FOREWORD

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

DNV service documents consist of amongst other the following types of documents:

— Service Specifications. Procedual requirements.
— Standards. Technical requirements.

The Standards and Recommended Practices are offered within the following areas:

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

• General
This document supersedes DNV-OS-A101, October 2010.

Main changes in April 2011
— In Sec.6, item F301 has been amended concerning two-way voice communication system.
— Appendix B “Guidelines for Illumination Levels and Battery Capacity” has been deleted, and previous Appendix C has been renumbered accordingly.
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SECTION 1
GENERAL

A. Introduction

A 100 Introduction
101 This standard provides general safety and arrangement principles for offshore units and installations.
102 The standard is applicable to overall safety and integrity aspects of all types of floating offshore units and fixed installations.
103 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.

A 200 Objectives
201 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 and escape or 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 certification and classification services.

A 300 Classification
301 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 Table A1.

<table>
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A 400 Alternative solutions
401 Alternative solutions may be substituted where shown to provide an equivalent or higher level of integrity or safety than the requirements under this standard. Justification of alternative solutions shall be documented.

B. Normative References

B 100 General
101 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 200 to 400.
SOLAS references are as quoted in MODU Code 1989 and fulfil class requirements. Note that for compliance with flag state requirements, later amendments may be applicable.
102 Any deviations, exceptions and modifications to the codes and standards shall be documented and agreed between the supplier, purchaser and verifier, as applicable.

B 200 DNV Offshore Standards
201 The latest revision of the DNV Offshore Standards listed in Table B1 applies.
B 300 DNV Recommended practices

301 The latest revision of the DNV Recommended practices listed in Table B2 applies.

<table>
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B 400 Other references

401 The latest revision of the documents listed in Table B3 applies.

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C. Informative References

C 100 General

101 The codes and standards in Table C1 are referenced in the text of this offshore standard, and may be used as a source of supplementary information.

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<td>API RP 500</td>
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<td>API RP 505</td>
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<td>API RP 521</td>
<td>Guide for Pressure-Relieving and Depressurising Systems</td>
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<td>Guidelines for Risk and Emergency Preparedness Assessment</td>
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<td>Recommendations for the protection of diesel engines for use in zone 2 hazardous areas</td>
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D. Definitions

D 100 Verbal forms

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

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

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

D 200 Definitions

201 Accommodation area: Space used for cabins, offices, lavatories, corridors, hospitals, cinemas, public spaces etc. Service spaces and control stations may be included within the accommodation area.

202 Product Storage area: 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.

203 Control station or Control room: 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.

204 Design accidental events: 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.

205 Design accidental loads: Loads or actions resulting from a defined accidental effect. These loads are included in the basis for design of a system or a structure.

206 Drilling area: 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.

207 Embarkation area: 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.

208 Emergency response: 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.

209 Emergency services: Fire and gas detection, fire fighting equipment, emergency generator, etc. that need to be used in an emergency.

210 Enclosed space: Space bounded by floors, bulkhead and/or decks that may have doors, windows or other similar openings.

211 Evacuation: Means leaving the unit or installation and moving away from the vicinity in an emergency, in a systematic manner and without directly entering the sea.

212 Hazardous areas: 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.

213 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.

214 Important for safety: Areas, systems and functions, which are provided to prevent, detect, control and mitigate the effects of an accidental event.
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.

(SOLAS Reg. II-2/3.20, MODU Code 1.3.29).

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.

(SOLAS Reg. II-2/3.19, MODU Code 1.3.30)

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. (IACS UR F35 or UI SC15)

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 offshore drilling unit: Mobile offshore unit designed for drilling operations. It can be self-elevating, semi-submersible or ship shaped.

Mobile unit: Offshore installation or unit which is designed to remain at a location for a relatively limited period of time and which can be moved from place to place without major dismantling or modification.

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.

Floating offshore installation: A buoyant construction engaged in offshore operations including drilling, production, storage or support functions, and which is designed and built for installation at a particular offshore location. Floating LNG terminals are also considered to be Floating Offshore Installations.

Mobile offshore 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.

Fixed offshore installation: A non-buoyant construction engaged in offshore operations including drilling, production, storage or support functions, and which is designed and built for installation at a particular offshore location. Gravity based LNG terminals are also considered to be Fixed Offshore Installations.

Offshore installation: A collective term to cover any construction, buoyant or non-buoyant, designed and built for installation at a particular offshore location.

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.

Prevailing wind: Wind direction, which has the highest probability of occurrence.

Processing area: Area designated for separation, compression, treatment and disposal of reservoir fluids.

Riser area: Area containing import and/or exports risers and includes the isolation valve on the riser. See also Turret area.

Safety assessment: 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.

Safety criteria: Qualitative and quantitative criteria, which express the maximum tolerable risk to personnel, environment, safety functions etc.

Safety systems: Systems, which are provided to prevent, detect, control or mitigate the effects of an accidental event. Failure of a safety system could lead to the development or escalation of an accidental event.

Semi-enclosed location: 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.
236  **Tank deck**: Deck, or part of a deck, which forms the top of a product storage tank.

237  **Temporary refuge or shelter area**: Area provided to protect personnel from the effects of an emergency, which is beyond immediate control. 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.

238  **Turret area**: Area containing mooring equipment, which enables the unit to rotate relative to fixed facilities or pipelines on the seabed. Import and export risers are usually located within the turret area.

239  **Utility areas**: Areas for combustion equipment, power generation, switchboards, boiler, water injection facilities, workshops, storage areas, drilling utilities and general machinery. 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.

240  **Essential system**: Generally defined as a system which supports equipment which needs to be in continuous operation for maintaining the unit’s manoeuvrability. The definition is extended for systems associated with the offshore unit/installation to cover systems which are needed to be available on demand to prevent development of, or to mitigate the effects of an undesirable event, and to safeguard the personnel, environment and the installation.

241  **Important system**: Generally defined as a system supporting equipment which needs not necessarily be in continuous operation for maintaining the unit’s manoeuvrability, but which is necessary to maintain the unit’s main functions. The definition is extended for systems associated with the offshore unit/installation to cover systems, which ensures reliable operation and which maintains plant operation within operational limitations.

### D 300 Abbreviations

The abbreviations in Table D1 are used.

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<td>LNG</td>
</tr>
<tr>
<td>MAC</td>
</tr>
<tr>
<td>MODU</td>
</tr>
<tr>
<td>NDE</td>
</tr>
<tr>
<td>NE</td>
</tr>
<tr>
<td>OS</td>
</tr>
</tbody>
</table>
E. Documentation

E 100 General

101 Documentation requirements shall be in accordance with the NPS DocReq (DNV Nauticus Production System for documentation requirements) and DNV-RP-A201.

102 For specific documentation requirements related to use of this standard for classification, see DNV-OSS-101 and DNV-OSS-102.

---

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>In full</th>
</tr>
</thead>
<tbody>
<tr>
<td>OSS</td>
<td>Offshore service specification</td>
</tr>
<tr>
<td>PALL</td>
<td>Pressure alarm low low</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 sub sea shutdown valve</td>
</tr>
<tr>
<td>SSIV</td>
<td>Sub-surface isolation valve</td>
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<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>
SECTION 2
DESIGN PRINCIPLES AND ACCIDENTAL LOADS

A. General

A 100 Objective

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

A 200 Application

201 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.

B. Design Principles

B 100 Main principles

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

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

103 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. Refer also DNV-RP-C204 - Design Against Accidental Loads.

104 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.

B 200 Additional requirements

201 In meeting the main design principles in 100, 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.

C. Design for Accidental Loads

C 100 General

101 The provisions given in C and D 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.

102 Each project shall, however, consider the applicability of the generic load approach used in D 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.

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103 For complex or non-standard applications a more comprehensive assessment shall be carried out. Guidance on carrying out such an assessment is given in Appendix B.
D. Generic Design Accidental Loads

D 100 General

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

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

— integrity of shelter areas
— usability of escape ways
— usability of means of evacuation
— global load bearing capacity.

103 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, and are generally based on accidental loads affecting safety functions which have an individual 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.

104 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.

105 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.

D 200 Dropped objects

201 It is assumed that lifting arrangements comply with Sec.3 F with regard to location of cranes and lay down areas and with respect to lifting operations over pressurised equipment.

202 It is assumed that critical areas are designed for dropped object loads as defined in 203 and 204.

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

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

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

\[ E = M \cdot g_0 \cdot h \] (kJ)

\[ M = \text{mass of object (tonnes)} \]

\[ g_0 = 9.81 \text{ m/s}^2 \]

\[ H = \text{drop height in air (m)} \]

Guidance note:
The impact energy at sea level is normally not to 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.

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D 300 Collision loads

301 The kinetic energy to be considered is 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 \( v = 2 \text{ m/s} \).

302 The impact energy is given as:

\[ E = \frac{1}{2}(M + a)v^2 \] (kJ)
303 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.

304 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.

D 400 Unintended flooding

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

\[ p_d = 10 \cdot h_b \quad (\text{kN/m}^2) \]

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

D 500 Loads caused by extreme weather

501 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).

D 600 Explosion loads

601 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.

602 In a ventilated compartment the explosion load given by the explosion overpressure and duration is mainly determined by the relative ventilation area and the level of congestion.

Guidance note:
For compartment volumes of approximately 1000 m³ and relative ventilation area of about 0.5, ignition for stochiometric 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.

603 The design overpressure in a ventilated shale shaker room with volume less than 1000 m³, with moderate congestion, may be taken as 200 kPa (2 barg), combined with a pulse duration of 0.3 s, unless a more detailed assessment is carried out.

604 The design overpressure in connection with explosion on open drill floor area may be taken as 10 kPa (0.1 barg), combined with a pulse duration of 0.2 s, unless a more detailed assessment is carried out.

Guidance note:
Where an explosion passes through a large number of stored pipes (more than 10 x 10), local overpressure may rise considerably. Stored pipes should therefore be stored with a minimum air gap between pipes.

605 Where a more detailed assessment is carried out in evaluating the explosion load in a vented compartment, the considerations given in 606 to 609 shall be accounted for.

606 The vent area, \( A_v \), can be taken as the sum of free opening areas and blowout panel areas (i.e. light weather cladding) provided the static opening pressure of the panels is less than 5 kPa (0.05 barg). The relative vent area, \( a \), is given as \( A_v \) or \( \text{Volume}^{2/3} \).

Guidance note:
The duration of the positive phase pressure pulses is expected to vary from 0.2 s for fairly open compartments to 1 s for quite closed compartments. The structural response may in many cases be estimated on a static basis.

607 If panels or walls are intended to give explosion relief by failing, a maximum pressure up to 2 to 3 times
their static release pressure can still be expected within the compartment.

Guidance note:
This is the case only if the total ventilating area of those panels and walls is large enough to be the dominating factor. For large and congested compartments local pressures may give a greater load.

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608 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. The diameter can be estimated as \( D = \sqrt{A} \) where A is the smallest cross-sectional area. L is the greatest dimension of the compartment.

609 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.

610 Design explosion overpressure in a completely enclosed compartment handling hydrocarbons (e.g. STP or STL rooms) shall be subject to special attention. The following principles shall apply:

a) Generally, bulkheads that need to remain intact after an explosion, e.g. towards storage tanks, shall be designed for an overpressure of 400 kPa (4 barg) and a pulse duration of 1 s. This assumes that the safety features required elsewhere in this standard are in place, i.e. control of ignition sources through area classification, provision of suitable ventilation, gas detection and emergency shutdown systems.
b) If a lower explosion design pressure is used this must be justified through more detailed assessment.

611 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. DNV-OS-E201), in order to avoid possible pressure vessel rupture.

612 Doors for pig launchers shall be oriented in a direction where inadvertent opening would result in minimal damage.

613 For process areas on open deck covering a relatively small area (e.g. 20 m x 20 m) an explosion overpressure of 30 kPa (0.3 barg) may be used in design combined with pulse duration of 0.2 s.

Guidance note:
The overpressure values quoted in 613-615 for process plant on deck assume that the plant area is congested.
Volume blockage ratio (possible blocking volumes vs. total volume considered) may be used as a measure of congestion.
Volume blockage ratio less than 0.05 may be considered as not congested.
The values quoted also assume that the process area is not enclosed by walls or roof.

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614 For process areas on open deck covering a medium size area (e.g. 20 m x 40 m) an explosion overpressure of 100 kPa (1.0 barg) may be used in design combined with pulse duration of 0.2 s.

615 For process areas on open deck covering a larger footprint than in 614 an explosion overpressure of 200 kPa (2.0 barg) may be used in design combined with pulse duration of 0.2 s.

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

Guidance note:
Where a solid process deck is used, the location of possible leak sources below this deck should be minimised. Similarly, for internal turret designs the number of leak sources within the enclosed sections should be minimised.

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

617 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.

618 Typical design values are summarised in Table D1. This shall be read together with the reservations in the text of D.

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

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---
D 700 Heat loads

701 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 will be considered as acceptable.

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

702 Where radiation levels at lifeboat stations exceeds 12.5 kW/m², radiation protection shall be provided.

703 Heat loads as a result of blowout during drilling operations will primarily be a function of blowout rate, hydrocarbon composition, and distance. The relationship related to impact on safety functions is shown in Figures 1 and 2.

### Table D1 Nominal Overpressures

<table>
<thead>
<tr>
<th>Area no.</th>
<th>Offshore Installation</th>
<th>Area 1)</th>
<th>Design Blast Overpressure 2) (barg)</th>
<th>Pulse Duration (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Drilling rig</td>
<td>Drill floor with cladded walls</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>2</td>
<td>Drilling rig</td>
<td>Shale shaker room with strong walls, medium sized</td>
<td>2</td>
<td>0.3</td>
</tr>
<tr>
<td>3</td>
<td>Mono-hull FPSO</td>
<td>Process area, small</td>
<td>0.3</td>
<td>0.2</td>
</tr>
<tr>
<td>4</td>
<td>Mono-hull FPSO</td>
<td>Process area, medium 3) sized with no walls or roof 4)</td>
<td>1</td>
<td>0.2</td>
</tr>
<tr>
<td>5</td>
<td>Mono-hull FPSO, large</td>
<td>Process area, large with no walls or roof</td>
<td>2</td>
<td>0.2</td>
</tr>
<tr>
<td>6</td>
<td>Mono-hull FPSO</td>
<td>Turret in hull, STP/STL room with access hatch</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>Production platform, Semi-sub</td>
<td>Process area, large with no or light walls, 3 storeys, grated mezzanine and upper decks 5)</td>
<td>2</td>
<td>0.2</td>
</tr>
<tr>
<td>8</td>
<td>Production platform, fixed</td>
<td>Process area, medium sized, solid upper and lower decks 6), 3 storeys, 1 or 2 sides open</td>
<td>1.5</td>
<td>0.2</td>
</tr>
<tr>
<td>9</td>
<td>Integrated Prod/Drilling</td>
<td>Process area and drilling module each medium sized on partly solid decks, 3 storeys, 3 sides open</td>
<td>1.5</td>
<td>0.2</td>
</tr>
<tr>
<td>10</td>
<td>Integrated Prod/Drilling</td>
<td>X-mas tree/wellhead area, medium sized with grated floors</td>
<td>1</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Notes:
1) All areas, with the exception of #1 and #6, are considered to be congested. Designs intended to give an even more compact process area than typical offshore practice are expected to have larger nominal overpressures.

2) All leak rates are considered, but for explosions, large leaks (e.g. 50 kg/s) dominate the explosion risk.

3) The terms small, medium, large for process area are not specifically defined, however examples of typical footprint sizes are given in the text above.

4) A process area with more than one level is expected to have somewhat higher overpressure if the footprint area is the same.

5) A design with solid mezzanine and upper decks would result in a higher nominal overpressure.

6) If all decks are grated the nominal overpressure is expected to be lower.

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

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

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---
Figure 2
Distance to impact levels as function of blowout rate.
75% oil and 25% gas

Guidance note:
These Figures may be used to assess a specific design with respect to the safety criteria specified in 701, 702 and 703. The 100% gas case should be used in assessing shallow gas blowouts and production from gas reservoirs. The gas or oil mixture case should be used for production from oil or condensate reservoir. Consideration may be given to duration of load with respect to ability to move off position.

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704 For drilling in water depths less than 100 m the potential effects of subsea blowouts must also be considered.

705 For production units or installations, heat loads in connection with ignition following loss of containment of hydrocarbons shall be taken as follows, unless otherwise documented:

a) In areas with both gas containing and oil or condensate containing equipment, critical items shall be designed to withstand a jet fire (250 kW/m²) for 30 minutes and a pool fire (150 kW/m²) 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 (150 kW/m²) for 60 minutes.

c) In areas with only gas containing equipment, critical items shall be designed to withstand a jet fire (250 kW/m²) for 30 minutes.

706 The following critical items shall be designed to withstand the specified design heat load:

— protective walls
— structures supporting hydrocarbon pressure vessels
— structures capable of blocking escape ways
— essential safety systems
— main structure.
SECTION 3
ARRANGEMENT

A. General

A 100 Objective

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

A 200 Application

201 The requirements of this section shall be applied to all units and installations. Additional, specific requirements for arrangement of different unit types are given as indicated in Table A1.

B. Segregation of Areas

B 100 General

101 The unit or installation shall be divided into different areas according to the type of activities that will be carried out and the associated hazard potential.

102 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.

103 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. The effect of prevailing winds and potential for segregation by less hazardous areas shall also be considered for area protection.

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

105 Where control stations or control functions are located in LER/LIRs outside the accommodation block/safe area special precautions against gas ignition related to gas detection, ventilation and shutdown will need to be provided.

C. General Arrangement

C 100 General

101 Where practicable, the orientation of the unit or installation, with respect to wind direction, shall aim to avoid smoke or gas impairment of escape, muster and evacuation areas.

102 Equipment shall be arranged with a view to providing:

— 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
— facilitation of well operations and control in normal and emergency situations
— 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.

---c-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---
D. Location of Plants and Equipment

D 100 Location of safety systems

101 Important safety systems and controls 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.

102 Where redundant safety equipment is used in meeting 101, this shall not be vulnerable to the same accidental events as the main system.

103 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.

104 The bridge of mobile installations 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 14.7 apply.

105 Field control panels and energy or actuation sources for well control equipment, pipeline and riser ESD valves shall be protected from dimensioning accidental events such as fire, explosion and mechanical impact, to ensure emergency operation of the barrier as necessary.

D 200 Location of risers and ESD valves

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

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

D 300 Location of air intakes and other openings

301 Intakes for ventilation and combustion air shall be located to avoid ingress of hazardous substances. Such intakes shall be outside hazardous area.

302 Exhausts from combustion equipment and ventilation systems shall be located to avoid cross contamination of air inlets.

303 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.

304 External entrances to areas important for safety shall be provided with air locks if located where smoke or gas ingress is possible during an emergency.

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

D 400 Fired heaters, combustion engines and hot surfaces

401 Fired heaters and combustion engines shall normally be located at a safe distance from hazardous areas. Special precautions shall be taken where such items could cause ignition of accidental gas or liquid release. This could include use of gas tight enclosures, overpressure ventilation, gas detection and automatic isolation, insulation or cooling of hot surfaces etc.

Guidance note:
See recognised standards such as EEMUA publication 107 for protection of diesel engines for use in zone 2 hazardous area or API RP 14J, paragraphs 5.5 and 5.6.

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402 Other requirements for protection of hot surfaces are presented in DNV-OS-D101.

403 Where fired heaters and combustion engines are located in the vicinity of hazardous areas, the potential for an incident to escalate from such equipment to the hazardous area shall be minimised, e.g. through use of segregation and/or fire barriers.

404 The potential consequences of high-energy missiles from gas turbines shall be considered in relation to location of equipment. Damage to safety functions and associated controls shall be avoided.

D 500 Location of flares and vents

501 Flares, burner booms, engine exhausts and other similar ignition sources shall be located to avoid ignition of normal or accidental gas releases. Use of dispersion calculations should be considered.

502 The flare and vent systems shall comply with API RP 521 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).

E. Storage of Hazardous Substances and Cryogenic Liquids

E 100 General

101 Stores for hazardous substances shall be segregated from, and located at a safe distance from accommodation spaces and control stations. Indoor storage areas are to have access from open deck and have efficient ventilation.

102 Equipment for storage and handling of cryogenic liquids (e.g. liquid nitrogen) shall be located in open areas with efficient natural ventilation. Equipment with potential for significant leakage shall be located in a bunded area, which is constructed of materials suitable for sustaining low temperatures. Reference also Sec.9 dealing with LNG terminals

Guidance note:
Evaporating cryogenic gases will be heavier than air and care should be taken to ensure that such gases do not contaminate lower modules.

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F. Cranes and Lay Down Areas

F 100 General

101 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.

102 The need for load handling above pressurised hydrocarbon equipment, hazardous inventories, and equipment important for safety shall be avoided as far as possible. Suitable impact protection shall be provided where such lifting cannot be avoided.

103 Lay down areas shall normally be located in non-hazardous areas and provided with heavy-duty barriers to prevent damage to adjacent equipment. On floating installations, necessary points for securing of deck loading shall be provided.

G. Other Requirements

G 100 General

101 The helicopter deck shall be located with a view to minimising hazards from obstructions, turbulence, gas vents or exhaust plumes, whilst providing a good approach path during prevailing weather conditions. The helicopter shall not be required to cross the unit or installation during such approaches.

102 Major hydrocarbon inventory areas, e.g. wellhead, drill floor, riser and tank deck areas shall be arranged to allow efficient external fire fighting assistance.
SECTION 4
HAZARDOUS AREA CLASSIFICATION

A. General

A 100 Objective

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

A 200 Application

201 This section applies to all offshore units and installations covered by this standard. The standards listed in Table A1 may be applied or referred to for basic or supplementary information. The code revision applicable is that valid at date of issue of this standard unless otherwise agreed.

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

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

B. Basic Principles

B 100 Definition of hazardous areas

101 Hazardous areas are all 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.

102 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).

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).

Guidance note:
Note that conditions of ventilation may change the zone definition for each grade of release. Also, the likelihood of detecting the leak may influence the zone.
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103 Non-hazardous areas are areas, which are not hazardous according to the definitions in 101 and 102.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---
B 200 Hazardous fluids (sources)

201 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.

202 Appendix A gives guidance for general categorisation of sources of release based on definitions in B100.

B 300 General principles for area classification

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

302 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.

303 It is not normally acceptable to locate open, non-hazardous areas enclosed, or significantly enclosed, by hazardous areas.

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

C. Extent of the Hazardous Zone

C 100 General

101 The extent of the hazardous area depends on the rate of release, ventilation conditions, and fluid properties.

102 The extent of the hazardous area shall be based on guidance in recognised standards listed in Table A1.

103 See Sec.7 for additional requirements for production and storage units and Sec.8 for criteria for drilling units.

Guidance note:
Where a standard quotes a discrete distance for the extent of hazardous area, this should be evaluated taking account of the source of release and the overall hazard involved.

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104 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.

D. Openings, Access and Ventilation Conditions

D 100 General

101 The level and extent of hazardous area classification is dependent upon ventilation. Adequate ventilation is required to ensure that releases are rapidly dispersed. The adequacy of ventilation conditions shall be justified and documented.

Guidance note:
Adequacy of ventilation implies that stagnant areas should be prevented and that a minimum of 12 volumetric air changes per hour should be achieved.

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.

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D 200 General requirements for mechanical ventilation systems

201 See DNV-OS-D101 for general requirements for ventilation systems (e.g. capacity, functionality, penetrations etc.).
202 See Sec.3 for requirement for location of air intakes.
203 See DNV-OS-D301 for requirements for gas detection in ventilation air intakes and outlets.
204 Ventilation systems for hazardous areas shall be separate from ventilation systems for non-hazardous areas.
205 Hazardous enclosed spaces shall be ventilated with underpressure 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 be designed to minimise the risk of sparks occurring.
206 Inlet and outlet ventilation openings shall be arranged to provide efficient ventilation in relation to the location of equipment and sources in the area.
207 Ventilation inlet ducts passing through a more hazardous area than the ventilated space shall be operated at overpressure in relation to the hazardous area.
208 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.
209 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.

D 300 Supplementary requirements for overpressure protection of enclosed spaces

301 Any enclosed non-hazardous space containing ignition sources and located in Zone 1 and Zone 2 areas shall be maintained at overpressure. Ventilation intakes shall be located in a safe area. Note certain limitations on arrangement given in Sec.3.
302 Alarms and isolation of ignition sources shall be initiated on detection of an explosive atmosphere adjacent to the ventilation air inlets, in accordance with the shut down philosophy for the unit or installation. 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.
303 Failure of overpressure ventilation shall be alarmed at a manned location. Alarm delay of up to 30 seconds may be applied to minimise spurious alarms when doors are intentionally opened.

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

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D 400 Loss of ventilation in hazardous areas dependent upon mechanical ventilation

401 Immediate remedial action to restore ventilation shall be taken upon identified loss of mechanical ventilation in hazardous areas.
402 Ignition sources shall be isolated where ventilation cannot be restored within a short time, typically 30 seconds, or if gas is detected either within the area or in the immediate vicinity during ventilation failure.

D 500 Dilution ventilation

501 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.

Guidance note:
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. A safety factor of 4 should be applied in the calculations, (i.e. aiming for < 20% LEL). For turbine hoods a minimum of 90 air changes per hour will normally be sufficient.

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

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).
503 The ventilation system shall be suitable to avoid stagnant areas, and flow of ventilation air shall be continuously monitored.
504 Non-Ex-certified electrical equipment and other ignition sources shall be isolated immediately upon failure of ventilation, or upon gas detection > 25% LEL, unless such shutdown can cause escalation of the...
danger, in which case suitable alarms shall be given in control room and other essential locations which may need to provide immediate action.

D 600 Air locks
601 The requirements for air locks apply when they are installed to prevent smoke or gas ingress.
602 Air locks shall consist of gas tight steel bulkheads and gas tight self-closing doors.
603 The air lock shall be mechanically ventilated at a positive pressure against the adjacent hazardous area or outside atmosphere.
604 The air lock shall as a minimum be classified as zone 2.

D 700 Ventilation of battery compartments
701 Ventilation arrangement for battery rooms shall be in accordance with DNV-OS-D201 Ch.2 Sec.2 I404.

E. Electrical Installations in Hazardous Areas

E 100 General requirements
101 Electrical equipment and cables installed in hazardous areas shall be limited to that necessary for operational purposes.
102 All electrical installations in hazardous areas shall comply with the requirements of DNV-OS-D201 Ch.2 sec.11.
103 Electrical equipment with temperature Class T3 (maximum 200°C) shall be used when hydrocarbon gases give rise to hazardous areas.
104 Warning signboards shall be fitted, either easily visible from the hazardous areas and of size about 600 x 400 mm with letters of height about 30 mm, or smaller signboards at each socket outlet in or adjacent to the hazardous areas, with text, e.g.:
PORTABLE ELECTRICAL EQUIPMENT SUPPLIED BY FLEXIBLE CABLES SHALL NOT BE USED IN AREAS WHERE THERE IS GAS DANGER.
105 A warning signboard shall be fitted at each connection for welding apparatus outside of the engine room, with text, e.g.:
WELDING APPARATUS SHALL NOT BE USED OUTSIDE THE ENGINE ROOM, UNLESS THE WORKING SPACE AND ADJACENT SPACES ARE GAS-FREE.
Connections for welding apparatus shall normally not be located in hazardous areas.
SECTION 5
EMERGENCY SHUTDOWN (ESD) PRINCIPLES

A. General Requirements

A 100 Objectives

101 The provisions of this section aim to ensure that shutdown systems are provided as suitable and effective to safeguard personnel and plant against hazardous events on the unit or installation.

A 200 Application

201 These requirements shall be applied to all offshore units or installations having direct operational contact with hydrocarbons.

202 The requirements of DNV-OS-D202 apply to the emergency shutdown system.

A 300 Definition

301 An emergency shutdown system comprises:

—— manual input devices (push buttons)
—— interfaces towards other safety systems, 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.

A 400 Basic provisions

401 The ESD system shall be designed so that the risk of unintentional shutdown caused by malfunction or inadvertent operation is minimised.

402 The ESD system shall be designed to allow testing without interrupting other systems onboard.

403 The ESD system shall have continuous availability R0 as defined in DNV-OS-D202, Ch.2 Sec.1 B200.

404 The ESD Operator Station shall be located in a non-hazardous and continuously manned area.

405 The ESD central control unit shall be powered from the main power system and from a monitored Uninterruptible Power Supply (UPS) capable of at least 30 minutes continuous operation on loss of main power. The UPS shall be powered from both the main and the emergency power system.

B. Safety and Shutdown Philosophy

B 100 General

101 The philosophy shall comprise functional requirements for the safety systems upon detection of an abnormal condition. The fail-safe functionality for the safety systems shall be included.

102 The philosophy document shall indicate actions to:

—— limit the duration and severity of the incident
—— protect personnel exposed to the incident
—— limit environmental impact
—— facilitate escape, muster and evacuation, as necessary.

103 Inter-relationships and requirements for the following systems 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.

C. Fail-Safe Functionality

C 100 General

101 Upon failure of the shutdown system, all connected systems shall default to the safest condition for the unit or installation.

102 The safest conditions for the systems onboard shall be defined. The safest conditions defined in Table C1 shall normally apply. Deviation from the requirements of Table C1 shall be justified.

Guidance note:
This is primarily intended for systems shutdown/operation and not individual components within the system.
The table is not intended to be comprehensive, so that other safety-related systems should also be considered in a similar way.

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103 In the context of this section, ‘circuit’ is defined as any signal transfer facility, e.g. electrical, pneumatic, hydraulic, optical or acoustic.

104 Failures to be considered for the shutdown system shall include broken connections and short circuits on input and output circuits, loss of power supply and if relevant loss of communication with other systems.

| Table C1 Safest conditions and corresponding output circuit configuration |
|-------------------------------------------------|---------------------------------|-------------------|
| System                                          | Safest condition in case of failure to the shutdown system | Output circuit configuration |
| Process plant including associated utilities    | Shut down                       | NE                |
| Drilling system                                 | Operational 1)                  | NDE               |
| Fire pump drivers (start function)              | Operational                     | NE                |
| Electrical power generation, including required auxiliary systems, for units not dependent upon active position keeping | Shut down 2)                    | NE                |
| Electrical power generation, including required auxiliary systems, for units dependent upon active position keeping | Operational 2)                  | NDE               |
| Uninterruptible power supplies for power generation, control and safety systems | Operational 2)                  | NDE               |
| Propulsion and steering for units not dependent upon active position keeping | Shut down 2)                    | NE                |
| Propulsion and steering for units dependent upon active position keeping | Operational                     | NDE               |
| Turret locking and turning systems 3)           |                                 |                   |
| Utility systems which do not affect essential functions | Shut down                       | NE                |

1) See DNV-OS-E101 for further details.
2) 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 by-pass of high level ESD trips during transit).
3) 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 systems and fairleads etc. will need to be addressed.

NDE = normally de-energised NE = normally energised
D. Protection Systems and Shutdown Logic

D 100 General

101 Shutdown shall be executed in a pre-determined, logical manner to meet the objectives defined in Sec.5 B. Definition of the logic and required response time shall include consideration of interactions between systems and dynamic effects, e.g. for process plant.

102 A shutdown logic shall be implemented to determine the response to different degrees of emergency or upset condition. The shutdown logic should be as simple as possible. The shutdown logic given in Fig.1 shall be applied as a basis with additional due recognition of installation specific requirements.

103 Mobile Drilling Units

See Sec.8 for simplified alternatives applicable to mobile drilling units.

Figure 1
Outline of emergency shutdown logic

*Surface controlled sub sea shutdown valve
104 Shutdown shall not result in adverse cascade effects, which depend on activation of other protection devices to maintain a plant in a safe condition. The shutdown system shall be designed to ensure that any ongoing operations can be terminated safely when a shutdown is activated.

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

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

107 The process protection system and shutdown logic shall be based on guidance given in API RP 14C or ISO 10418.

108 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.).

109 Gas detection shall initiate alarm in the crane cabin. Non-operational cranes shall be automatically de-energised if hydrocarbon gas is detected in the vicinity of the crane. Operational cranes shall be subject to manual isolation of uncertified electrical equipment and other ignition sources.

110 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.

111 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.

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

113 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 room.

E. Automatic and Manual Shutdown

E 100 General

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

102 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.

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

104 Other manual shutdown buttons shall be located at strategic locations on the unit or installation. Locations indicated in Table E1 shall be applied as a basis with additional consideration given to installation-specific requirements.

| Table E1 Location of push buttons for manual shutdown |
|-----------------------------------------|----------------------------------|
| **Shutdown level**                      | **Location of push-button**      |
| Abandon platform (APS)                  | — main and emergency control rooms |
|                                         | — muster stations, lifeboat stations and helicopter deck |
|                                         | — bridge connections between platforms |
| Emergency shutdown (ESD)               | As for APS, plus:                |
|                                         | — process control room           |
|                                         | — driller’s control cabin        |
|                                         | — exits from process, drilling, wellhead, riser areas etc. |
|                                         | — along main escape routes       |
| Process shutdown (PSD)                 | — main control room              |
|                                         | — process control room           |
|                                         | — exits from process, drilling, wellhead, riser areas etc. |
|                                         | — along main escape routes       |
| Manually activated call point (MAC)    | Readily available for use in all normally manned areas |

It may be appropriate to limit the number of field installed pushbuttons for lower level trips (e.g. for PSD) in order to avoid confusion about their use.

105 For mobile offshore drilling units the arrangement shall as a minimum comply with IMO MODU Code Sec. 6.5.
F. Certification of Electrical Equipment for Use in an Emergency

F 100  General

101  The following systems shall be operable after “Abandon Platform” (APS) shutdown:

— emergency lighting, for half an hour at:
  — every embarkation station on deck and over sides
  — in all service and accommodation alleyways, stairways and exits, personnel lift cars, and personnel lift trunks
  — in the machinery spaces and main generating stations including their control positions
  — in all control stations and machinery control rooms

— blowout preventer control
— general alarm
— public address
— battery supplied radio-communication.

102  Electrical equipment left operational after APS shutdown shall be certified for operation in zone 2 areas with the exceptions given in 104.

103  Electrical equipment located in non-hazardous areas which is affected by a gas release, and left operational after gas detection shall be certified for zone 2, with the exceptions given in 104.

104  Safety critical, uncertified electrical equipment may be left operational after ESD or gas detection affecting its area of location, provided that the ventilation to the room where the equipment is located is efficiently isolated. Typical living quarter design will meet this requirement, other enclosed spaces will be specially considered.
SECTION 6
ESCAPE AND COMMUNICATION

A. General

A 100 Objectives

101 The design of the unit or 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.

A 200 Application

201 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.

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

B. Escape Routes

B 100 Principles

101 Safe, direct and unobstructed exits, access, and escape routes shall be provided from all normally manned areas of the unit or installation to temporary refuge, muster areas and embarkation or evacuation points.

102 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 unit or installation.

Guidance note:
Dedicated escape routes need not necessarily apply to very infrequently manned areas, e.g. which are subject to structural inspection only, where suitable arrangements can be made with temporary access facilities (e.g. scaffolding etc.).

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

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B 200 Sizing

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

Guidance note:
Typical values for width of escape routes would be 1m for main escape routes and 0.7m for secondary escape routes, with consideration given to areas for manoeuvring a stretcher.

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B 300 Walkways, stairs, ladders and lifts

301 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.

302 Lifts shall not be considered as an emergency means of escape.

303 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. Dead end corridors greater than 7 m in length shall be avoided.

304 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.
B 400  Escape from machinery spaces category A

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

402  Where the machinery space is below open deck level the means of escape shall be according to the following:

a)  Two sets of steel ladders separated as widely as possible, leading to similarly separated doors in the upper part of the space, which give access to the open deck. One of these ladders shall normally provide continuous fire shelter from the lower part of the space to a safe position outside the space. Fire shelter shall be of suitably insulated steel, with a self-closing door at the lower end.

b)  One steel ladder leading to a door in the upper part of the machinery space which gives access to the open deck, and additionally, a steel door located in a lower part of the machinery space and separated from the ladder. The lower door shall be operable from both sides and shall lead to a safe escape route from the lower part of the space to the open deck.

Guidance note:
The number of means of escape may be reduced based on a consideration of the nature and use of the space and the normal level of manning within the space. (ref MODU Code 9.3.2).

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B 500  Railings and barriers

501  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.

C. Muster Areas

C 100  All muster areas

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

102  All muster areas shall be suitably sized to enable efficient accounting of personnel and donning of personal protective equipment. Areas shall be suitably arranged to enable movement of stretchers.

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

D. Emergency Lighting

D 100  Specific requirements

101  All manned areas on the unit or 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.

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

103  Muster areas, embarkation areas, launching arrangements and the sea below life saving appliances shall be adequately illuminated by emergency lighting.

E. Marking and Warning Signboards

E 100  General

101  Signs and marking shall be provided along escape routes, showing exit points and the direction to muster areas, embarkation areas and means of escape to sea. Signs shall be provided in sufficient numbers to be visible from any regularly manned area on the unit or installation.

102  Main escape routes shall be marked or painted to make them conspicuous and avoid blockage by portable equipment and supplies.

103  Fire fighting equipment shall be marked as required in DNV-OS-D301.

E 200  Marking of unit or installation and helicopter deck

201  The name of the unit or installation shall be marked on all sides and shall be easily visible in daylight and at night.
202 Marking of the unit or installation shall be in accordance with relevant national and international regulations. The requirements of the International Regulations for Preventing of Collision at Sea (COLREG) apply to navigation lights and sound signals for mobile units in transit.

203 Helicopter decks and obstructions to helicopter operations shall be illuminated and marked in accordance with relevant national or international regulations. The standards issued by International Civil Aviation Organisation shall apply where other, specific requirements have not been agreed.

E 300 Safety plans and warning signboards

301 Orientation and safety plans shall be strategically located at major circulation points on the unit or 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.

302 Areas for storage of flammable, radioactive, explosive or otherwise hazardous substances shall be marked with appropriate warning signboards.

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

304 Self-closing doors between areas with different area classification shall be fitted with signboards. See IEC 61892-7, paragraph 4.6.4 for details.

305 Warning signboards shall be fitted at openings direct to sea.

F. Communications and Alarms

F 100 Objectives

101 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.

F 200 Definitions

201 An 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.

F 300 General requirements

301 These requirements are in addition to the internal communication system requirements found in the applicable statutory regulations.

— The two way voice communication extensions at control stations and the navigation bridge shall have priority.
— The required internal communication systems shall be capable of being supplied from the emergency source of power, for a period of at least 18 hours.
— The two-way voice communication system shall be supplied by a battery or an uninterruptible power supply as a stand-by power supply sufficient to operate the system for at least 30 minutes.

302 Alarms initiated from the following systems shall be provided where relevant:

— general emergency (ESD) or muster
— fire detection
— hydrocarbon gas detection
— toxic gas (e.g. Hydrogen sulphide) detection
— fire extinguishing medium release (CO2 or other gases with lethal concentrations)
— power-operated watertight door closing
— machinery fault detection.

303 All alarms shall be indicated visually and audibly in the control centre.
An alarm philosophy shall be established ensuring that the alarms are simple and unambiguous. The philosophy shall define which alarms are broadcast to the entire unit or installation and whether this should occur automatically or not.

The unit or installation shall be equipped with a public address system. The alarm system may be combined with the public address system, provided that:

- alarms automatically override any other input
- 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.

The number of alarms during abnormal conditions shall be assessed and reduced as far as practicable by alarm processing/suppression techniques in order to have operator attention on the most critical alarms that require operator action.

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.

Guidance note:
See IMO Resolution A.830(19) Code on Alarms and Indicators, 1995 for details on priorities, grouping, locations and types, including colours, symbols etc.
National authorities may have specific requirements deviating from the IMO Resolution. These will normally be acceptable for classification purposes.

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

Activation of the general alarm shall be possible from the main control stations, including navigation bridge and radio room.

In addition to the alarm systems, a two-way communication system shall be provided for transmittal of alarm, instructions and information between those who may require them.

The alarm and communication system shall be powered from the main power system and from a monitored Uninterruptible Power Supply (UPS) capable of at least 1 (one) hour continuous operation on loss of main power. The UPS shall be powered from both the main and the emergency power system.

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

The alarm system shall be regularly tested.
SECTION 7
SPECIAL PROVISIONS FOR PRODUCTION AND STORAGE UNITS

A. General

A 100 Introduction

101 In addition to the provisions given elsewhere in this standard, the following requirements apply specially for floating production and/or storage units.

102 For general arrangements of ship shaped units, see to Rules for Classification of 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
— gas freeing and venting of product storage tanks (arrangement and location of P/V valves)
— ventilation system within the storage area
— inert gas plants
— crude oil washing arrangements.

B. Arrangement

B 100 General

101 The unit shall be oriented to provide efficient natural ventilation of hazardous areas, and safeguard areas important to safety.

102 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.

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

104 Requirements given in IMO instruments applicable for oil tankers, gas carriers etc. may be applied to special designs or issues that are not addressed in these standards.

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

106 To ensure satisfactory operation in all weather conditions, ventilation inlets and outlets for rooms with essential equipment shall be located in such positions that closing appliances will not be necessary. Such rooms are machinery spaces, emergency generator room, switchboard rooms and control stations.

Guidance note:
Basis for determining acceptable locations for ventilators as mentioned above should be an examination of the extent green sea for the unit. For areas clearly not affected by green sea, e.g. at the top of the bridge, documentation for location of the inlets and outlets will not be necessary.

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107 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.

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B 200 Process and storage tank decks

201 The space between process 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.

202 The process deck shall be provided with suitable process drainage and bunding for operational and accidental spillage collection. Drainage shall prevent large oil spills and firewater from impairing escape routes or spreading to storage tank deck.

203 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.

**B 300 Risers and piping**

301 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.

302 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.

303 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.

**Guidance note:**

Special consideration must 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.

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304 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.

**B 400 Entrances and openings**

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

402 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 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.

**B 500 Crude oil storage area and cofferdams**

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

502 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.

503 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.

504 Crude oil tanks, slop tanks and enclosed spaces adjacent to these tanks shall be arranged with suitable access for inspection of structural elements.

505 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.

506 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.

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

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

509 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.

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

**B 600 Slop tanks**

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

602 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.

603 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.

604 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).

605 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.

B 700 Crude oil pump rooms and pipe tunnels

701 Submerged (deep well) crude pumps shall be used where practicable, in order to limit risk of hydrocarbon leaks in confined spaces. The requirements in 702 to 705 apply where use of deep well pumps is not practicable.

702 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.

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

704 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).

705 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.

B 800 Mooring systems

801 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.

802 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.

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

C. Hazardous Area Classification

C 100 General

101 These requirements are supplementary to general requirements given in Sec.4.

C 200 Product storage tank areas

201 The hazardous area classification of product storage tank areas shall follow a recognised code, ref. Sec.4 Table A1.

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

203 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, ref. Sec.4 Table A1
— 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.

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D. Equipment and Cables in Hazardous Areas

D 100 General

101 Except for small spaces such as air-locks, 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.

102 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.
SECTION 8  
SPECIAL PROVISIONS FOR DRILLING UNITS

A. General

A 100 Introduction
101 In addition to the provisions given elsewhere in this standard, the following requirements apply specially for floating drilling units.

B. Arrangement

B 100 General
101 Design and location of equipment shall take account of motion of the unit and the possible effects of green sea.

B 200 Mooring systems
201 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.

202 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.

B 300 Moonpools
301 Moonpools shall have adequate scantling and stiffening to avoid damage from impact from load handling.

302 For ship shaped drilling units, the moonpool for drilling shall be surrounded by a cofferdam. However, upon special consideration, 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.

B 400 Production and well testing
401 Drilling units intending to utilise facilities for storage and offloading of crude oil are to satisfy relevant requirements for production and storage units.

402 Arrangement of areas for well testing equipment and burner booms shall be given special attention. See Sec.3 for general requirements for arrangement and location of flares, and Sec.4 and C for hazardous areas.

C. Hazardous Area Classification

C 100 General
101 These requirements are supplementary to general requirements given in Sec.4.

102 Typical drilling plants shall be classified in accordance with requirements in IEC 61892-7 and IMO MODU Code sec. 6.2.

C 200 Drilling plant
201 Drilling mud transported in piping systems after the last stage of degassing shall not normally be regarded as a source for hazardous area. Consequently, mud pump rooms and mud mixing rooms are not normally classified hazardous unless there are other sources in the area.

202 Drilling fluid should be considered as hazardous when it is flammable and is handled at temperatures above flash point, e.g. due to high formation temperatures.

Guidance note:
Mud (e.g. oil based) may be considered hazardous when its temperature can be raised to the flashpoint or auto-ignition temperature during storage, usage and possible release (contact with warm surfaces).

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

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

Where a cementing unit is used for well control (kill) operations and may use active mud, the space containing the cementing unit may require classification.

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.

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

Deck drainage systems shall be segregated from drains from non-hazardous areas.

D. Electrical Installations in Hazardous Areas

D 100 General

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

Cables that necessarily will have to be so located that they may come into contact with mud are to be constructed of materials resistant to oil based mud.

E. Shutdown

E 100 General

International requirements for a simplified shutdown hierarchy may be applied on agreement between yard and owner. The principles of Sec.5 D remain applicable for areas that are vulnerable to an emergency originating from plant for well testing.

At least two emergency control stations shall be provided. One of the stations is to be located near the drilling console and the second station is to be at a suitable manned location outside the hazardous areas.

The control stations are to be provided with:

— manually operated contact makers 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.

F. Escape, Evacuation and Communications

F 100 General

At least one escape route from the drilling derrick and from driller’s cabin should lead directly to a safe place without requiring personnel entry to the central drill floor area.
SECTION 9
SPECIAL PROVISIONS FOR LNG IMPORT AND
EXPORT TERMINALS (AND LNG PRODUCTION UNITS)

A. General

A 100  General
101  The following requirements apply specifically to LNG terminals. They will be applicable to both floating and fixed installations.
102  These requirements should be considered as supplementary to the requirements given in the main body of this document.

B. Risk Assessment

B 100  General
101  With reference to Sec.2 C103, 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 Appendix B.

B 200  Hazards
201  The assessment 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.

202  The following generic hazards listed in Appendix B A500 should 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

203  In addition to the above hazards the following specific hazards should 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

204  Any additional hazards identified by the assessment should also be addressed.

205  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).

Guidance note:
For calculation of effects of accidental loads reference is made to DNV RP C204, Design against Accidental Loads.
C. Arrangement

C 100 General

101 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.

102 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.

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

104 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.

105 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.

C 200 Location of equipment

201 On floating installations consideration should 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.

202 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.

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

204 Equipment should 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.

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

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

207 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 should be considered.

208 Where a process deck is provided above a storage area, sufficient space should 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.

C 300 Location of storage tanks

301 Storage tank location should 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.

Guidance note:
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.

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

C 400 Piping

401 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.

402 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.

403 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

404 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.

C 500 Mooring of floating installations

501 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

502 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

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

D. Hazardous Area Classification

D 100 Codes and standards

101 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 should be demonstrated.

102 These codes include:

— IEC 60079-10
— API RP 500 / 505
— NFPA 59A
— IGC

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.

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103 Where not adequately covered by a code, the extent of hazardous area in connection with vents or special features should 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.

104 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.

D 200 Entrances and openings

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

Guidance note:
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.

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

E 100  General
101  Emergency shutdown should take account of the major functions of the installation, i.e. LNG transfer, LNG storage, gas/LNG processing and gas import/export.
102  The terminal emergency shutdown system should also take account of the operation of any gas carrier which is moored to the terminal.
103  LNG transfer system controls, gas carrier systems and carrier berthing should 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.

104  Alarms to indicate potential overfilling of tanks should be set with sufficient margin to ensure that flow can be stopped before maximum filling level is reached.
105  Alarm levels for gas detection should be set to give a low level alarm and a high level alarm at 20% and 60% of Lower Explosion Limit respectively. Reference is made to DNV-OS-D301 for actions on gas detection.

F. Escape and Communication

F 100  Escape routes
101  At least one escape route shall remain available following an accidental event in connection with LNG storage tanks, processing, transfer or import/export.
102  Where necessary protection against spray of cryogenic material should be provided.
103  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.3 D500 concerning limitation on activities related to various radiation levels.
APPENDIX A
CATEGORISATION OF SOURCES OF RELEASE

A. Categorisation

A 100 General
101 Note that the categorisation may require adjustment based on the actual design of the component or frequency of use.

A 200 Continuous sources of release
201 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.

A 300 Primary sources of release
301 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.

A 400 Secondary sources of release
401 Typical secondary sources of release:
   — standard flanges, connections and valves
   — pumps and compressors (depending on design)
   — areas outside of Zone 0 or 1 if release point has varying rates and frequency of release
   — ventilation openings from a Zone 2 area
   — bell nipple (drilling nipple)
   — wireline stuffing box
   — set-back drill pipe if coated with drilling mud
   — 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

A. Safety Assessment

A 100 General

101 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.

102 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.

103 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.

104 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.

105 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.

106 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).

A 200 Application and objective

201 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 202 to 204.

202 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.

203 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.

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

A 300 Application to mobile offshore units

301 Standard classed MOUs

For standardised designs constructed to classification requirements, the methodology given in DNV “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 classed “reference rig”.

302 Application of this methodology may be undertaken in lieu of the requirements in 400 to 700.

303 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 400 to 700 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.
A 400 Scope of assessment

401 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.

<table>
<thead>
<tr>
<th>ACTIVITIES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Concept design</strong> (C106)</td>
</tr>
<tr>
<td>Identify or develop concept(s) and specifications based on recognised industry practice and requirements.</td>
</tr>
<tr>
<td><strong>Hazard identification</strong> (A500)</td>
</tr>
<tr>
<td>Systematically and thoroughly identify potential hazards.</td>
</tr>
<tr>
<td><strong>Hazard reduction</strong> (A600)</td>
</tr>
<tr>
<td>Select hazard reduction measures with an aim to reduce identified hazards wherever practicable.</td>
</tr>
<tr>
<td><strong>Hazard evaluation</strong> (A600)</td>
</tr>
<tr>
<td>Qualitatively or quantitatively evaluate hazard effects, consequences and frequency.</td>
</tr>
<tr>
<td>Include hazard reduction measures (A600)</td>
</tr>
<tr>
<td>Include effect of safety systems and dimensioning loads. (C705)</td>
</tr>
<tr>
<td><strong>Comparison with safety targets and criteria</strong></td>
</tr>
<tr>
<td>Establish where final consequences of hazards breach safety targets. Where safety targets are not met, apply criteria. Where criteria are not met, consider additional hazard reduction and dimensioning load specification.</td>
</tr>
<tr>
<td><strong>Finalise design</strong></td>
</tr>
<tr>
<td>Verify that dimensioning loads and assumptions are included into final design and construction specifications.</td>
</tr>
</tbody>
</table>

*Note:*
Shaded areas indicate matters to be included in safety assessment document.

**Figure 1**
Flowchart for formal safety assessment
A 500 Hazard identification

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

502 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.

503 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.

504 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.

A 600 Hazard reduction

601 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.

602 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.

603 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.

604 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 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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A 700 Hazard evaluation

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

702 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 705.

703 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.
704 Where used, models and data should be appropriate, and from industry recognised sources.

**Guidance note:**
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.

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705 *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.

706 The final selection of dimensioning accidental loads shall be suitable for the installation to meet the safety criteria. See Table A1 for typical safety targets. Where the safety criteria are exceeded, the initial dimensioning loads may need to be revised.

<table>
<thead>
<tr>
<th>Table A1 Typical safety targets</th>
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<tr>
<td><strong>No.</strong></td>
</tr>
<tr>
<td>1.</td>
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</tbody>
</table>

**B. Alternative Requirements**

**B 100 General**

101 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 200 and 300.

**B 200 Regional requirements**

201 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 A.

**B 300 Alternative safety targets and criteria**

301 Other safety standards, such as regional or owner or operator criteria, may be applied in lieu of those in Table A1 provided that they are equivalent to or more stringent than the personnel safety requirements in this standard.