

OFFSHORE STANDARD
DNV-OS-A101

SAFETY PRINCIPLES AND
ARRANGEMENTS

JANUARY 2001

DET NORSKE VERITAS

FOREWORD

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

- *Offshore Service Specifications*. Provide principles and procedures of DNV classification, certification, verification and consultancy services.
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- *Recommended Practices*. Provide proven technology and sound engineering practice as well as guidance for the higher level Offshore Service Specifications and Offshore Standards.

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- B) Materials Technology
- C) Structures
- D) Systems
- E) Special Facilities
- F) Pipelines and Risers
- G) Asset Operation

Amendments October 2002 and October 2001

This Code has been amended, but not reprinted in October 2002 and 2001. The changes are incorporated in the Web, CD and printable (pdf) versions. The amendments are shown in red colour in the Web and CD versions.

All changes affecting DNV Offshore Codes that have not been reprinted, are published separately in the current *Amendments and Corrections*, issued as a printable (pdf) file.

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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 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.

<i>Reference</i>	<i>Title</i>
DNV-OSS-101	Rules for Classification of Offshore Drilling and Support Units
DNV-OSS-102	Rules for Classification of Floating Production and Storage Units

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.

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.

<i>Reference</i>	<i>Title</i>
DNV-OS-C301	Stability and Watertight Integrity
DNV-OS-D101	Marine and Machinery Systems and Equipment
DNV-OS-D202	Instrumentation and Telecommunication Systems
DNV-OS-D301	Fire Protection

B 300 DNV Recommended Practices

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

<i>Reference</i>	<i>Title</i>
DNV-RP-A201	Standard Documentation Types
DNV-RP-A202	Documentation of Offshore Projects

B 400 Other references

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

<i>Reference</i>	<i>Title</i>
	DNV Rules for Classification of Ships
IP 15	Institute of Petroleum; Area Classification Code for Petroleum Installations – Part 15

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.

<i>Reference</i>	<i>Title</i>
API RP 14C	Analysis, Design, Installation and Testing of Basic Surface Safety Systems for Offshore Production Platforms
API RP 14J	Design and Hazard Analysis for Offshore Production Facilities
API RP 500	Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Division 1 and Division 2
API RP 505	Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Zone 0, Zone 1, and Zone 2
API RP 521	Guide for Pressure-Relieving and Depressurising Systems
COLREG	Convention on the International Regulations for Preventing of Collisions at Sea, 1972
DNV-OS-E101	Drilling Plant
DNV-OS-E201	Hydrocarbon Production Plant
DNV report no. 98AAAEIA	Guidelines for Risk and Emergency Preparedness Assessment

EEMUA publication 107	Recommendations for the protection of diesel engines for use in zone 2 hazardous areas
ICAO	Standard for helicopter landing areas
IEC 60079-10	Electrical apparatus for explosive gas atmospheres - Part 10: Classification of hazardous areas
IEC 61892-7	Mobile and fixed offshore units - Electrical installations - Part 7: Hazardous area
IMO 1989 MODU Code	Code for the Construction and Equipment of Mobile Offshore Drilling Units, 1989, as amended
IMO Res. A.830(19)	Code on Alarms and Indicators, 1995
ISO 10418	Petroleum and natural gas industries - Offshore production platforms - Analysis, design, installation and testing of basic surface safety systems
ISO 13702	Petroleum and natural gas industries - Control and mitigation of fires and explosions on offshore production installations - Requirements and guidelines
SOLAS	International Convention for the Safety of Life at Sea, 1974, as amended

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 Cargo area: Part of a unit or installation which contains: the cargo spaces, the pump rooms and/or cofferdams adjacent to cargo 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.

215 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.

216 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).

217 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)

218 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.

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

220 Mobile unit: Offshore installation or unit which is designed to be 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.

221 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.

222 Offshore installation: A collective term to cover any construction permanently supported by or fixed to the sea floor by gravity, piles or by other means; other than offshore units.

223 Offshore unit: Any floating offshore structure (including vessels and barges), whether designed for operating afloat or supported by the seabed.

224 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.

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

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

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

228 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.

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

230 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.

231 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.

232 Storage area: See *Cargo area*.

233 Tank deck: Deck, or part of a deck, which forms the top of a cargo tank.

234 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.

235 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.

236 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.

D 300 Abbreviations

301 The abbreviations in Table D1 are used.

Table D1 Abbreviations	
Abbreviation	In full
ALS	Accidental limit states
API	American Petroleum Institute
APS	Abandon platform shutdown
BOP	Blow out preventer
CCR	Centralised control room
DNV	Det norske Veritas
EEMUA	Engineering Equipment and Materials Users Association
ESD	Emergency shutdown
FMEA	Failure mode and effect analysis
HAZID	Hazard identification
HAZOP	Hazard and operability (study)
IACS	International Association of Classification Societies
IACS UI	Unified interpretation
IACS UR	Unified requirement
ICAO	International Civil Aviation Organisation
IEC	International Electrotechnical Commission
IMO	International Maritime Organization
ISO	International Organisation of Standardisation
KO	Knock out
LAHH	Level alarm high high
LALL	Level alarm low low
LEL	Lower explosion limit
MAC	Manually activated call point
MODU	Mobile Offshore Drilling Unit
NDE	Normally de-energised
NE	Normally energised
OS	Offshore standard
OSS	Offshore service specification
PALL	Pressure alarm low low
PSD	Process shutdown
RP	Recommended practice
SCSSSV	Surface controlled sub sea shutdown valve
SSIV	Sub-surface isolation valve
STL	Submerged turret loading
STP	Submerged turret production
UEL	Upper explosion limit
ULS	Ultimate limit states
UPS	Uninterruptible power supply

E. Documentation

E 100 General

101 Design documentation normally produced to document aspects covered by this standard is given in DNV-RP-A201 and DNV-RP-A202.

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

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.

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:

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

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 C.

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.

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.

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

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:

$$\begin{aligned} E &= M \cdot g_0 \cdot h \text{ (kJ)} \\ M &= \text{mass of object (tonnes)} \\ g_0 &= 9.81 \text{ m/s}^2 \end{aligned}$$

H = 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.

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

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 $v = 2$ m/s.

302 The impact energy is given as:

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

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

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.

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 stoichiometric gas mixtures is expected to lead to pressures of approximately 100 kPa (1 barg) in cases with medium level of congestion. High lev-

el of congestion may increase the pressure with a factor of 2 to 3. Larger volume also tends to increase the pressure.

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

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 0.2 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.

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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 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.

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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 cargo tanks, shall be designed for an overpressure of 400 kPa (4 barg). 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 an area of less than 20 m x 20 m with a not congested arrangement, an explosion overpressure of 20 kPa (0.2 barg) may be used in design combined with pulse duration of 0.2 s.

Guidance note:

Volume blockage ratio (possible blocking volumes vs. total volume considered) may be used as a measure of congestion.

On an open deck arrangement the most critical areas to be evaluated will be those where gas build up is possible, e.g. below a process deck.

Volume blockage ratio less than 0.05 may be considered as not congested.

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614 For process plant on open deck covering larger areas and thus permitting long flame acceleration and for designs, which may be considered as congested, an explosion overpressure of 50 kPa (0.5 barg), combined with a pulse duration of 0.2 s, shall be used in design unless a lower figure can be documented.

615 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.

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

- protective walls
- structures capable of blocking escape ways
- essential safety systems
- structure supporting hydrocarbon containing equipment.

617 Minimum design values are summarised in Table D1. This shall be read together with the reservations in the text of D. Other values may be used where documented by more detailed studies.

Table D1 Typical design overpressures			
Location	Design overpressure (barg)	Pulse duration (s)	Reference 600
Shale shaker room	2	0.2	603
Open drill floor	0.1	0.2	604
Process area, small and not congested	0.2	0.2	613
Process area, large or congested	0.5	0.2	614
Totally enclosed compartments (critical structure only)	4	1	610

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.

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.

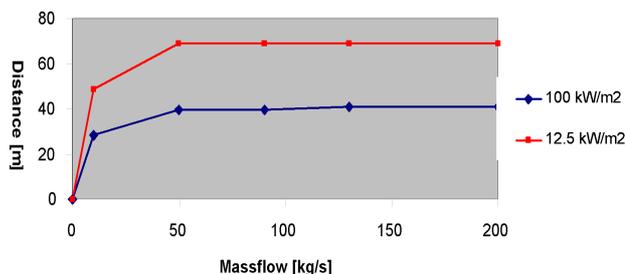


Figure 1
Distance to impact levels as function of blowout rate. 100% methane

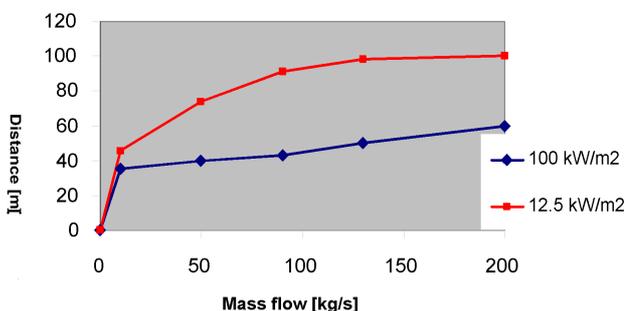


Figure 2
Distance to impact levels as function of blowout rate. 75% oil and 25% gas

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.

Table A1 Additional requirements

Reference	Unit type
Sec.7	Special requirements for floating production and/or storage units
Sec.8	Special requirements for drilling units

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 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.

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.

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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 minimum 3 m 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.

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.

Table A1 Reference standards	
Reference	Title
IEC 60079-10	Electrical apparatus for explosive gas atmospheres - Part 10: Classification of hazardous areas
IEC 61892-7	Mobile and fixed offshore units - Electrical installations - Part 7: Hazardous area
IMO 1989 MODU Code	Code for the Construction and Equipment of Mobile Offshore Drilling Units, 1989, as amended
API RP 505	Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Zone 0, Zone 1, and Zone 2
IP 15	Institute of Petroleum; Area Classification Code for Petroleum Installations – Part 15

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, Table C2, and IP 15 paragraph 2.15 provide further information to 201 and 203.

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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:

The guidance on duration for each 'grade of release' has been taken from IP 15 paragraph 1.5.5.2 and 1.5.4 for a continuously operated plant in open air. 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.

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. See IP 15, paragraphs 3.1.5 and B.2.

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 The dimensional limits of the hazardous zones shall include consideration of the size and rate of release, characteristics of the fluid, and degree of ventilation at the point of release.

Guidance note:

Normally the standardised zones given in recognised standards will be acceptable providing the application is equivalent to that used in the standard.

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305 A gas tight fire barrier may be used to limit the extent of a hazardous zone subject to the requirements of IP 15, 6.2.5 and figure 6.8.

306 Openings, penetrations or connections between areas of different hazardous area classification shall be avoided, e.g. through ventilation systems, air pipes or drain systems. Table C1 identifies some acceptable precautions for doors between such areas.

B 400 Buoyancy of release

401 A gas or vapour is regarded as buoyant or lighter than air if its density is less than 0.75 relative to ambient air.

Guidance note:

Methane and hydrogen are considered as lighter than air. Methane at cryogenic temperatures will be heavier than air.

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402 Crude oil vapour can be regarded as heavier than air provided that the difference in density between the hydrocarbon fractions is limited.

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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C. Openings, Access and Ventilation Conditions

C 100 General

101 The level and extent of hazardous area classification is dependent upon ventilation. Adequate ventilation is required

102 Table C1 indicates the effect of openings and ventilation on the hazardous area zone for enclosed areas and open areas with significant obstructions to ventilation.

103 Pits or sumps in classified areas are normally inadequately ventilated, and shall be classified as Zone 1 as indicated in Table C2.

Table C1 The effect of openings and ventilation on hazardous area zone classification for enclosed areas and open areas with obstructed ventilation

Grade of release	Open area with obstructions to ventilation or enclosed area. Both with internal source of release ^{3),7)}		Enclosed area with no internal source of release, but with opening to external zone	
	Adequate ventilation	Inadequate ventilation	Adequate ventilation	Inadequate ventilation
Continuous	Zone 0 ⁽¹⁾	Zone 0 ⁽¹⁾	Zone 0 ⁽²⁾	Zone 0 ⁽²⁾
Primary	Zone 1 ⁽¹⁾	Zone 1 ⁽¹⁾	Zone 1 ^(4, 6)	Zone 1
Secondary	Zone 2	Zone 1	Zone 2 ⁽⁵⁾	Zone 1 ⁽⁴⁾

- 1) Location of a continuous or primary grade source within an enclosed area is not acceptable practice and shall be avoided.
- 2) Location of an enclosed area without overpressure protection in a Zone 0 is not acceptable practice and shall be avoided.
- 3) Normally the area classification will apply to the complete area. However, if the area is large with a small source of release and with efficient, local ventilation, the source may not influence the classification of the complete area.
- 4) The enclosed area may be classified as Zone 2 if the only opening is a gas tight, self-closing door, which is opened infrequently. The enclosed area shall be ventilated at a higher pressure than the outside area. Loss of ventilation shall be alarmed at a manned control station.
- 5) The enclosed area may be classified as non-hazardous if the only opening is a gas tight, self-closing door, which is opened infrequently. The enclosed area shall be ventilated at a higher pressure than the outside area. Loss of ventilation shall be alarmed at a manned control station.
- 6) The enclosed area may be classified as non-hazardous if the access is fitted with an air lock. The enclosed area shall be overpressure ventilated. Loss of ventilation shall be alarmed at a manned control station. See Sec.4 C300 and Sec.4 C400 for requirements for ventilation and Sec.4 C600 for requirements for air locks.
- 7) Any openings in enclosures containing an internal source shall be regarded as a source of release to adjacent areas. The classification of the external area shall be based on the grade of release within the enclosure. Where relevant, the zone classification may be reduced per ⁴⁾ and ⁶⁾, depending on the type of door fitted. The zone dimension shall be based on the largest hazard radius of all internal sources, measured from the edges of the opening.

104 For definition of Grade of release, reference is made to IP 15.

C 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.

C 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. See also Table C1. 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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304 An enclosed space shall be purged (typically minimum 5 volumetric air changes) and verified as gas free before uncer-

tified electrical equipment or other ignition sources are energised after loss of overpressure.

C 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, or if gas is detected during ventilation failure. See Table C2 for a summary of protective measures to be taken in the event of ventilation failure.

Table C2 Summary of protective measures to be taken in the event of failure of ‘adequate ventilation’ or ‘overpressure ventilation’ (The table is based on IEC 61892-7, paragraph 8.5.2 and IP 15 paragraph 6.6.1 and 6.6.3.).			
Classification of area in the event of failure of ventilation	Classification of equipment or other electrical sources		
	Apparatus suitable for use in Zone 1	Apparatus suitable for use in Zone 2	Non- Ex-certified electrical equipment or other ignition sources ¹⁾
Required protective measures			
Zone 1 ⁶⁾	No action necessary	<ul style="list-style-type: none"> — Alarm ²⁾ — Immediate, planned action to restore pressurisation — Programmed trip of ignition sources if ventilation cannot be readily restored or if significant concentration of flammable gas is detected ⁴⁾ 	<ul style="list-style-type: none"> — Alarm ²⁾ — Immediate, planned action to restore pressurisation — Automatic trip of ignition sources within a suitable time delay ³⁾ — Immediate, automatic trip of ignition sources if flammable gas is detected ⁴⁾
Zone 2	No action necessary	No action necessary	As for Zone 2 apparatus in Zone 1 area

1) This equipment shall only be installed in a non-hazardous area, which is protected by overpressure ventilation during normal operations.
 2) The alarm may be delayed by up to 30 s to minimise spurious alarms.
 3) The actual trip may be initiated manually if an automatic trip function would jeopardise the safety of the installation. A suitable time delay, typically 15 to 30 minutes may be acceptable to allow action to restore ventilation.
 4) The trip may be manual or automatic. Trip on gas detection applies when detection is either within the area or in the immediate vicinity.
 5) For loss of dilution ventilation, see Sec.4 C503.
 6) The requirements for zone 1 apply to non-hazardous areas exposed to accidental gas release too.

C 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 < 25% LEL).

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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.

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 > 20% 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.

505 See IP 15, paragraph 8.8 for requirements for dilution ventilation of a gas turbine enclosure.

C 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 spaced at least 1.5 m and not more than 2.5 m apart.

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.

C 700 Ventilation of battery compartments

701 Ventilation arrangement for battery compartments shall be in accordance with Rules for Classification of Ships, Pt.4 Ch.8 Sec.2.

D. General Categorisation of Sources of Release

D 100 General

101 Appendix A gives guidance for general categorisation of sources of release based on definitions in Sec.4 B100.

102 Further guidance is available from IP 15 Sec.5.

E. Extent of the Hazardous Zone

E 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, the extent of the zone shall be larger than the boundary of 50% LEL concentration.

F. Electrical Installations in Hazardous Areas

F 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 the relevant DNV standard for electrical systems and equipment.

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, Sec.2 B.

404 The ESD central control unit shall be located in a non-hazardous and continuously manned area.

405 The ESD central control unit shall be powered from a monitored Uninterruptible Power Supply (UPS) capable of at least 30 minutes continuous operation on loss of its electrical power supply systems. 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.

Table C1 Safest conditions and corresponding output circuit configuration		
<i>System</i>	<i>Safest condition in case of failure to the shut-down system</i>	<i>Output circuit configuration</i>
Process plant including associated utilities	Shut down	NE
Drilling system	Operational ¹⁾	NDE
Fire pump drivers	Operational Failure of the control system shall lead to the start of the unit	NDE
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		

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.

105 A normally energised (NE) circuit is a circuit where energy is present as e.g. a floating electrical current or pneumatic or hydraulic pressure when the circuit is not activated by the shutdown system.

106 A normally de-energised (NDE) circuit is a circuit where energy is not present when the circuit is not activated by the shutdown system.

107 For a shutdown system with only NE outputs, all inputs shall be NE.

108 For a shutdown system with one or more NDE outputs, all inputs able to activate a NDE output shall be NDE.

109 All NDE input and output circuits shall be monitored for broken connection and short circuit.

D. Protection Systems and Shutdown Logic

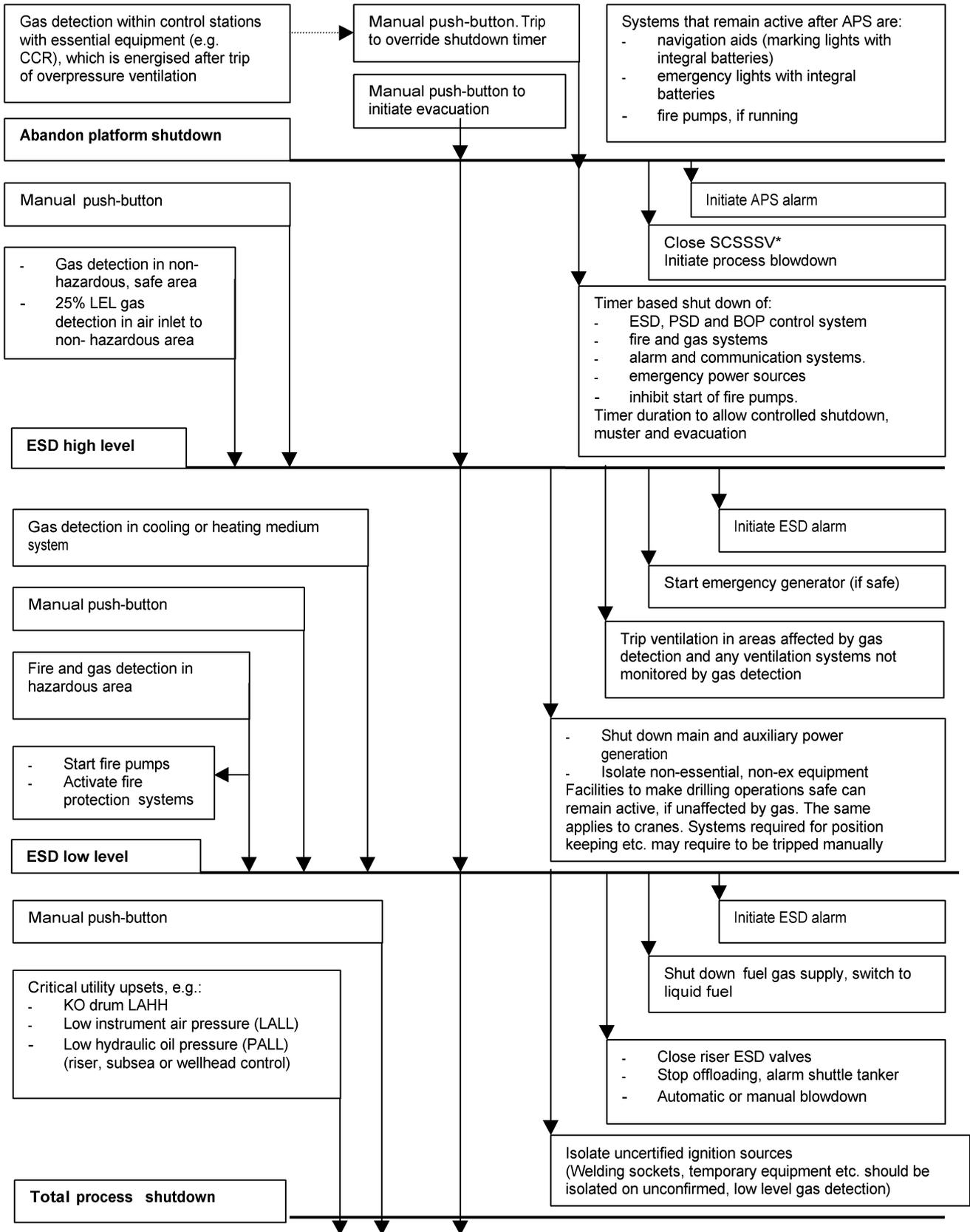
D 100 General

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.



*Surface controlled sub sea shutdown valve

Figure 1
Outline of emergency shutdown logic

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 may be used as guidance.

<i>Shutdown level</i>	<i>Location of push-button</i>
Abandon platform (APS)	<ul style="list-style-type: none"> — main and emergency control rooms — muster stations, lifeboat stations and helicopter deck — bridge connections between platforms
Emergency shutdown (ESD)	As for APS, plus: <ul style="list-style-type: none"> — process control room — driller's control cabin — exits from process, drilling, wellhead, riser areas etc. — along main escape routes
Process shutdown (PSD)	<ul style="list-style-type: none"> — 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 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 isolated
- gas detectors are installed in the room where the equipment is located
- facilities for manual shutdown of the equipment are available according to E102.

Guidance note:

Similar principles may be applied to the fire pump arrangement.

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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.

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.

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 ac-

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

- general emergency 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.

302 All alarms shall be indicated visually and audibly in the control centre.

303 A philosophy shall be established as to which alarms are broadcast to the entire unit or installation and whether this should occur automatically or not.

304 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.

305 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.

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

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

308 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.

309 The alarm and communication system shall be connected to an UPS with capacity of 1 hour supply. The UPS shall be powered from both the main and emergency sources of power.

310 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.

311 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 cargo tanks (arrangement and location of P/V valves)
- ventilation system within the cargo 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 cargo tanks, e.g. located outside the cargo 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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B 200 Process and cargo tank decks

201 The space between process deck and cargo 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 cargo 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 cargo tank deck.

203 The cargo 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 cargo tank deck. Where necessary, the cargo 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 facing bulkhead or within 3 m of the cargo or processing 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 Cargo tank areas

201 The ullage space in cargo tanks is defined as Zone 0.

202 The entire deck area above cargo tanks with adjacent cofferdams and ballast tanks shall be classified as Zone 1. The Zone 1 is to extend 1.5 m above deck level, extend horizontally from beam to beam, and longitudinally 3 m fore and aft of cargo tanks or to the nearest gas tight fire wall.

203 The area above Zone 1 in cargo tank area shall be classified as Zone 2. The Zone 2 shall extend a minimum of 1.5 m above the Zone 1. On production units with process equipment located above tank deck, the Zone 2 shall extend to the underside of the process deck. Areas with significant obstructions to ventilation, e.g. behind firewalls and superstructures, may require higher classification to Zone 1.

204 Cofferdams and ballast tanks adjacent to cargo tanks shall be classified internally as Zone 2, due to the potential for gas leakage through cracks. The air pipe outlet shall be classified as Zone 2 with a radius of 1.5 m. This classification shall also apply to other ballast tanks that are interconnected with ballast tanks located in hazardous area.

205 Pipe tunnels carrying hydrocarbons or with a common boundary with cargo tanks shall be classified as Zone 1.

206 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 is the source of a cylindrical hazardous Zone 1 with a radius of 10 m
- 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 or be a hazard to personnel in the area.

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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.

Guidance note:

The definitions of hazardous zones in 200 to 400 are those given in the IMO MODU Code and are repeated here for ease of reference.

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C 200 Hazardous areas Zone 0

201 The following shall be classified as Zone 0:

- a) Internal spaces of closed tanks and pipes for active drilling mud, as well as oil and gas products, e.g. escape gas outlet pipes.
- b) Spaces in which an oil or gas or air mixture is continuously present or present for long periods.

Guidance note:

Active drilling mud is considered as being the mud in the system, which is between the well and the final degasser discharge.

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C 300 Hazardous areas Zone 1

301 The following shall be classified as Zone 1:

- a) Enclosed spaces containing any part of the mud circulating system that has an opening into such spaces and is between the well and the final degassing discharge.
- b) Enclosed spaces or semi-enclosed locations that are below the drill floor and contain a possible source of release such as the top of a drilling nipple.
- c) Enclosed spaces that are on the drill floor and which are not separated by a solid floor from the spaces in a).
- d) In outdoor or semi-enclosed locations, except as provided for in b) the area within 1.5 m from the boundaries of any openings to equipment which is part of the mud systems as specified in 201, any ventilation outlets of Zone 1 spaces, or any access to Zone 1 spaces.
- e) Pits, ducts or similar structures in locations which otherwise would be Zone 2, but which are arranged so that dispersion of gas may not occur.

C 400 Hazardous areas Zone 2

401 The following shall be classified as Zone 2:

- a) Enclosed spaces, which contain open sections of the mud circulating system from the final degassing discharge to the mud pump suction connection at the mud pit.
- b) Outdoor locations within the boundaries of the drilling derrick up to a height of 3 m above the drill floor.
- c) Semi-enclosed locations below and associated with the drill floor and outdoor locations below the drill floor to the boundaries of the derrick or to the extent of any enclosure, which is liable to trap gases.
- d) Outdoor locations below the drill floor and within a radius of 3 m from a possible source of release such as the top of a drilling nipple.
- e) The areas 1.5 m beyond the Zone 1 areas specified in 301 d) and beyond the semi-enclosed locations specified in 301 b).
- f) Outdoor areas within 1.5 m of the boundaries of any ventilation outlet from or access to a Zone 2 space.
- g) Semi-enclosed derricks to the extent of their enclosure above the drill floor or to a height of 3m above the drill floor, whichever is greater.
- h) Air locks between a Zone 1 and a non-hazardous area.

C 500 Drilling plant

501 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.

502 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:

For guidance on extent of hazardous area, see IP 15 Sec. 4.5.8.

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503 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.

Guidance note:

For guidance on extent of hazardous area, see API RP 505 Sec. 11.16.1.

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

505 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.

506 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.

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

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

D. Electrical Installations in Hazardous Areas

D 100 General

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

102 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

101 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.

102 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.

103 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

101 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.

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. IP 15, Sec.5 provides guidance for typical process equipment.

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

GUIDELINES FOR ILLUMINATION LEVELS AND BATTERY CAPACITY

A. Illumination Levels

confirmed with reference to the lighting design standard, the defined accidental events and evacuation strategy for the unit or installation.

A 100 General

101 Table A1 gives guidelines for illumination levels and battery capacity. The guideline values and duration should be

Table A1 Guidelines for illumination levels and battery capacity			
<i>Area</i>	<i>Normal, recommended illumination level</i>	<i>Powered from emergency generator</i>	<i>Battery back-up requirement ³⁾</i>
General work areas and machinery spaces	200 lux, 300 lux on control panels	1)	15 lux
General walkways outdoor	100 lux	1)	15 lux
Accommodation area, cabins and corridors	150 lux ²⁾	1)	15 lux
Main control rooms, bridge, radio room and other emergency control stations	500 lux (adjustable)	100 lux	100 lux
Emergency generator room and fire pump rooms	200 lux	1)	25 lux
Temporary refuge	200 lux	100 lux	100 lux
Muster area	200 lux	100 lux	100 lux
Embarkation and launching area for life saving appliances	200 lux	100 lux	100 lux
Sea surface below life saving appliances	50 lux	50 Lux	N/A
1) General illumination levels should be 25 lux, with particular attention to illumination of access and escape routes and to exits from the area.			
2) Illumination levels in offices, galley, dining room, laundry etc. should be higher, typically 300 lux and above.			
3) Duration of battery back-up availability to be considered with respect to evacuation philosophy (typically 60 to 90 minutes).			

APPENDIX C 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 con-

struction. 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.

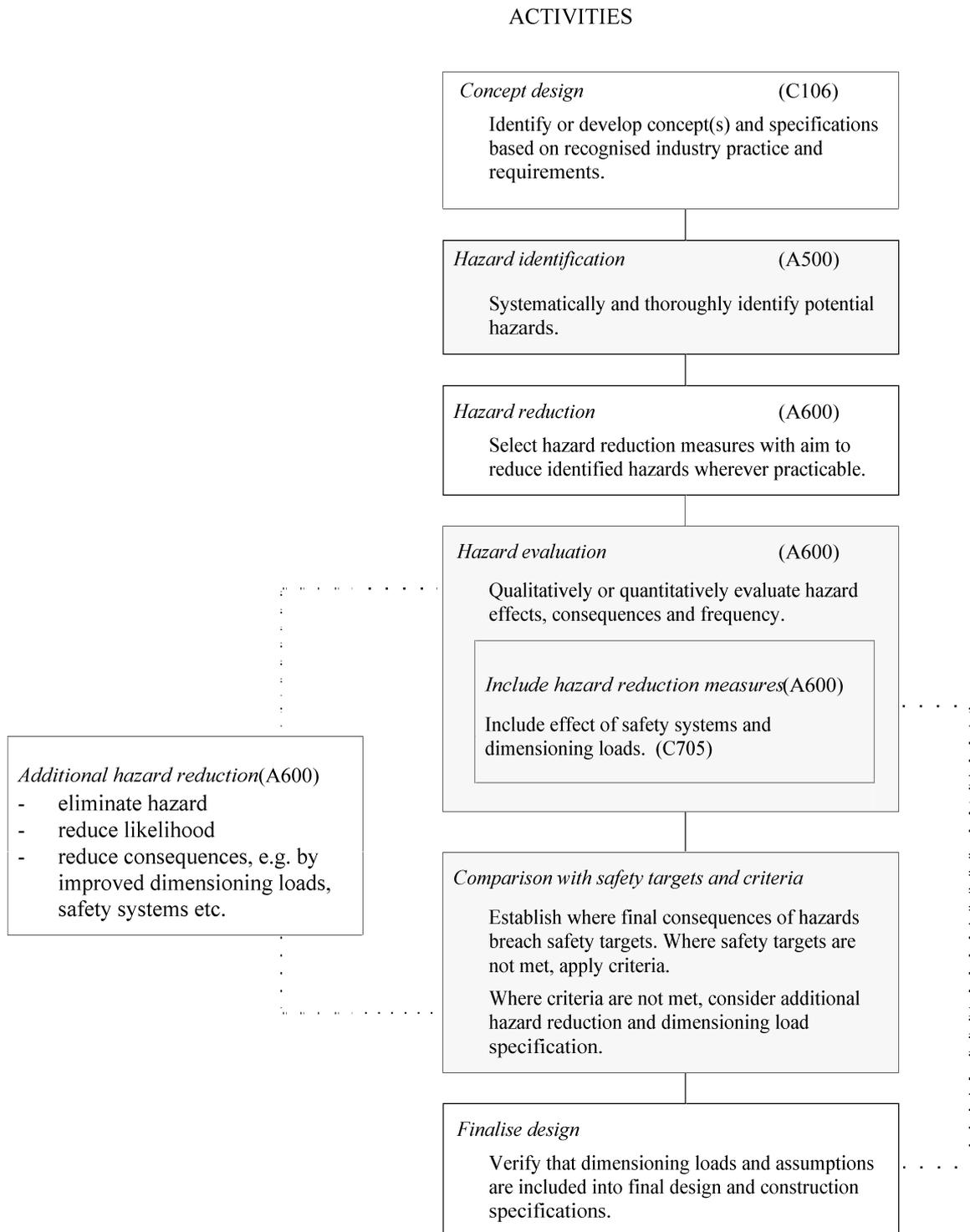
303 *Existing assessment work*

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.



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 by means of formal identification techniques, e.g. HAZOPS, HAZID, FMEA etc., 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.

No.	Safety target
1.	An escape route shall be available from every work area for sufficient time for personnel to reach the temporary refuge or evacuation facilities.
2.	The temporary refuge shall be capable of providing life support and communications for sufficient time to enable controlled evacuation from the unit or installation.
3.	Evacuation and escape facilities shall be available and reliable for use.
4.	Simultaneous loss of all safety targets shall not occur during the time required to: mitigate an accidental event, or leave the unit or installation.

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.

