mooring of floating installations

3.6.1 The requirements of Sec.6 [2.2] are applicable.

4 Hazardous area classification

4.1 Codes and standards

4.1.1 Codes and standards used in the LNG onshore industry, LNG maritime transport industry and oil and gas offshore industry may be used. However the applicability of the selected code to an offshore terminal shall be demonstrated.

4.1.2 These codes include:

— IEC 60079-10-1
Guidance note:
In general it is not recommended to mix the requirements of different codes on the same installation. It is not necessary to select the most restrictive code as long as the code selected adequately addresses the technical safety issues.

4.1.3 Where not adequately covered by a code, the extent of hazardous area in connection with vents or special features shall be determined on the basis of a dispersion analysis. The 50% LEL level may be used as a basis for determining the extent of the hazardous area.

4.1.4 Electrical equipment in cofferdams, ballast tanks and other spaces adjacent to gas storage tanks is to be limited to that necessary for operational reasons only.

4.2 Entrances and openings

4.2.1 Entrances and openings to accommodation spaces, machinery spaces, service spaces and control stations shall be fitted with airlocks, where they are within 3 m of the storage or processing area.

Restrictions on entry between storage areas and accommodation areas are typically more stringent on gas carriers. However use of airlocks is an accepted solution on offshore installations with storage. A more stringent requirement may be applied by a regulatory authority.

4.2.2 Air intakes are normally to be located not closer than 3 m from the boundary of a hazardous area.

5 Systems

5.1 Emergency shutdown (ESD)

5.1.1 These requirements are supplementary to the requirements in Sec.4.

5.1.2 The principles and the applicable requirements for Emergency Shutdown on FPSOs as given in Sec.7 [4] shall be followed and implemented.

5.1.3 Emergency shutdown shall take account of the major functions of the installation, i.e. LNG transfer, LNG storage, gas/LNG processing and gas import/export.

5.1.4 The terminal emergency shutdown system shall also take account of the operation of any gas carrier which is moored to the terminal.

5.1.5 LNG transfer system controls, gas carrier systems and carrier berthing shall be integrated into the ESD system so that the carrier may be safely disconnected and moved off location in the event of an emergency.

Guidance note:
Reference is made to publications from SIGTTO for similar operations at land terminals.

5.1.6 Alarms to indicate potential overfilling of tanks shall be set with sufficient margin to ensure that flow can be stopped before maximum filling level is reached.

5.1.7 Gas detection shall be set to give unconfirmed and confirmed detection. See DNVGL-OS-D301 for clarification of terms.

5.2 Escape routes

5.2.1 At least one escape route shall remain available following an accidental event in connection with LNG storage tanks, processing, transfer or import/export.

5.2.2 Where necessary protection against spray of cryogenic material shall be provided.
5.2.3 The worst case flaring scenario shall be used in determining radiation levels which might impair escape route availability.

Guidance note:
Reference is made to Sec.1 [3.4] concerning limitation on activities related to various radiation levels

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5.3 Cargo, inert and vent systems for units with in-service inspections

5.3.1 Cargo systems shall be designed in accordance with the requirements of DNV Rules for ships Pt.5 Ch.5.

5.3.2 The following additional requirements are applicable to units intended to perform in-service inspections of cargo tanks.

5.3.3 The following safety barriers shall be in place and maintained throughout all stages of the operations:

- Protection against over-/under- pressure, see Sec.7 [5.2].
- Protection against explosive atmospheres during inerting, cleaning, gas-freeing and re-inerting of cargo tanks, see Sec.7 [5.3].
- Protection of personnel during tank entry, i.e. double barrier against hydrocarbon sources, see Sec.7 [5.3].

5.3.4 A procedure, or similar, shall be developed to demonstrate that above safety barriers are in place throughout all operational modes. The procedure shall include a general system description, clearly define which operations are to be carried out simultaneously, and demonstrate which safety barriers are in place throughout all operations. The procedure shall also include illustrative functional diagrams/sketches of the system. The diagrams/sketches need not have a high detailing level but shall as a minimum show:

- Relevant tanks and connections e.g. inert gas and gas freeing systems, interface to LNG process, cargo offloading system, high-duty compressor and heater, BOG system, fuel gas system etc.
- Indicate position of barriers for all operations (spool pieces, blanks, valves, spades etc.).
- Details of key lock or key inter-lock systems, if any.

Guidance note:
"Relevant tanks and connections" means the number of tanks necessary to adequately illustrate all safety aspects of the operation. As such the required number will depend on how many simultaneous operations will be carried out.

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CHAPTER 3 CLASSIFICATION AND CERTIFICATION

SECTION 1 CLASSIFICATION

1 General

1.1 Introduction

1.1.1 As well as representing DNV GL’s recommendations on safe 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.

1.1.2 This chapter identifies the specific documentation, certification and surveying requirements to be applied when using this standard for certification and classification purposes.

1.1.3 A complete description of principles, procedures, applicable class notations and technical basis for offshore classification is given by the DNV GL rules for classification of offshore units, as listed in Table 1.

Table 1 DNV GL rules for classification - Offshore units

<table>
<thead>
<tr>
<th>No.</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>DNVGL-RU-OU-0101</td>
<td>Offshore drilling and support units</td>
</tr>
<tr>
<td>DNVGL-RU-OU-0102</td>
<td>Floating production, storage and loading units</td>
</tr>
<tr>
<td>DNVGL-RU-OU-0103</td>
<td>Floating LNG/LPG production, storage and loading units</td>
</tr>
<tr>
<td>DNVGL-RU-OU-0104</td>
<td>Self-elevating units</td>
</tr>
</tbody>
</table>

1.2 Applicable requirements

1.2.1 Requirements as covered by classification are governed by class notations. A complete description of these and their related scope can be found in the above listed Offshore Service Specifications.

1.2.2 Requirements applicable only for vessels with the voluntary notation ES can be found in the following Offshore Standards.

Table 2 DNV GL offshore standards including ES requirements

<table>
<thead>
<tr>
<th>No.</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>DNVGL-OS-A101</td>
<td>Safety principles and arrangements</td>
</tr>
<tr>
<td>DNVGL-OS-D101</td>
<td>Marine and machinery systems and equipment</td>
</tr>
<tr>
<td>DNVGL-OS-D202</td>
<td>Automation, safety, and telecommunication systems</td>
</tr>
<tr>
<td>DNVGL-OS-D301</td>
<td>Fire protection</td>
</tr>
</tbody>
</table>

1.2.3 Requirements applicable only for vessels with the voluntary notation ES for this standard are:

Enhanced ESD (Ref Ch.2 Sec.6 [4.1] and [4.3]) as is applicable for Drilling and Well intervention units.

1.3 Application

1.3.1 Where codes and standards call for the extent of critical inspections and tests to be agreed between contractor or manufacturer and client, the resulting extent is to be agreed with DNV GL.

1.3.2 DNV GL may accept alternative solutions found to represent an overall safety level equivalent to that stated in the requirements of this standard.

1.3.3 Any deviations, exceptions and modifications to the design codes and standards given as recognised reference codes shall be approved by DNV GL.

1.4 Documentation

Documentation for classification shall be in accordance with the NPS DocReq (DNV GL Nauticus production system for documentation requirements) and DNVGL-CG-0168.
SECTION 2 CERTIFICATION

1 Equipment categorisation

1.1 Principle requirement
Equipment shall be certified consistent with its functions and importance for safety.

1.2 Categories

1.2.1 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.

1.2.2 For equipment category I, the following approval procedure shall be followed:
— Design approval for Cat. IA and IB, followed by a design verification report (DVR) or type approval certificate.
— Fabrication survey followed by issuance of a product certificate.

1.2.3 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.

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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 is to be decided on the basis of manufacturer’s QA/QC system, manufacturing survey arrangement (MSA) with DNV GL and type of fabrication methods.
1.2.4 Equipment of category II is normally 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.

2 Certification requirements
Categorisation of various equipment that is normally installed in production systems is given in Sec. 2. Equipment which is not listed below but considered to be important for safety, shall be categorised after special consideration.

The following systems shall be certified:

- ESD system including boundary valves for the unit when relevant as e.g. inlet and export valves.
- PA/GA system.
APPENDIX A  CATEGORISATION OF SOURCES OF RELEASE

1 General
Note that the categorisation may require adjustment based on the actual design of the component or frequency of use.

2 Continuous sources of release
Typical continuous sources of release:
— internals of pressure vessels or storage tanks for flammable gas or vapours
— process apparatus developing flammable gas or vapours
— surface of flammable liquid
— vent pipes which discharge continuously, for long periods or frequently
— internals of pits containing active mud.

3 Primary sources of release
Typical primary sources of release:
— instrument and process vent pipes
— relief valves outlets
— pig receivers or launchers
— pump and compressor seals (depending on design)
— packed gland or seal of control valve
— sample points
— regularly used process drains (to open drain tundish)
— flexible pipes and hoses (depending on materials and design)
— ventilation openings from a Zone 1 area
— active mud in open gutters before final degassing
— shale shaker
— vent from drilling mud degasser system.

4 Secondary sources of release
Typical secondary sources of release:
— standard flanges, connections and valves
— pumps and compressors (depending on design)
— ventilation openings from a Zone 2 area
— bell nipple (drilling nipple)
— wireline stuffing box
— gas vents from kill and choke manifold
— diverter vents from drilling BOP.

Guidance note:
Welded piping systems without flanges or other leak sources are not regarded as sources of release.

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APPENDIX B  FORMAL SAFETY ASSESSMENT

1  Safety assessment

1.1  General

1.1.1 Use of the prescriptive requirements given in these standards together with responsible operation is intended to result in an acceptable level of safety when the offshore unit or installation is used for a standard application.

1.1.2 The prescriptive requirements are based on previous experience and safety studies and attempt to generalise with respect to design and application. In some cases this generalisation may not be appropriate to a specific design.

1.1.3 Where a design or application deviates significantly from the assumptions inherent in the generic approach, a detailed safety assessment should be carried out to assess acceptability of the design.

1.1.4 Design of certain units or installations will be of such a complex nature that it will be necessary to evaluate the design on a case to case basis to establish specific design accidental loads. Purpose built production units with complex production plant will fall into this category.

1.1.5 The term safety assessment refers here to a design tool, and should not be considered purely as a documentation exercise. In this sense, safety assessment provides input to design through systematic consideration of:

— the hazards that can occur
— role and performance of structure and facilities in preventing and protecting against hazards
— the effects of hazards on safety of personnel.

These steps are applied to ensure that the safety of personnel, and any other aspects such as environment, meet minimum safety levels. The safety levels are defined through safety targets and criteria.

1.1.6 Safety assessment is intended to be complementary to, and integrated with, the application of recognised design standards. The guidance and requirements of engineering standards will provide the basis for detailed engineering design that can be optimised by the application of, and findings from, the assessment (e.g. establishing optimum dimensioning accidental loads).

1.2  Application and objective

1.2.1 Safety assessment should be performed at concept and updated as the design evolves through detailed design and construction. The assessment is expected to provide input to decision-making and design basis with the aims stated in [1.2.2] to [1.2.4].

1.2.2 Design assessment work should be used to provide input to detailed design by addressing design basis hazards and optimising the protection measures to manage them, e.g. establish dimensioning accidental loads.

1.2.3 Preliminary assessment work should aim to ensure that a safe practicable concept is carried forward to detailed design. Matters to be considered include inherent safety through avoiding unnecessary hazards, reducing hazards, optimising layout etc.

1.2.4 The safety assessment should form part of the design and operating premises for the unit or installation.

1.3  Application to mobile offshore units

1.3.1 Standard classed MOUs

For standardised designs constructed to classification requirements, the methodology given in DNV GL “Guidelines for Risk and Emergency Preparedness Assessment” provides an alternative assessment method. The guidelines address the level of safety of mobile installations through comparative evaluation against a DNV GL classed “reference rig”.
Application of this methodology may be undertaken in lieu of the requirements in [1.4] to [1.7].

1.3.2 Existing assessment work

Relevant safety assessment work that already exists for similar designs need not be duplicated. Existing assessment information may be used in lieu of [1.4] to [1.7] provided that the information is clearly demonstrated to be applicable. In particular, any differences between the designs should be identified and addressed in order to ensure that:

— no additional hazards have been omitted
— prevention and protection measures are adequate for any new or changed hazards
— safety criteria are not exceeded.

1.4 Scope of assessment

A typical assessment process is shown in Figure 1. Some stages may require an iterative process as the concept develops and more details are known.
Figure 1 Flowchart for formal safety assessment
1.5 Hazard identification

Hazard identification should be performed by competent personnel from a suitable variety of engineering disciplines, operational and design backgrounds.

1.5.1 The identification should, as a minimum, focus on hazards that could directly, or indirectly, result in:

- loss of life
- major fire or explosion
- loss of structural integrity or control
- the need for escape or evacuation
- environmental impact.

A typical, but not necessarily exhaustive, list of hazards is:

- loss of well containment (blowout etc.)
- gas release into confined space
- release of toxic or other hazardous substance
- collisions
- helicopter crash
- structural and/or foundation failure
- stability and buoyancy
- dropped objects
- loss of mooring, propulsion, or station keeping.

1.5.2 The results of the hazard identification shall be documented. This should be reviewed as the unit or installation evolves in case of additional or changed hazards.

1.6 Hazard reduction

1.6.1 Identified hazards should be avoided wherever practicable, e.g. through:

- removal of the source of a hazard (without introducing new sources of hazard)
- breaking the sequence of events leading to realisation of a hazard.

Where hazards cannot be avoided, unit or installation design and operation should aim to reduce the likelihood of hazards occurring where practicable, e.g. by:

- reduction in number of leak sources (flanges, instruments, valves etc.)
- removal or relocation of ignition sources
- simplifying operations, avoiding complex or illogical procedures and inter-relationships between systems
- selection of other materials
- mechanical integrity or protection
- reducing the probability of external initiating events, e.g. lifting operations etc.
- reduction in inventory, pressure, temperature
- use of less hazardous materials, process or technology.

1.6.2 The consequences of hazards should be controlled and mitigated with the aim of reducing risk to personnel where practicable, e.g. through:

- relocation of equipment, improved layout
- provision of physical barriers, distance separation, fire walls etc.
- provision of detection and protection systems
- provision of means to escape and evacuate.

1.6.3 Where appropriate, dimensioning accidental loads shall be defined for selected hazard reduction
measures. The loads may be based on existing standards, and shall be verified as suitable by the evaluation, see 700.

Guidance note:
Default accidental loads stated in design standards, such as DNV GL Offshore Standards, are based on experience and past assessments. These may be applied as initial load estimates and are expected to be suitable in many cases.

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1.7 Hazard evaluation

1.7.1 Identified hazards and potential escalation shall be evaluated based on the effects, consequences and likelihood of occurrence.

1.7.2 The evaluation should address the sources and contributors in the chain of events leading to a hazard, including the effect of any prevention and protection measures, see also [1.7.5].

1.7.3 Where used, models and data should be appropriate, and from industry recognised sources.

1.7.4 The evaluation may be by means of qualitative and/or quantitative analysis as necessary to provide input for comparison with safety targets and safety criteria.

Hazards that are commonly considered as not reasonably foreseeable, i.e. extremely unlikely to occur, may be discounted from the evaluation provided that this is clearly indicated and justified in the assessment.

1.7.5 Dimensioning accidental loads

The dimensioning accidental loads for structure and important safety systems shall be identified and included in the evaluation. This is expected to include accidental loads such as:

— toxic or flammable fluids (e.g. smoke, hydrocarbon gas, etc.)
— fire
— explosion
— flooding and stability
— collision and impacts
— environmental effects.

and their effect on systems or facilities such as:

— fire and gas detection
— ESD, PSD, and other shutdown systems, including riser ESD valves and pipeline SSIV
— flare and depressurising system (blowdown)
— fire and explosion protection
— active fire protection systems
— impact protection
— alarm, internal, and external communications
— emergency power systems and UPS
— arrangements for escape and evacuation
— life support at temporary refuge and muster facilities
— structure
— mooring or positioning system
— turret turning and locking system
— stability systems
— well control and drilling.

1.7.6 The final selection of dimensioning accidental loads shall be suitable for the installation to meet the safety criteria. See Table 1 for typical safety targets. Where the safety criteria are exceeded, the initial dimensioning loads may need to be revised.
2 Alternative requirements

2.1 General
Statutory or voluntary requirements may also be applied in addition to, or in lieu of, basic safety assessment requirements. A selection of potential variations is stated in [1.2] and [1.3].

2.2 Regional requirements
Assessment can be required under certain national (shelf or coastal State) regulations. Where units or installations which shall be designed for operation in regions with statutory safety assessment requirements, those requirements may apply in lieu of [1].

2.3 Alternative safety targets and criteria
Other safety standards, such as regional or owner or operator criteria, may be applied in lieu of those in Table 1 provided that they are equivalent to or more stringent than the personnel safety requirements in this standard.

<table>
<thead>
<tr>
<th>No.</th>
<th>Safety target</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>An escape route shall be available from every work area for sufficient time for personnel to reach the temporary refuge or evacuation facilities.</td>
</tr>
<tr>
<td>2.</td>
<td>The temporary refuge shall be capable of providing life support and communications for sufficient time to enable controlled evacuation from the unit or installation.</td>
</tr>
<tr>
<td>3.</td>
<td>Evacuation and escape facilities shall be available and reliable for use.</td>
</tr>
<tr>
<td>4.</td>
<td>Simultaneous loss of all safety targets shall not occur during the time required to: mitigate an accidental event, or leave the unit or installation.</td>
</tr>
</tbody>
</table>
APPENDIX C GUIDELINE FOR IGNITION SOURCE CONTROL
WORKING METHODOLOGY

1 General
In Figure 1 there is a methodology that can be used for ignition source control for all electrically operated equipment located outside, not suitable for installation in zone 2, and which are being kept alive after start of an ESD situation.
Figure 1  Ignition source control – working methodology
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