NORSOK Standard

NORSOK S-001:2018

Published in Norway: 2018-06-20

Language: English

Technical safety

Teknisk sikkerhet

Reference number:
NORSOK S-001:2018 (en)

ICS: 75.180.01, 913.13

Contents

Foreword

NORSOK S-001:2018 was adopted as NORSOK Standard 2018-06-20.

NORSOK S-001:2018 supersedes NORSOK S-001 Rev. 4, February 2008.

NORSOK is an acronym for the competitive position of the Norwegian continental shelf and comprise petroleum industry standards in Norway. The collaboration initiative in 1993 between the authorities and the petroleum industry initiated the development of NORSOK standards.

Reducing the project execution time and developing and operating cost for petroleum installations on the Norwegian shelf was the target.

The intention for the Petroleum industry is to develop and use standards providing good technical and cost effective solutions to ensure that the petroleum resources are exploited and managed in the best possible way by the industry and the authorities. The industry will actively contribute to the development and use of international standards in the global market.

The NORSOK standards shall:

— bridge the gap based on experiences from the Norwegian continental shelf where the international standards are unsatisfactorily;
— replace oil company specifications where possible;
— be available as references for the authorities' regulations;
— be cost effective; and
— promote the Norwegian sector as an attractive area for investments and activities.

Developing new NORSOK standards and regular maintenance of existing standards shall contribute to maintain the competitiveness both nationally and internationally for the Norwegian petroleum industry.

The NORSOK standards are developed by experts from the Norwegian petroleum industry and approved according to the consensus principles as laid down by the guidelines given in NORSOK A-001 N directive.

The NORSOK standards are owned by the Norwegian Oil and Gas Association, the Federation of Norwegian Industries and the Norwegian Shipowners' Association. They are managed and published by Standards Norway.

Annex A is normative, Annex B and Annex C are informative.

Introduction

This NORSOK standard is organised according to principles given in Clause 5. Each clause of this NORSOK standard describes requirements for the individual safety barriers/-systems, and represents a generic performance standard for the different safety barriers. The following elements have been addressed for each safety barrier/-system:

— role gives a short description of the safety aspects related to the specific safety systems and barriers;
— interfaces lists the interface with other safety systems and barriers;
— required utilities describes utilities required for the safety system and barriers to fulfil its role;
— functional requirements specifies the performance required for the safety system and barriers to fulfil its role;
— survivability requirements defines requirements for the safety systems and barriers to function in or after a design accidental event.

Technical Safety

1 Scope

This NORSOK standard describes the principles and requirements for the development of the physical safety design, i.e. technical safety, of offshore installations for production of oil and gas. Where applicable, this NORSOK standard may also be used for mobile offshore drilling units.

This NORSOK standard, together with ISO 13702, defines the required standard to establish and maintain an adequate level of safety for personnel, environment and material assets.

2 Normative references

The following standards include provisions and guidelines which, through reference in this text, constitute provisions and guidelines of this NORSOK standard. Latest issue of the references shall be used unless otherwise agreed. Other recognized standards may be used provided it can be shown that they meet the requirements of the referenced standards.

NORSOK C-001, *Living quarters area*

NORSOK C-002:2015, *Architectural components and equipment*

NORSOK C-004:2013, *Helicopter Deck on Offshore Installations*

NORSOK D-001, *Drilling facilities*

NORSOK D-010, *Well integrity in drilling and well operations*

NORSOK H-003, *Heating, ventilation and air conditioning (HVAC) and sanitary systems*

NORSOK L-001, *Piping and valves*

NORSOK L-002, *Piping design, layout and stress analysis*

NORSOK L-005, *Compact flanged connections*

NORSOK N-001, *Structural design*

NORSOK N-003, *Actions and action effects*

NORSOK N-005, *In-service integrity management of structures and maritime systems*

NORSOK P-002, *Process System Design*

NORSOK R-002, *Lifting Equipment*

NORSOK T-001, *Telecom Systems*

NORSOK T-100, *Telecom Subsystems*

NORSOK Z-008, *Risk based maintenance and consequence classification*

NORSOK Z-013, *Risk and emergency preparedness analysis*

NORSOK Z-015, *Temporary Equipment*

CENELEC CLC/TR 50427, *Assessment of inadvertent ignition of flammable atmospheres by radio-frequency radiation*

EN 54 all parts, *Fire Detection and Alarm Systems*

EN 403, *Respiratory protective devices for self-rescue - Filtering devices with hood for escape from fire - Requirements, testing, marking*

EN 1127-1, *Explosive atmospheres - Explosion prevention and protection - Part 1: Basic concepts and methodology*

EN 1838, *Lighting applications – Emergency lighting*

EN 12266-1, *Industrial valves - Testing of metallic valves - Part 1: Pressure tests, test procedures and acceptance criteria - Mandatory requirements*

EN 12266-2, *Industrial valves - Testing of metallic valves - Part 2: Tests, test procedures and acceptance criteria - Supplementary requirements*

EN 62682 *Management of alarms systems for the process industries*

ISO 10418:2003/AC:2009, *Petroleum and natural gas industries – Offshore production installations – Basic surface process safety systems*

ISO 10423, *Petroleum and natural gas industries - Drilling and production equipment - Wellhead and christmas tree equipment*

ISO 10497, *Testing of valves - Fire type-testing requirements*

ISO 13702:2015, *Petroleum and natural gas industries – Control and mitigation of fires and explosions on offshore production installations – Requirements and guidelines*

ISO 15138, *Petroleum and natural gas industries - Offshore production installations - Heating, ventilation and air-conditioning*

ISO 16069, *Graphical Symbols – Safety Signs -- Safety Way Guidance System (SWGS)*

ISO 22899, *Determination of the resistance to jet fires of passive fire protection materials -- Part 1: General requirements*

ISO 80079-36. *Explosive atmospheres - Part 36: Non-electrical equipment for explosive atmospheres - Basic method and requirements*

IEC 60079–(part 10, part 14:2013/COR1:2016 and part 29), *Explosive atmospheres*

IEC 60331–(all parts), *Tests for electric cables under fire conditions – Circuit integrity*

IEC 61508–(all parts), *Functional safety of electrical/electronic/programmable electronic safety-related systems*

IEC 61511–(all parts), *Functional safety – Safety instrumented systems for the process industry sector*

IEC 61892–(parts 1, 2, 3, 5, 6:2013 and 7) *Mobile and fixed offshore units – Electrical installations*

API RP 14C:2017, *Recommended Practice for Analysis, Design, Installation, and Testing of Basic Surface Safety Systems for Offshore Production Platforms (8th ed)*

API Spec 17J, *Specification for Unbonded Flexible Pipe*

API STD 520, *Sizing, Selection, and Installation of Pressure-relieving Devices*

API STD 521, *Pressure-Relieving and Depressurizing Systems*

Directive 94/9/EC, *Concerning equipment and protective systems intended for use in potentially explosive atmospheres (ATEX "Product")*

DNVGL-ST-E406, *Design of Free Fall Lifeboats*

DNVGL-ST-F201, *Dynamic risers*

EEMUA 191 *Alarm systems - a guide to design, management and procurement*

EI 15, *Model code of safe practice Part 15: Area classification code for installations handling flammable fluids*

LSA Code, IMO SOLAS *Life saving appliances (LSA) Code, adopted by the Maritime Safety Committee by resolution MSC.48 (66)*

Norwegian Oil and Gas Association GL064, *Anbefalte retningslinjer for etablering av områdeberedskap*

Norwegian Oil and Gas Association GL070, *Guidelines for the Application of IEC 61508 and IEC 61511 in the petroleum activities on the continental shelf*

Norwegian Oil and Gas Association GL075, A*nbefalte retningslinjer for vannbaserte brannbekjempelsessystemer*

Norwegian Oil and Gas Association GL094, *Kravspesifikasjoner for redningsdrakt til bruk på norsk kontinentalsokkel.*

MODU Code, *Code for the construction and equipment of mobile offshore drilling units*

NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*

NFPA 13, *Installation of Sprinkler Systems*

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*

NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*

NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*

NFPA 20, *Standard for the Installation of Stationary Fire Pumps for Fire Protection Spray Systems*

NFPA 750*, Standard on Water Mist Fire Protection Systems*

NMA Regulations No.67, *Regulation concerning ballast systems on mobile offshore units (Ballast Regulations)*

NMA Regulations No. 90, *Evacuation and Life-saving appliances on mobile offshore units*

NMA Regulations No. 123, *Regulation for mobile offshore units with production plants and equipment*

NMA Regulations No. 998, *Regulation concerning positioning and anchoring systems on mobile offshore units*

3 Terms and definitions

For the purposes of this NORSOK standard, the following terms, definitions and abbreviations apply.

3.1
shall (requirement)
expression in the content of a document conveying objectively verifiable criteria to be fulfilled and from which no deviation is permitted if compliance with the document is to be claimed

Note 1 to entry: Requirements are expressed using the verbal forms specified in ISO/IEC Directives, Part 2 clause 7.2 Table 3.

3.2
should (recommendation)
expression in the content of a document conveying a suggested possible choice or course of action deemed to be particularly suitable without necessarily mentioning or excluding others

Note 1 to entry: Recommendations are expressed using the verbal forms specified in ISO/IEC Directives, Part 2 clause 7.3 Table 4.

Note 2 to entry: In the negative form, a recommendation is the expression that a suggested possible choice or course of action is not preferred but it is not prohibited.

3.3
may (permission)
expression in the content of a document conveying consent or liberty (or opportunity) to do something

Note 1 to entry: Permissions are expressed using the verbal forms specified in ISO/IEC Directives Part 2 clause 7.4 Table 5.

3.4
can (possibility and capability)
1: expression in the content of a document conveying expected or conceivable material, physical or causal outcome.
2: expression in the content of a document conveying the ability, fitness, or quality necessary to do or achieve a specified thing

Note 1 to entry: Possibility and capability is expressed using the verbal forms specified in in ISO/IEC Directives, Part 2 clause 7.5 Table 6.

3.5
area classification
division of an installation into hazardous areas and non-hazardous areas and the sub-division of hazardous zones under normal operation.

Note 1 to entry: Normal operation is a situation when the plant is operating within its design parameters. Minor releases of flammable material may be part of normal operation. For example, releases from seals that rely on wetting by the fluid being pumped are considered to be minor releases. Failures (such as breakdown of pump seals, flange gaskets or spillage caused by accidents) that involve repair or shutdown are not considered to be part of normal operation, and may require special precautions of potential ignition sources.

3.6
design accidental load
accidental load/action used as a basis for design

Note 1 to entry: The design load/action can be the same as the dimensioning accidental load/action, but it can be higher, based on different input and assessments such as ALARP, minimum requirements in the regulations etc.

3.7
design fire
the design fire for load bearing structures and fire divisions includes as a minimum:
- the dimensioning fire
- worst credible process fire
- fire class requirements, e.g. H-class

3.8
detection area
area, or areas, of similar environmental and operating conditions and hazards, and with similar detection and protection arrangements.

Note 1 to entry: For HC areas, the detection area is normally similar to the fire area in question. Very large fire areas may exceptionally be split into two or more detection areas, e.g. large tank decks on FPSOs. Each detection area will have a C&E Diagram, e.g. FPDS.

3.9
dimensioning accidental load
an accidental load/action that a function or a system shall be able to withstand for a given period of time to meet the defined acceptance criteria for risk

3.10
dimensioning gas cloud
the minimum stoichiometric gas cloud which, when ignited, can create an explosion resulting in an explosion pressure exceeding the dimensioning explosion load of the area

3.11
escape route
route from an area of an installation leading to a muster or embarkation area.

3.12
essential equipment
equipment that shall be kept alive to maintain production or drilling/well operations.

Note 1 to entry: Such equipment may include main power generator, main electrical distribution panels, diesel engines, heaters, boilers ventilation systems, unless defined as a safety critical item

3.13
evacuation
planned method of leaving the installation in an emergency situation

3.14
evaluation
a simplified assessment which does not require to be documented in a separate analysis or study report

Note 1 to entry: The reasoning and conclusions should be described e.g. in the safety strategy.

3.15
explosion load
the load generated by combustion of a flammable gas or mist which generates pressure and drag effects

3.16
fire area
area separated from other areas either by physical barriers (fire/blast division) or sufficient distance which will prevent a fire or explosion to spread to another fire area when exposed to the design loads.

3.17
fire load
time and space dependent radiative and convective heat load from a fire

3.18
fire water (FW) pump system
total system which supplies water for firefighting system

Note 1 to entry: i.e. water inlets with filters, FW pumps, risers, power sources, power transmissions, fuel pipes/tanks and control systems

3.19
hazardous area
an area in which a flammable atmosphere is or may be expected to be present in quantities such as to require special precautions for the control of potential ignition sources

3.20
ignition Source
equipment and activities which may under certain circumstances cause ignition of an explosive atmosphere

Note 1 to entry: Typically ignition sources relate to the following type of equipment; non Ex-certified electrical equipment (or not approved for Zone 2), open flames, direct heat and hot surfaces, rotating machinery and combustion engines, mechanical sparks, static electricity, radio frequency energy, chemical reaction (e.g. iron sulphide).

Note 2 to entry: Electrical equipment will not constitute an ignition source if in compliance with relevant IEC zone requirements or better.

3.21
ignition source groups
Group 1 (non-essential equipment): non-explosion protected equipment which is not affecting production availability or safety integrity.

Group 2 (essential equipment): non-explosion protected equipment which shall be kept alive to maintain production and drilling operation.

Group 3 (safety critical equipment): non-explosion protected equipment that shall be in operation to ensure rescue and medical treatment of injured personnel, escape and evacuation, prevent escalation or bring the installation to a safe state.

3.22
inhibit
disabling of the safety instrumented function input and prevention of a shutdown action;

Note 1 to entry: e.g. by disabling of the input signal to the shutdown logic while still presenting the alarm to the operator

3.23
intermittently manned
work area or work place where inspection, maintenance or other work is planned to last at least 2 h, but less than 8 h a day for at least 50 % of the installation's operation time

3.24
local equipment room (LER
a room containing electrical and instrumentation equipment

3.25
main area
area that includes similar functions on the installation.

Note 1 to entry: Main areas can be the:

a) living quarter
b) utility area
c) drilling area
d) wellhead area
e) process area
f) storage area for hydrocarbons

Note 2 to entry: Drilling and wellhead area may be combined. See subclause 20.4.1.

3.26
muster area
designated area where mustering shall take place in the event of general and/or evacuation alarm, and where personnel is sheltered while emergency response and evacuation pre-planning are undertaken

3.27
non-essential equipment
any equipment not affecting production availability or safety integrity

3.28
non-hazardous area
all areas not classified as hazardous under normal operation

3.29
normally not manned area
work area or work place that is not permanently or intermittently manned.

3.30
normally not manned installations
installations that can be left unmanned and still maintain their intended function through remote control

3.31
override
disabling of the safety instrumented function output and prevention of a shutdown action, e.g. by disabling the signal from shutdown logic to an individual shutdown output action.

3.32
permanently manned
work area or work place manned at least 8 hours a day for at least 50 % of the installations operation time

3.33
safety critical equipment
equipment that shall be in operation to ensure rescue and medical treatment of injured personnel, escape and evacuation, prevent escalation or bring the installation to a safe state,

Note 1 to entry: e.g. equipment powered from UPS and/or emergency generator(s), fire water pump drivers, etc. Ignition source Group 3, see definition, is a sub-group of this equipment.

3.34
well barrier
envelope of one or several barrier elements preventing well fluids from flowing unintentionally from the formation into another formation or to surface.

4 Abbreviations

For this document, the following abbreviations apply.

AC/h	air changes per hour
AFP	active fire protection
AIS	automatic identification system
API	American Petroleum Institute

APS	abandon platform shutdown
ASV	annular safety valve
ASME	American Society of Mechanical Engineers
ATEX	Atmosphères Explosibles (forskrift om utstyr og sikkerhetssystem til bruk i eksplosjonsfarlig område)
BOP	blow out preventer
C&E	cause and effect
CAP	critical action panel
CCR	central control room
DHSV	down hole safety valve
DIFFS	deck integrated firefighting system
EDP	Emergency Depressurisation
EER	evacuation, escape and rescue
EN	European Standard
ESD	emergency shutdown
F&G	fire and gas
FPDS	fire protection data sheet
FPSO	floating production, storage and offloading
FSU	floating storage unit
FW	fire water
HC	hydrocarbon
HMI	human machine interface
HVAC	heating, ventilation and air conditioning
IEC	International Electrotechnical Commission
IMO	International Maritime Organisation
IDLH	Immediate Danger to Life and Health
ISC	ignition source control
ISO	International Organization for Standardization
IR	infrared
LAHH	level alarm high high (trip level)
LCS	loading computer system
LEL	lower explosive limit
LELm	lower explosive limit meters
LER	local equipment room
LIR	local instrument room
LQ	living quarter
MCP	manual call point
MOB	man over board

MODU	mobile offshore drilling unit
MV	master valve
NA	not applicable
NFPA	National Fire Protection Association
NMA	Norwegian Maritime Authority
NNMI	normally not manned installations
PA	public address
PAGA	public address and general alarm
PFD	probability of failure on demand
PFP	passive fire protection
PSD	process shutdown
PSV	pressure safety valve
RIO	Remote input/output
SAS	safety and automation system
SIL	safety integrity level
SOLAS	International Convention for the Safety of Life at Sea
SSIV	subsea isolation valve
UHF	ultra high frequency
VDU	visual display unit
UPS	uninterruptible power supply
VHF	very high frequency
WV	wing valve

5 Management of technical safety

5.1 General

Technical safety management (loss prevention) in project development comprises activities to identify risks and to develop and document safety strategies and performance requirements for safety systems and barriers. These are iterative processes as the project develops and design matures. Necessary supporting documentation (e.g. studies, analysis and design reviews) shall be provided with due consideration for timely input to design and procurement processes. Concepts combining a jack-up drilling rig and a fixed installation require special consideration, ref. aspects described in Annex A - Jack-up/jacket constellations.

A follow-up system shall be established that enables proper documentation, handling, follow-up and closeout of agreed actions and recommendations from the various studies and analyses in the project.

In the event space is allocated for future expansions in new project developments, the design should incorporate sufficient flexibility to include capacity for the additional equipment, e.g. fire water, flare etc. fire water.

For modification projects (e.g. upgrading of existing installation/module, tie-in of satellite field), technical safety management activities adjusted to project scope and complexity shall be performed, including new analyses or updating of existing analyses for factors that are affected by the modification.

The individual project or installation shall perform specific hazard identification and risk analysis and evaluation processes. Based on this process, the requirements in this document shall be supplemented as necessary to manage the risk.

5.2 Activities related to technical safety design

5.2.1 Overview

A flow diagram illustrating some of the main activities related to technical safety design is shown in Figure 1. The activities are detailed in the immediate following subclauses. Reference is made to NORSOK Z-013 for details related to risk assessment.

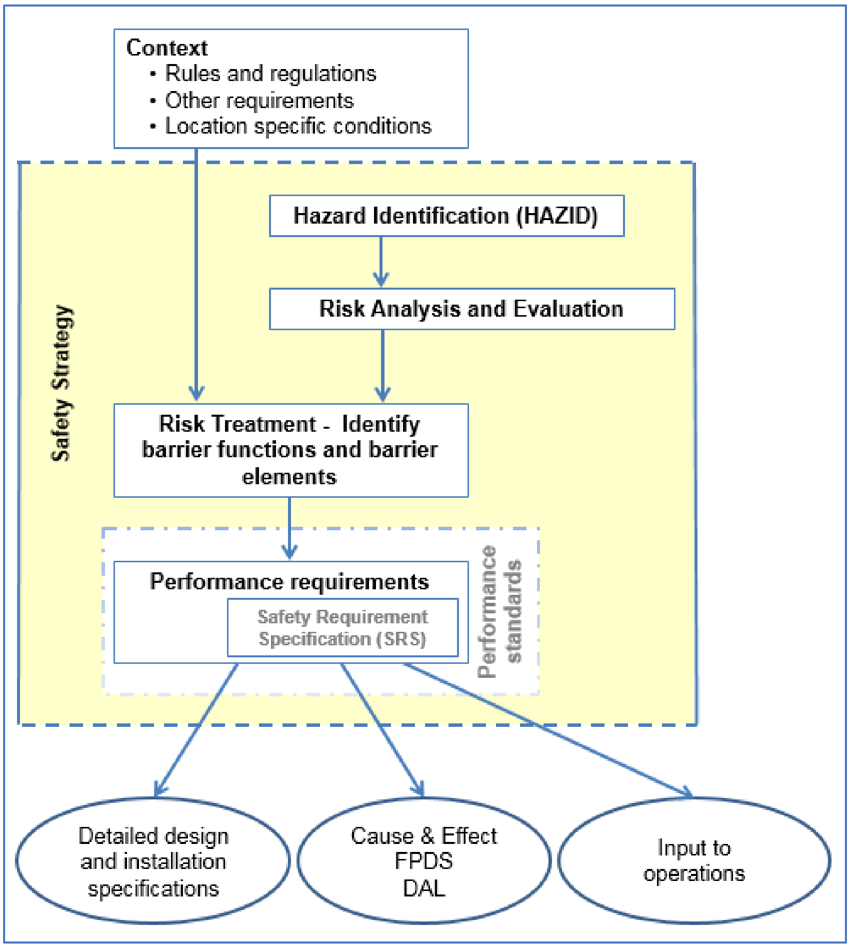

Figure 1 — Activities related to technical safety design

5.2.2 Define context

Context needs to be defined and compiled so that frame conditions, limitations and ambitions for the installation (and its areas and activities) are available for relevant personnel involved in technical safety issues or technical safety management. Examples of context are legislation, standards (internal/ external), concept decisions, operating conditions, prerequisites for use, assumptions/ requirements and demands to risk reduction. The context applied for the management of technical safety has to be traceable and documented.

A major part of the context will be defined early in the development of an installation. During the installation life cycle the context will provide a basis for use/ reassessment and it need to be updated to ensure that all relevant changes and modifications are included.

5.2.3 Identify hazards and accidental events (HAZID)

The starting point for the risk assessment is to identify hazards and their accidental events that are relevant for the design and operation of the installation.

Within management of technical safety, various hazard identifications need to be performed. The structure of HAZIDs should preferably be area based, but for some cases they may also be a HAZID node (e.g. part of well, process or utility systems), phase or operational based.

Based on hazard identifications it shall be possible to present an overview of possible hazards and accidental events that can occur in different areas and during different activities. The level of detail and depth of hazard identification will be dependent of the maturity of the projects.

5.2.4 Perform risk analyses and evaluations

Risk and safety analyses / studies shall be performed to establish sufficiently detailed information about the risk associated with the identified hazards and accidental events. The information will be used to evaluate the risk and to decide which solutions (barriers), and related requirements that are needed for preventing, controlling and mitigating the hazards in addition to generic requirements given by the context.

Evaluation of risk includes an assessment of:

— compliance with predefined evaluation criteria (e.g. minimum requirements and acceptance criteria in context);
— necessary ALARP processes to demonstrate that risk has been reduced to a level as low as reasonably practicable;
— uncertainties associated with the hazards, accidental events and their consequences as well as the risk reducing effect of the barriers.

The results from risk analyses are used for many purposes. One is to provide information and decision support related to the need for and role of risk reducing measures (barriers) and their required performance. Another is to provide decision support regarding the risk level assessed and if this is considered acceptable for the facility. Reference is made to subclause 5.10 for examples of studies and evaluations.

For a development project, the degree of details in the risk and safety analyses / studies will increase as the project matures through different phases. Thus, solutions, assumptions and conservative estimates typically used in early stages may be verified or changed due to more detailed analyses.

5.2.5 Identify and define barrier functions, systems and elements (risk treatment)

The need for barrier functions shall be established based on the context, identified hazards and accidental events, risk analyses and risk evaluation activities. Documentation shall be prepared so that it is possible to identify the need for barrier functions in each installation area or relevant HAZID node.

When the need for barrier functions are identified, systems and elements necessary for realizing the barrier functions shall be defined.

Technical barriers often require some form of monitoring, control or activation by people to function as intended. Depending on the characteristics of the facility and its risk picture, different levels of automation may also be chosen for certain safety systems. Therefore, operational and emergency situation considerations shall be an integral part of technical barrier process. As part of project development, safety system design shall include a human factors study amongst others documenting the following:

— Identification of safety critical tasks ("operational barrier elements") required for the safety system to function. These include tasks related to start-up, monitoring, operation, incident response and recovery in the event of technical failure.
— Description of performance requirements. These include who is responsible for performing a task, under what circumstances it is expected to be performed, available response time and how it shall be carried out.

The results from the study shall be used as input to design, as well as preparations for operations. Input to design should include HMI and alarm system specifications, levels of automation, equipment labelling, system capacities and tolerances.

This standard focuses on technical design requirements and addresses operational and organizational aspects supplementing the technical barriers.

5.2.6 Safety strategies

Documentation shall be prepared to record how specific hazards or accidental events are managed by the use of barrier functions, systems and elements. This documentation can be denoted the 'safety strategy' (or 'the barrier strategy') and can replace the need for Fire and Explosion Strategy (FES) and the Escape, Evacuation and Rescue Strategy (EER strategy) as required by ISO 13702.

Safety strategies do not necessarily need to be described in a single document. The strategy may be described and included in other relevant documentation where this is natural and appropriate. The need to develop separate strategies can be viewed in relation to the other documentation which exists or is prepared for the individual facility.

Safety strategy documentation should also be prepared to outline applicable overall principles for design, layout, arrangement, philosophies and other high-level design and operational aspects related to barriers; e.g.:

— how different safety documentation are linked together;
— risk reduction principles - inherent safety design;
— premises for design;
— design provisions for the operating phase;
— accidental loads and resistance.

5.2.7 Define performance requirements

Verifiable performance requirements shall be established to ensure that the barrier function is fulfilled. In some situations, performance requirements can also be set directly to barrier functions. Performance requirements shall be established as an integrated part of the design and construction process, as the decisions on what safety systems and barriers to install and their corresponding specifications are made.

Performance requirement (PR) for technical barrier elements can be divided into the following categories:

— **Functionality** i.e. the ability of the barrier or barrier element to execute the objectives (intended role) affecting the progress of an accident, e.g. by ensuring capacity and effectiveness. The minimum functional requirement of barrier/barrier element is often given by regulations, referred standards and company internal requirements. However, the specific safety strategy can call for stricter or more nuanced requirements.

- **Integrity** of the barrier/barrier element, i.e. the barrier / barrier element's ability to be present when needed (reliability and availability). These requirements can be determined based on specific safety analysis-/studies or the implementation of generic minimum requirements. The following general requirements apply:
  - Design and realisation, inclusive of relevant operating issues, of all safety instrumented systems (SIS) shall be based upon the principles of IEC 61508/IEC 61511. The minimum requirements presented in Norwegian Oil and Gas Association GL070 may be used instead of a full safety analysis/risk assessment for standardised solutions.
  - The applicable safety system, or affected parts of it, shall be designed to fail-to-safe principle, whereby the system goes to a predefined safe state in the event of detectable malfunction. It shall be designed with the aim of avoiding single defects / failures that may prohibit safety actions being executed. If it is not feasible to implement a fail-to-safe principle, an equivalent level of safety shall be achieved by redundancy and/or diagnostics and fault alarm to relevant manned control room.
  - The probability of single defects / failures causing inadvertent trip actions shall be as low as reasonably practicable (e.g. provide fault tolerance by means of automatic diagnostic features and redundancy).
  - All barriers or parts thereof, shall be protected against or withstand environmental conditions that may compromise their safety functions, e.g. ice, snow, sand, water, etc.
- **Survivability** of the barrier/barrier element, i.e. its ability to function under relevant accident scenarios and loads. Equipment with a safety function, during and after the accident, should be located so that the possible impact from accidental loads is minimised. To develop the survivability requirements, the design loads that shall form the basis for design of facilities, systems and equipment need to be determined, ref. subclause 5.6 Accidental loads and resistance.

Barriers/safety systems may be dependent on safety critical tasks to function, through e.g. monitoring, activation or control. For relevant safety systems, performance requirements should also be defined for operational / organizational barrier elements, ref. subclause 5.4.

Each clause of this document from clause 6 and onwards describes generic design principles and requirements for the different safety systems and barriers. The installation specific performance requirements shall be developed based on this framework to manage the risk.

5.2.8 Define performance Standards

It may be beneficial to group the various performance requirements into performance standards including a description of the role of the safety functions. Dependencies on and interfaces with other systems should also be described.

5.2.9 Establish safety requirement specification (SRS)

A Safety Requirement Specification (SRS) is a documentation of requirements related to safety instrumented systems (SIS). The SRS documentation shall be developed during projects and shall provide the design basis for required SIS.

Generally, the SRS shall contain the relevant key information for use in specifying and operating the instrumented safety functions. However, the information required may be contained in other project documents referred to in the SRS, e.g. performance standards. Duplication of information should be avoided.

The SRS shall contain three main types of requirements:

— functional requirements such as capacities and response times,
— integrity requirements such as PFD and SIL, and,
— operating prerequisites and constraints.

Further reference is given to IEC 61511 (Functional Safety – Safety Instrumented Systems for the process industry sector”) and Norwegian Oil and Gas Association GL070.

5.2.10 Safety specifications, diagrams, drawings, philosophies, etc.

Documentation that needs to be developed to deepen or clarify performance requirements when necessary. Ref. subclause 5.10 Documentation. Also, see Annex C for proposed format and information for data sheets for selected Safety Equipment.

5.3 Risk reduction principles and inherent safety design

In concept development, priority shall be given to solutions that are inherently safe. If the hazard cannot be eliminated, probability reducing measures should be given priority over consequence reducing measures.

The objectives of risk reduction principles and inherent safety design are to:

— eliminate or reduce potential hazards/increase inherent safety by;
— reduction, e.g. reducing the hazardous inventories or the frequency or duration of exposure;
— substitution, e.g. substituting hazardous materials with less hazardous ones;
— attenuation (moderation), e.g. using the hazardous materials or processes in a way that limits their hazard potential;
— simplifications, e.g. making the facility and process simpler to design, build and operate, hence less prone to equipment, control and human failure;
— reduce probability of hazardous events;
— establish mitigating measures, e.g. through safety barriers.

The ALARP principle (As Low As Reasonable Practicable) shall be used to select the safety solutions.

5.4 Design provisions for the operating phase

Effective management of technical barriers in project development and design processes also need to address relevant dependencies with operational and organizational aspects for the operating phase. Some examples of interfaces between technical, operational and organizational aspects to be considered are:

— operational prerequisites for start-up and use;
— measures and restrictions that are necessary in the event of overriding, disconnection or in the event of missing/impaired safety systems and barriers;
— maintenance;
— competence;
— emergency preparedness;
— manual intervention.

In order to ensure solutions which are suited for varying conditions, particular prerequisites shall be accommodated for in the design phase (and sustained during the operating phase). Examples of aspects that should be addressed are:

— assumptions including conditions and possible actions, when operating in different modes, i.e. normal, test, fault, failure, degraded. (Relevant assumptions in risk analyses should be according to requirements in the different installation specific performance standards);

- provisions, routines and logs for isolation of safety related functions during testing and maintenance, e.g. by inhibit (disabling input signal) and override (disabling output action). Such isolation should not render unnecessarily large parts of the system inactive. Logging, manual or automatic, of any such isolation action, e.g. time, number and duration, is mandatory;
- requirements for compensatory measures. (Responsible personnel for the operating phase will need to implement the necessary measures to remedy or compensate for non-conformities, missing or impaired barriers).

The basis for inspection, testing and maintenance shall be described as part of project development in close liaison with the end user and be finalized before start-up. Important elements are:

- Systems, equipment and barriers shall be classified as regards the health, safety and environment consequences of potential functional failures. Information in performance standards shall regardless of other criticality analyses (e.g. according to NORSOK Z-008) be used as basis for categorizing safety critical equipment.
- An inspection-, testing- and maintenance programme for safety barriers shall be developed as part of project development. The programme should include test/inspection/maintenance methods and intervals. These shall be determined based upon regulatory requirements, company requirements, performance requirements, results/assumptions from analyses (e.g. SIL), criticality analysis (ref NORSOK Z-008), manufacturers' recommendations, operating experience and relevant plant maintenance strategy. For instrumented safety systems, also see Norwegian Oil and Gas Association GL070. For structures, see NORSOK N-005.
- The safety functions/systems should, where reasonably practicable, allow for the required testing to be carried out without interrupting production or operations.
- Systems shall be established for monitoring barrier integrity, including possible deficiencies and degradation. The system should be established and populated with data during commissioning.

5.5 Commissioning and start-up

Safety management during installation, start-up and the operating phases shall be defined in specific commissioning and operating procedures. This includes activity requirements and descriptions addressing:

- installation and commissioning manuals;
- start-up procedures.

Verifying that relevant barrier elements meet all the specified performance requirements is the main objective in the commissioning phase. The commissioning test shall be performed under as realistic operating conditions as possible. Some tests, e.g. depressurisation systems or hydraulic power for ESD systems may have to be put through final capacity testing shortly after operations have started.

The fire water system shall be subject to full scale dimensioning fire water demand scenario test, i.e. simultaneous release of all deluge skids covering the largest and largest neighbouring fire area.

Relevant experience from commissioning and start-up shall be transferred to the operational phase.

Safety related systems/functions required for safe project execution shall be operational to reflect the risk when the facility is gradually moved from construction to full operational status. Systems required for life support, communication, evacuation, fire detection, active and passive fire protection shall be operational when the facility is to be inhabited.

5.6 Accidental loads and resistance

5.6.1 General

The accidental loads/actions that can affect facilities or parts of facilities shall be determined. Also, the design loads that shall form basis for design and operation of facilities, systems and equipment need to be determined. Determination of design loads shall ensure that both deterministic and functional requirements in applicable regulations are met. The chosen design accidental loads that are to be used as basis for design shall ensure that facilities, systems and equipment are designed in such a way that relevant accidental situations will not result in unacceptable consequences.

In addition to loads described in the subsequent sections, the following loads shall be included (ref. NORSOK N-003 Actions and action effects and NORSOK Z-013 Risk and emergency preparedness analysis);

— swinging/falling loads (e.g. impact loads to be absorbed without critical damage including subsea pipeline, risers and equipment),
— ship collisions (e.g. impact loads to be absorbed without critical damage including effects on wells and risers), and
— extreme environmental loads.

5.6.2 Gas explosions

Explosion loads from ignited gas clouds are strongly dependent on factors such as:

— cloud size and gas concentration;
— gas type;
— confinement and/or congestion of the affected area;
— explosion relief solutions;
— ignition location.

Design explosion loads shall be established using a recognised method (e.g. NORSOK Z-013) and a representative geometric explosion model with representative equipment density.

It is recognized that in the initial design the detail arrangement may not have been developed. An explosion study should be performed at an early stage, enabling the key installation parts to be located favorably with regard to explosion. The methods and detailing of the input will reflect this situation. Explosion loads shall be defined for relevant horizontal and vertical area dividers (pressure and impulse from explosion) and relevant equipment (pressure/drag forces). Explosion loads shall also be defined for areas external to the initial explosion location (typical LQ, utility modules etc.) if applicable.

Equipment that can become a flying object and can significantly impair critical safety equipment/structures such as fire divisions, riser valves, wellheads, blowdown piping, should be considered secured. Examples of such equipment are well hatches, panels, temporary equipment, etc.

5.6.3 Hydrocarbon fires

5.6.3.1 General

The heat load from hydrocarbon fires is strongly dependent on:

— hydrocarbon composition and fire type (gas, liquid, jet, liquid spray or pool fire);
— fire size (optical thickness, velocity, turbulence and heat loss);

— geometry and ventilation conditions (turbulence, fuel/ventilation controlled, preheating of air, heat loss).

5.6.3.2 Main load bearing structures

For main load bearing structures, the heat load distribution is of great importance. A validated computational fluid dynamics (CFD) model shall be used to provide realistic modelling of the fire source and the effect of the surroundings in order to define the design accidental load. Care shall be taken when selecting simulation cases. Either these shall be selected and used conservatively, or a larger number of simulations are necessary to be statistically representative.

5.6.3.3 Worst credible process fire

The worst credible process fire (WCPF) in a fire area is derived from an ignited leak in the ESD-segment including possible escalation that will give the worst exposure of main load bearing structures and fire divisions with regard to duration (not related to the time needed for safe evacuation) and heat load distribution. ESD valves and emergency depressurization valves limiting the supply of fuel can be assumed to function. With respect to liquid spills, the open drain or grating in the area can be taken into account.

The load from the WCPF shall be covered by the design accidental load for main load bearing structures and fire divisions. The identified WCPF shall not escalate to hydrocarbon pipeline risers or to wells (flow from reservoir) to avoid impairment of the main load bearing structures.

Typical relevant scenarios would be:

1) a fire from the liquid segment giving the longest duration above critical rate related to main load bearing structures and fire divisions;
2) a jet fire from the largest gas EDP segment escalating to item 1 above.

Relevant segments to be considered for WCPF are topside process segments limited by ESD valves. For wellhead areas, gas lift volumes in well annuli shall be included in the evaluation to determine the WCPF, unless the supply to the annulus is protected with a hydraulically activated integrated wellhead valve, i.e. with an ESD function, and there are no other leak points on the annulus that can give new critical leak rates, ref. also subclause 26.4.

When assessing the WCPF, consequences of possible escalation to one other ESD segment (including the largest gas lift annulus volume unless protected as described above), shall be taken into account. Normally such escalation will not occur at the end of the fire under consideration and prolong this in a way affecting the worst exposure of the main load bearing structures and fire divisions. In most cases escalations will result in a large increase in the fire size in a certain time period, but normally not in a way that will affect the duration of the initial fire in a critical manner.

5.6.3.4 Unacceptable ruptures of process equipment in a fire situation.

Rupture of process equipment in fire situations is unacceptable if this leads to one of the following:

— a fire duration and heat load distribution that is not covered by the design accidental load to protect structures and fire divisions. Ref. worst credible process fire;
— BLEVE (Boiling Liquid Expanding Vapor Explosion) – normally only relevant for volatile liquids such as propane;
— fatalities or serious injury in fire areas outside of the area of the initial event (fire) before escape to safe areas has been carried out; or

— impairment of main safety functions if incident frequencies exceed risk acceptance criteria, ref. NORSOK Z-013.

In addition, ruptures that may lead to major economic losses may be defined as unacceptable. Each installation needs to define unacceptable ruptures based on these principles. In addition, the ALARP-principle is important and the best solution would be to avoid the risk of ruptures due to fires by all other means than passive fire protection due to e.g. reduced corrosion under insulation and inspection.

The actual criteria will normally be expressed as:

— minimum time to rupture causing a certain release rate;
    - o dependent on estimated time to escape from actual fire area and if an escalation has the possibility to hinder escape from other fire areas;
— max allowed pressure at time of rupture for piping and vessels (normally different);
    - o important for pressure shock effects, missile effects from vessels and recoil effects from pipes;
    - o dependent on layout, size of area and possibility for impairment of muster areas and hindering of evacuation;
— max allowed release rate, important for;
    - o impairment of escape routes;
    - o exposure of neighbouring areas and hence fire spread;
    - o impairment of muster areas and evacuation means;
— will normally be different at different times after start of fire;
— dependent on;
    - o layout, size of area and possibility for impairment of muster areas and hindering of evacuation;
    - o released mass (duration) and fire protection of the surroundings.

Typical minimum values for the above criteria are suggested below. These values shall be carefully considered for the actual use (i.e. for the specific installation), and modified as needed based on the given principles. If any emergency action can lead to the presence of personnel close to the fire, this shall be taken into account. Safe escape of personnel that will have to pass the fire, e.g. personnel in the far end or personnel involved in well securing (closure of well valves and/or BOP) during well interventions shall be accommodated for.

Typical minimum values;

— Vessels
    - o Not allowed to rupture before 10 minutes after start of the initial fire.
    - o Not allowed to rupture before internal pressure is below 4.5 barg.
— Pipes
    - o Instantaneous release shall not prevent all escape possibilities for personnel anywhere on the installation to reach Muster Areas.
    - o Hydrocarbon release rate from any one escalation caused by a small jet fire (250 kW/m^2) shall not exceed 2 kg/s until personnel have escaped the area of the fire. Typical time for escape from an area of the fire is 2 minutes. For areas difficult to get out of, this time shall be prolonged.
    - o Hydrocarbon release rate from any one escalation caused by fires larger than 2 kg/s, shall not exceed the initial fire size until personnel have escaped the area of the fire.
    - o In early screening work, larger fires can be represented with 350 kW/m^2 and should not escalate with more than 5 kg/s.
    - o For the first two minutes after escape from the area of the fire, gas release rate from any escalation shall not exceed 10 kg/s to accommodate safe escape from all other areas (this rate will normally not impair all escape routes from other areas).

- o Hydrocarbon release rate from any escalation shall not exceed 100 kg/s (typical value to avoid excessive heat radiation and smoke impairment) until all personnel have reached the Muster Areas.

It is recommended to standardise on tubing that has a design pressure of approximately twice the plant's highest normal operating pressure to allow escape from the fire-affected area prior to rupture of tubing exposed to fire.

5.6.3.5 Process equipment and piping – fire calculations

A simplified estimate of the temperature development of objects and/or process piping and equipment in a fire can be based on a heat balance equation for the surface of the object:

$$q_{net} = \alpha_s \cdot \sigma \cdot T_r^4 + h(T_f - T_s(t)) - \varepsilon_s \cdot \sigma\, T_s(t)^4$$

Where

q_{net}	net heat transfer to object (W/m²)
ε_s	emissivity of the surface material (-)
α_s	absorptivity of the surface material (-) (equals to ε_s emissivity)
σ	Stefan-Boltzmann's constant = $5.67*10^{-8}$ (W/m²*K⁴)
$T_{r'}$	flame radiation temperature (K)
T_f	flame gas temperature (K)
$T_s(t)$	surface temperature of the material at time t (K)
h	convective heat transfer coefficient (W/m²K)

The following assumptions are recommended:

- For steel surfaces, a value of 0,85 for ε_s is recommended. For jet fires, a convective heat transfer coefficient (h) of 100 W/m²K is recommended. For other types of fires, a heat transfer coefficient of 30 W/m²K is recommended.
- The flame radiation temperature, T_r, can be set equal to the flame gas temperature, T_f, and selected to obtain the recommended heat flux for the chosen fire scenario.

The total incident heat load on an object is here defined as:

$$q_{in} = \sigma \cdot T_r^4 + h(T_f - T_{amb})$$

Where

T_{amb}	Temperature of the surroundings (not influenced by fire)

For estimation of the temperature development in objects exposed to fires the recommended values for this incident heat load (time and space dependent radiative and convective heat load from fire) are shown in Table 1.

Table 1 — Proposed Incident Heat Fluxes for fuel controlled fires exposing pressurised process systems (no Credit for Water Deluge has been included in the table)

	Jet / Liquid spray fire[a)]		Pool fire [a)]	
	For leak rates m > 2 kg/s	For leak rates m > 0,1 kg/s	Burning rate m > 2 kg/s	Burning rate m > 0,1 kg/s
Local peak heat load	350 kW/m²	250 kW/m²	250 kW/m²	150 kW/m²
Global average heat load	100 kW/m² [b)]			

Notes

a The heat flux will vary during the fire duration, and the values in this table are used as the average incident heat flux

b The global average heat load of 100 kW/m² is to be used for fire exposed area only as long as the leakage rate and burning rate is above 2 kg/s (for jet fires, same duration as 350 kW/m² peak load). To use this load for the whole segment is generally considered conservative. Smaller areas receiving this load may be used provided it can be properly documented. This can be done by comparing realistic flame sizes with the extension of the segment under consideration, or for instance by using realistic fire simulations. See Figure 2.

In addition to heat load level, the exposure duration is very important for the consequences from fires. The duration is dependent on ESD segment size and content, time to shutdown, time to start depressurisation, depressurisation rate and leak rate.

When calculating if and when process segments will rupture due to jet fire exposure due to material weakening, the heat exposure from a leak should be evaluated by assessing two representative points in the fire as follows:

— Point 1: Using the maximum duration of a leak rate from any ESD segment in the area above 2 kg/s as the duration with local peak heat load of 350 kW/m² (representing a point at some distances from the leak).
— Point 2: Using the maximum duration of a leak rate above 0,1 kg/s as the duration with local peak heat load of 250 kW/m² (representing a point close to the leak).

NOTE For calculation purposes it is assumed that the equipment has not been exposed to heat loads from point 1.

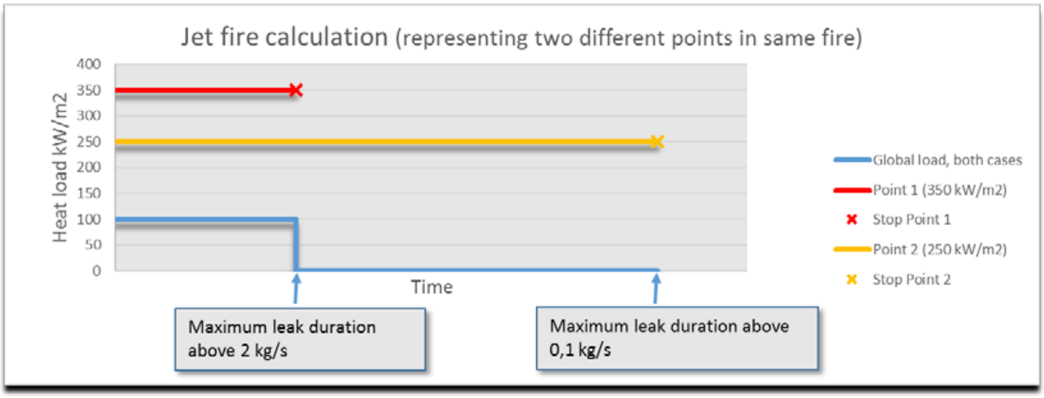

Figure 2 — Jet fire calculation

The same principle applies for pool fires, but with different fire loads, ref. Table 1. This will determine the heating up of the metal of the most exposed parts of the segments, and hence the weakening of the material.

The global average heat load is used as an input to the depressurisation calculations including the effect of boiling and vapour expansion of the segment inventory.

5.7 Qualification of technology

Technology that requires qualification is defined as systems or components for which an acceptable reliability is not demonstrated by a documented track record for the particular application. The technology shall be qualified following a systematic approach, such as laid down in DNV-RP-A203 [1] or similar guideline, in order to demonstrate that it meets specified functional requirements and reliability targets.

5.8 Experience transfer

To ensure transfer of technical safety experience from relevant installations in operation, experience transfer activities should be part of the project development process. Sources of experience should include

- operational experience of relevant installations,
- project execution of relevant installations and modification to these,
- good technical solutions,
- solutions/equipment to be avoided.

5.9 Temporary equipment

Temporary equipment shall be in accordance with NORSOK Z-015 Temporary Equipment and follow the relevant principles of this document, e.g. survivability of safety critical equipment and ignition source control. For temporary equipment operated as self-contained units, well completion and workover units etc, the interfaces shall be considered in the design phase both for normal and emergency situations, e.g., available power to secure operations in emergency situations and ignition source control. Main lay-down areas should be prepared for connection of containers and temporary equipment to the platform's Fire & Gas system.

5.10 Documentation

The following safety documents should be developed during development of a new installation and be kept updated during the lifetime of the installation:

- Risk assessments (HAZID, HAZOP, risk analysis, risk evaluations, etc.);
- Safety strategies documentation which may include the Fire and Explosion Strategy (FES) and Escape Evacuation and Rescue Strategy (EER Strategy), also see subclause 5.2.6 Safety Strategy;
- Safety performance requirements which may be grouped in Safety Performance Standards;
- Safety system specifications and philosophies (supporting the Safety Strategy);
- Fire water report;
- Flare report;
- Design accidental load specification;
- Risk analyses and evaluations, including but not limited to:
    - survivability analyses for safety systems and barriers under the emergency conditions (scenarios and loads) which might be present when it is required to fulfil its role;
    - ESD Valve sectionalisation and if applicable other valves that have a role in an ESD situation, e.g. check valves;
    - reliability and availability;
    - fire load analyses;
    - explosion analyses;

  - dispersion analyses;
  - local vents;
  - PFP requirement and Fire integrity analysis;
- Safety arrangements documentation, drawings and diagrams as follows:
  - Fire and blast divisions;
  - Penetration dossier for fire divisions;
  - Structural passive fire protection;
  - Area classification;
  - Fire and gas detection layout;
  - Fire Protection Data Sheets (FPDS) (see example in Annex B)/ Area Safety Charts / F&G cause and effect (C&E) diagrams;
  - Escape routes, muster areas, areas for first aid treatment;
  - Safety equipment plot plans;
  - Active firefighting (plot plans and P&IDs);
  - P&IDs and Process safety analysis tables (SAT);
  - PSD/ESD cause and effect (C&E) diagrams;
- ESD shutdown hierarchy;
- SRS for instrumented safety systems.

Safety interface documentation shall be produced where relevant in order to ensure that safety requirements are addressed and implemented in the development of the design and between different contractors and installations, e.g. subsea installation, storage units and fixed platforms.

6 Layout

6.1 Role

The layout and arrangement of an installation shall reduce probability and the consequences of accidents through location, separation and orientation of areas, equipment and functions. The layout can amongst other contribute to:

- minimize the possibility of hazardous accumulations and spread of both flammable liquids and gaseous hydrocarbons;
- minimize the probability of ignition;
- separate areas required to be non-hazardous from those designated as being hazardous;
- minimize the consequences of fire and explosions and thereby reduced escalation risk;
- facilitate effective emergency response;
- provide for adequate arrangements for escape and evacuation.

6.2 Interfaces

Layout and arrangement including explosion barriers will interact with design and performance of other safety systems and barriers.

6.3 Required utilities

Layout is not dependent on any specific utility.

6.4 Functional requirements

6.4.1 Main design principles

The installation(s) shall be oriented with respect to the dominant wind direction to minimize the likelihood of a gas release or smoke drifting towards the accommodation and primary evacuation means.

The installation shall be divided into main areas (accommodation, utility, drilling, wellhead, process and hydrocarbon storage). The main areas shall be located and designed to minimize the risk to people, environment and assets. Main areas shall normally be separated by use of physical barriers as fire and blast divisions to prevent the escalation of an accident from one main area to another. The utility area should serve as a barrier between hazardous areas and LQ.

For installations that are part of a complex, the impact from major accidents e.g. blowouts and riser fires on the neighbouring installations shall be assessed. Mitigating measures can be length of the bridge, radiation shielding, etc.

Muster areas, accommodation, evacuation means and escape routes shall be located where they are least affected by fires and explosions.

Safety systems shall be located or protected to ensure operation during relevant emergency conditions. Systems and equipment such as FW pump units, emergency generator(s) and switchboards, UPS, ESD/F&G nodes, ballast and position keeping controls shall be located as safe as possible in the accommodation or utility area. The PSD node should be located in the same room as the ESD/F&G nodes, reference is made to subclause 10.5.

CCR shall be located as safe as possible in the accommodation or utility area with easy and safe access to evacuation facilities.

Equipment and piping containing hydrocarbons shall be located or protected to minimize consequences from dropped objects, crane boom fall and swinging loads etc.

Ventilation inlets, including combustion air inlets, shall be located in a safe area with respect to accidental gas leakages, ref. subclause 17.4.6.

Doors from non-hazardous rooms facing directly towards hazardous areas should be avoided. Doors bordering naturally ventilated areas shall be self-closing and conform to fire partition requirements. Non-hazardous rooms with doors or openings less than 3 m away from hazardous area should be avoided.

Equipment enclosures, e.g. for noise suppression, shall be subject to special consideration with respect to required safety functions. Such consideration should include impacts to F&G detection, fire water, drain, ventilation (effect on explosion overpressure and source of ventilation - see 17.4.**6**), area classification, Ex category on components, access, entering of confined space, light fixtures etc. The equipment enclosures should be made as small as possible in order to avoid it becoming a separate detection/fire area.

6.4.2 Riser flow line area

Hydrocarbon risers and associated equipment shall be designed and located to minimise risk due to accidental events (such as gas leakages, fires, explosions, ship impact and dropped objects), including accidents where riser or associated equipment is the initial source.

Pig launchers and receivers shall be located in open naturally ventilated areas at the periphery of the platform facing sea, and with hatches directed away from equipment and structures. It shall not be possible to open pressurized pig launchers/receivers.

Risers and riser ESD valves shall be located or protected to minimize the likelihood of damage below the ESD valves causing release of pipeline/riser inventories. The riser shall be protected against design accidental loads. Reference is also made to subclause 8.4.4 for other riser requirements.

The riser ESD valves shall be located as close to sea-level as practicable, i.e. cellar deck or lower. Riser ESD valves should be located in open, naturally ventilated area and such that liquid accumulation below the valve is avoided.

6.4.3 Process area

Fire and explosion assessments shall be performed along with the development of the layout to minimise the built-in escalation potential. This shall be ensured through the following principles:

— Equipment and piping containing high-pressure gas should be located in the upper decks above the module support frame or main hull.
— Liquid vessels should be located lower than gas equipment.
— Low-pressure equipment containing large amount of liquids should be located and arranged so that exposure to jet fires is minimised.

Process vessels, process piping, pig launchers and receivers and other hydrocarbon containing equipment shall be protected from external impact (e.g. from dropped objects or missiles due to disintegration of rotating machinery) or as found required through analysis.

6.4.4 Well areas

Drilling risers and conductors shall be designed and positioned or protected to minimize the likelihood of damage, including that due to ship impact and dropped objects.

For installations with main support frame (MSF), the wellheads should be located above the MSF in order to reduce exposure of the MSF from a wellhead fire.

6.4.5 Piping

Routing of piping containing hydrocarbon to or through the utility area shall be avoided except for fuel lines to utility systems. Hydrocarbon piping shall not be routed within the LQ areas.

Hydrocarbon transfer lines to/from bridges should be routed as safe as possible, preferably along the periphery of the installation.

Routing of piping containing any liquid or hydrocarbon gas is not allowed through electrical room, instrument room and control room. However, atmospheric systems (e.g. non-hazardous drains) may be routed through such rooms provided corrosion resistant materials are used and there are no leakage points, flanges etc within the room.

To avoid area classification of production laboratory, pressure control valves for flammable gases shall be located in open air outside laboratory.

Routing of hydrocarbon piping within areas where emergency equipment is located shall be limited to diesel fuel supply lines for emergency equipment themselves.

Pipework containing flammable liquid should not be routed such that a leak can come into contact with hot surfaces with temperature exceeding auto-ignition temperature, e.g. above combustion engines and exhaust piping.

On FPSO crude lines to aft offloading systems are accepted provided they are located at the side of the installation.

6.4.6 Lifting and lay down

Crane coverage and lay down areas shall be arranged to promote safe crane operations with free visibility from crane cabin and minimise the risk of dropped objects. Considerations shall be given to sidewise movement of load.

Within defined lifting zones equipment, or piping, containing hydrocarbons, flammable or toxic gas/liquid shall be protected from dropped objects.

Lifting above high voltage equipment and cables shall be assessed, and protection shall be considered installed.

The lifting zones shall be defined and shown on the lifting map in crane cabin. Crane software should give alarm in crane when lifting restriction boundaries are exceeded. Allowable weight chart for laydown areas shall be established.

Laydown and storage area should not be located in hazardous area. Location of laydown areas and temporary storage of equipment shall be considered to minimize effect on explosion overpressure, ventilation, flying debris from explosions and possible negative effects on technical barriers (e.g. F&G detection, FW system, natural ventilation).

Reference is made to NORSOK R-002 for further details.

6.4.7 Storage and handling of explosives

Explosives shall be stored and handled such that the risk of fire, explosion and falling/flying objects is as low as possible, e.g.:

- Area of storage shall have a low probability of impact from falling loads and heat radiation from possible fires threatening the storage area. Fire water shall be available for cooling of perforating guns in the event of fire in the area. See subclause 21.4.10.221.4.7 for requirements for fire water.
- The storage area shall be clearly marked and with restricted access.
- Quantities of stored explosive substances shall at any time be kept to a minimum. The duration of explosive substances storage at site shall be adapted to the planned period of use.
- Provisions should be in place to safely handle explosives that can constitute a risk in the event of a hazard and accident situation:
  - provisions for safe removal or relocation of explosives by cranes in the event of a fire in areas near the explosives should be available;
  - loaded perforating guns should be stored with end caps permitting pressure relief (venting) in the event of exposure to a fire.
- Explosives shall be secured so that they do not inadvertently explode during storage and use, e.g., electrically triggered perforation equipment shall be shielded against radio waves and other electrical fields. Detonators or initiators that require the enforcement of radio silence shall not be used.

6.4.8 Floating installations

For floating installations, the following shall apply:

- Systems with hydrocarbons with flashpoint below 60 °C shall not be installed in columns or pontoons for floating installations. Storage of diesel in atmospheric tanks is acceptable.

- Vital control functions (e.g. maritime control/bridge, process control and special emergency preparedness functions) shall be arranged in one common control centre for the entire installation.
- Process area shall be separated from FPSO hydrocarbon storage tank top by air gap of minimum 3 m and plated deck and bunding in order to avoid hydrocarbons spreading to the storage tank deck.
- Reference is made to 21.4.4 with respect to fire protection of tank deck.
- Equipment that can represent an ignition source (e.g. exhaust ducts and generators) should be located upwind of potential leak sources on floating installation that will be turned up against the wind.
- The effects of 'green sea' shall be carefully evaluated and means of protection arranged.
- Submerged crude pumps shall be used for FPSOs. If submerged pumps are not selected for FSUs, the decision shall be supported by a safety study.
- Crude oil transfer lines or any other hydrocarbon line shall not be located in double bottom.

6.4.9 Turret

The turret arrangement design shall aim at achieving open naturally ventilated areas and minimising explosion pressure. Enclosed mechanically ventilated areas should be restricted to LER/LIR with control or special equipment that requires special protection or cannot be located in outdoor environment. Such enclosed premises shall have overpressure ventilation, with air taken from and exhausted to a non-hazardous area. Location of the premises themselves as well as their ventilation inlets shall take into account the prevailing wind directions.

Where anchor winches are arranged on the deck below riser termination and ESD valves, the deck separating the areas shall be solid and gas tight.

Turret areas and piping shall be designed to minimise the risk of jet fires towards tank tops.

6.4.10 Explosion design principles

The amount of explosion relief available, the degree of blockage and congestion in an area of an explosion shall be optimised to reduce explosion risk. Design principles in ISO 13702, A.3, B.1, B.10 to B.11, should be followed.

The use of explosion panels and weather protection shields shall be kept to a minimum. Natural ventilation and open modules shall be preferred. Where such arrangements are likely to cause an unacceptable working environment, special solutions such as temporary shields for maintenance operations should be considered.

The arrangement of equipment in an area, and particularly near ventilation openings, can have a major influence on the peak overpressures expected in an area. Cable trays, junction boxes, piping and equipment shall be located so that they will not significantly increase turbulence, block explosion ventilation openings and reduce the free vent area, and thus increase explosion loads.

6.4.11 Hot air exposure of helicopter deck

Offshore installations will contain a variety of systems and processes that can emit gases and hot air plumes, typically generated by turbine generators, diesel engines, flares, and emergency depressurisation systems. Hot air flow from these systems may create turbulence and other thermal effects that may severely affect helicopter operations, unless adequate risk reducing measures are taken at the design stage. The design shall be in accordance with clause 5, NORSOK C-004 Helicopter Deck on Offshore Installations.

6.5 Survivability requirements

Equipment with a safety function, during and after the accident, shall generally be located and protected such that its role and function are maintained.

7 Structural integrity

7.1 Role

The structural integrity shall withstand all design load conditions (action) under normal operation and also ensure that the relevant safety functions are maintained after impact from design accidental loads .

7.2 Interfaces

Structural integrity has interfaces with the following safety systems and barriers:

- Layout (Clause 6);
- Containment (Clause 8);
- Passive fire protection (Clause 20);
- Active Fire Protection (Clause 21);
- Escape and evacuation (Clause 22);
- Marine systems and position keeping (Clause 24);
- Avoidance of Vessel Collisions (Clause 25).

7.3 Required utilities

Structural integrity is normally not dependent on any specific utility. Water filled structures may be dependent on supply of sea/fire water.

7.4 Functional requirements

Load bearing structures shall be designed with sufficient robustness in accordance with NORSOK N-001.

7.5 Survivability requirements

The design shall ensure sufficient structural integrity to withstand design accidental loads. This applies to the main structure as well as other critical structures such as derricks and flare towers which may lead to severe worsening of the accident scenario in case of collapse. The capacity of main load bearing structures shall as a minimum be maintained until the facility has been evacuated and be designed in accordance with requirements in NORSOK Z-013, NORSOK N-003 and NORSOK N-001. The design accidental fire load for the structure shall as a minimum include the worst credible process fire, ref. 5.6.3.3.

In addition, environmental consequences (e.g. from well blowout) and consequences for neighbouring installations shall be considered (e.g. bridge connections, jack-up / jacket, etc.).

8 Containment

8.1 Role

The containment function shall prevent release of hydrocarbons, other flammable fluids and/or harmful fluids (chemicals, toxic gases, steam, etc.).

8.2 Interfaces

The containment function has interfaces with the following safety systems and barriers:

- Layout (Clause 6);
- Process safety system (Clause 10);
- Passive fire protection (Clause 20);
- Active Fire Protection (Clause 21).

8.3 Required utilities

The containment function is not dependent on any specific utility.

8.4 Functional requirements

8.4.1 General

All risers, piping, valves, connections, pumps, rotating machinery, instruments and other components in the systems handling hydrocarbons, other flammable fluids and/or harmful fluids (chemicals, toxic gases, etc.) shall be designed, constructed, maintained and operated with the aim to avoid leaks to occur.

All components and systems shall be designed to enable necessary inspection, testing and correction in compliance with established inspection and maintenance program.

8.4.2 Piping

The use of flexible hoses connected to processing systems shall be minimized, e.g. there should be a fixed system for annulus de-pressurization of gas lift wells.

The use of flexible hose connections for well stream transfer within the turret and between turret and ship, should be minimised.

8.4.3 Flanges and connections

The number of mechanical connections (flanges and hubs) in systems with hydrocarbon inventory shall be kept to a minimum, i.e. by use of welded connections where feasible. Mechanical connections in a hydrocarbon piping system shall as a minimum conform to NORSOK L-001.

NOTE It should be noted that flanges of a compact type, according to NORSOK L-005, have a significantly lower leak frequency as compared to traditional ASME flanges. Hence, a reduced risk level can be obtained by selecting compact type flanges.

Relief/emergency depressurisation headers should be designed without flanges. Flanges for future tie-ins is acceptable. These shall be of a compact type. Passive fire protection shall be applied in accordance with subclause 20.4.3.

There should be no flanges in hydrocarbon piping to, or through, the utility area to avoid hazardous classification and resulting requirements for additional safety systems and barriers. One flanged connection may be installed on the fuel line to each combustion engine, turbine and fired unit in the utility area as well as transfer lines in offloading systems in utility areas for connecting the equipment without affecting the area classification.

With respect to instrument connections (connected to a piping valve) to hydrocarbon vessels, piping or equipment, the bore/orifice through the vessel-/piping wall (through nozzle) should be as small as possible to minimise the leak rate in the event of instrument connection leaks. Consideration shall be made to possible hydrate formation, wax deposit or plugging due to other deposits.

A flanging philosophy should be established by relevant disciplines, taking into account the installation and operational risk of type of connections and welded solutions. Generally, the number of flanges should be minimized.

8.4.4 Risers

The following applies above sea level for the riser side of the ESD valve for pipelines containing flammable fluids:

— Flanges on the pipeline side of the riser ESD valves shall not be used for fixed steel type risers. The benefit of installing an SSIV shall be evaluated.
— For flexible risers an SSIV shall be installed at the riser base. An SSIV can also be a non-return valve provided function/reliability requirements are established and that it is tested.

  The SSIV can be omitted provided that the consequence of a release is sufficiently small, i.e. does not prevent escape and evacuation due to escalation to other risers and result in loss of structural integrity. Parameters affecting the evaluation are type of concept, semi-type or ship-shape floating installation, passive fire protection on structure and risers, stabilized liquid or short distance to isolation valves on subsea template or other platform.

Two mechanical connections above water is accepted on the riser side of ESD valve connecting the flexible riser to the rigid section topside to simplify installation and replacement of the flexible riser. The flanges should be of compact type, see NORSOK L-005. Mechanical connections shall be leak tested via a test port to verify leak tight assembly before the riser is filled with fluid for pressure and leak testing. The bolts and flanges shall have passive fire protection.

With respect to flexible risers particular attention shall be made to the design, operation, condition monitoring and inspection to ensure pressure containment integrity during the whole lifetime of the risers.

For both flexible risers and steel type risers, a tie-in connection is acceptable subsea if;

— the flexible pipe attached to the connector shall be specified in accordance with API Spec 17J, while the rigid pipe attached to the connector shall be specified in accordance with DNVGL-ST-F201;
— the location of the connector is optimised (distance, water depth) such that possible risk impacts are reduced as far as practicable;
— design and performance verification of subsea flanges and hubs shall be according to ISO 10423;
— for a flanged connection, compact flanges according to NORSOK L-005 shall be used for flexible risers.

Instrument connections or any other connections on the pipeline side of the riser ESD valve are not permitted, except if overpressure protection of the riser/pipeline/flowline is required due to high well shut-in pressure (design to full pressure is not practical). In such cases two instrumented safety function shall be implemented ref. subclauses 10.4.1 and 10.4.7. A PSV shall also be installed to cater for HIPPS leaks. If the PSV is required to meet the overpressure criteria in accordance with SIL allocation for the involved safety function, the relief and flare capacity shall be adjusted accordingly.

With reference to Figure 3 the PSV arrangement shall comply with the following:

- An ESD valve upstream Riser PSV to be installed and located as close as possible to the offtake from the riser.
- The ESD valve shall be welded, i.e not flanged.
- The ESD valve shall receive automatic shutdown signal on confirmed fire detection in the riser area and location of Riser PSV as well as on APS. The ESD valve should not receive any other automatic shutdown signals (from e.g. PSD, PCS, ESD, …).
- The ESD valve should be fail in position and have fire/heat protection of valve, actuator and signal cable similar to the Riser ESD valve. The fire / heat protection should in addition to the riser valve fire integrity requirement, also ensure valve closure upon demand when exposed to jet fire (for ~4-5 minutes).
- Local reset function of the ESD valve as required for other ESD valves should not be implemented to ensure possibility of remote operation of the ESD valve from CCR.
- It should be ensured that the riser is not the weakest point of the pipeline/riser system.

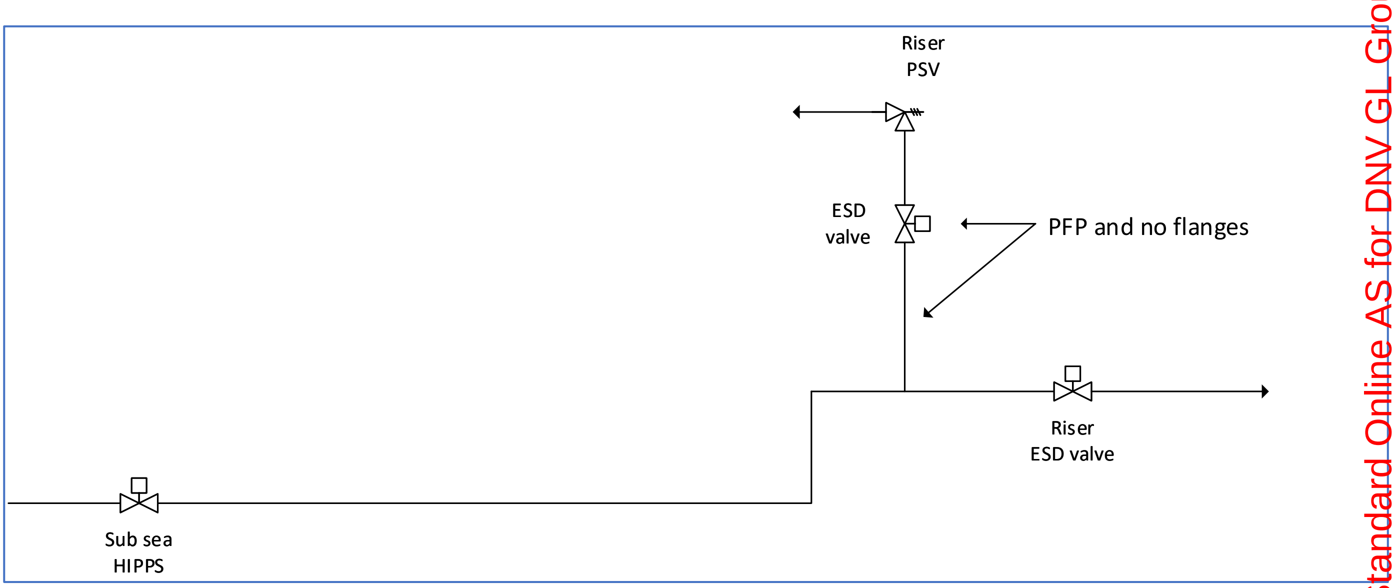

Figure 3 — PSV arrangement to handle HIPPS leaks

8.5 Survivability requirements

Equipment and piping within the containment function, including instrument tubing (see subclause 5.6.3.4), shall resist the design accidental loads they can be exposed to. With respect to explosion loads the design accidental load should be applied to the equipment and piping within the containment function. To decide which hydrocarbon segments that shall withstand design fire load, see subclause 5.6.3.3 and 5.6.3.4.

9 Open drain

9.1 Role

The purpose of the open drain system is to provide measures for containment and proper disposal of flammable liquid spills, as well as handling rain water and fire water.

9.2 Interfaces

Open drain has interfaces with the following safety systems and barriers:

— Layout (Clause 6);
— Containment (Clause 8);
— Passive fire protection (Clause 20);
— Active Fire Protection (Clause 21).

9.3 Required utilities

Open drain safety function is not dependent on any specific utility.

9.4 Functional requirements

The requirements for open drain systems are valid for the whole installation (wellhead, drilling, process and utility areas).

9.4.1 Minimize fire/escalation risk arising from spills and leaks

Measures shall be provided for dealing with spills and leaks in all areas that have a source of flammable or hazardous liquid so as to minimize the risk of fires and personnel exposure to hazardous materials. The drainage systems shall be designed in accordance with NORSOK P-002 and ISO 13702.

The capacity of the drainage system, i.e. including overflow lines for fire water, shall be able to handle full fire water capacity and the liquid leak rate associated with the worst credible process fire, typically 5 kg/s within the bunded area. The drain header capacity shall be sufficient to avoid backpressures that cause liquid to flow back into other open parts of the system during deluge/firefighting. Simultaneous deluge/firefighting in relevant number of areas shall be considered, according to the safety strategy.

All tanks and vessels containing flammable liquids shall have a deck bunding covering the tank perimeter controlling spreading of spills, and there shall be drainage within the bunding.

Design of the drain system to handle fire water on a floater is challenging due to vessel motions which may result in liquid flowing directly to sea. Particular attention should be made to prevent spreading of fire water and drainage between fire areas, decks and lower escape ways.

Tanks collecting drains from hazardous areas shall be purged with inert gas to prevent explosive mixtures.

9.4.2 Separation of drain systems

Closed and open drainage facilities shall be arranged so that they cannot affect each other adversely.

Hazardous and non-hazardous open drains shall be physically separated to prevent backflow of hydrocarbons from hazardous to a non-hazardous area. However, they can be processed in the same oily water treatment system.

If liquid from the hazardous and non-hazardous open drains are pumped to the same caisson or sump, the possibility of backflow into the non-hazardous open drain shall be prevented.

Measures shall be implemented to prevent that vapors from the oily water treatment system enter the drainage systems, i.e. liquid seals shall be provided where the headers from open drain enter the collection tank(s), and these shall be designed for maximum possible back pressure.

Collection tanks shall be vented to an atmospheric vent system, and the outlet shall terminate at a safe location, i.e. away from personnel, equipment air intakes and sources of ignition.

Fire water and liquid spills on the helideck shall be drained in a safe, controlled and effective manner through a dedicated pipe drainage system.

The open drain system shall provide effective means, e.g. liquid/fire seals, to prevent flammable liquid vapors and gases to spread to other fire areas via the drain system. Vent lines from seals shall be routed back to the area where the drains originate, or to a safe location.

There shall be no connection between the drilling and production open drain systems. Drilling drain systems will require special solutions to handle solids and particles from drilling areas. Reference is made to NORSOK P-002.

Temporary storage of flammable liquids in tote tanks shall only be located in areas with an adequate collection and drain system.

9.5 Survivability requirements

The drain system, such as drain box and piping, shall not impair the integrity of fire divisions, see subclause 20.4.1.

10 Process safety system

10.1 Role

Process safety means of protection, including mechanical protection devices and safety instrumented functions, shall ensure that the process conditions do not exceed specified process safety limits.

The aim is to control any abnormal process operating conditions to prevent and/or minimize possible accidental releases. Typical actions, by means of protection such as Process Shutdown (PSD) functions and Pressure Safety Valves (PSV), include:

- Stop hydrocarbon flow
- Shutdown process and utility equipment
- Pressure relief
- Isolate leaks
- Shutdown heat input to the process

The extent of a PSD situation will depend on type of abnormality, and may vary from equipment shutdown with minimum effect on the production rate, to a total process shutdown.

10.2 Interfaces

The process safety system has interfaces with the following safety systems and barriers:

- Layout (Clause 6);
- Containment (Clause 8);
- Emergency Shutdown (Clause 10);
- Emergency Depressurisation and Flare/Vent System (Clause 12);
- Human – machine interface (HMI) for CCR systems (Clause 16);
- Marine Systems and Position Keeping (Clause 24).

10.3 Required utilities

The performance of the process safety system is dependent on:

— uninterruptible power supply (UPS) to keep the PSD system operational upon loss of main electrical power;
— hydraulic supply including back-up hydraulic accumulators for closure of double acting valves;
— instrument air supply (local accumulators, if necessary).

10.4 Functional requirements

10.4.1 Process safety principles

The process safety functions shall provide a reliable and fast detection of process upsets and execution of the actions that are considered necessary to control the situation and avoid escalation.

For topside functions, the PSD system shall be independent from the process control system.

For subsea systems requiring PSD protection, the PSD function shall be independent of the subsea control system, i.e. if any failure of the subsea control system will require PSD protection, e.g overpressure protection.

Process and auxiliary systems shall be designed such that no single failure during operations can lead to unacceptable hazardous situations. The process safety system shall normally provide two levels of protection to prevent or minimize the consequences of an undesirable event within the process. If practicable, the two levels shall be provided by functionally different types of device. The design shall be in accordance with NORSOK P-002.

Process safety layers of protection shall be established and designed in accordance with API RP 14C or ISO 10418 including referenced process standards that in a prescriptive manner often make recommendations of conventional solutions. Note that ISO 10418 in subclause 6.2.15 states that if an instrument-based system is used for primary protection, it will not need to comply with IEC 61511-1 provided the secondary protection system is self-actuating (PSV or rupture disc) and meets the requirements of relevant codes and standards. Then, a deterministic approach based upon industry accepted typical protective solutions is also acceptable for PSD functions, e.g predefined performance requirement (PFD values) as established in Norwegian Oil and Gas Association GL070.

In order to avoid cascading effect, the process shutdown shall be realized in accordance with ISO 10418, 6.2.16 / API RP 14C, 4.2.3.

Where utilities, such as cooling water, are shared by process systems and equipment in non-hazardous areas, the utility system shall be designed to prevent migration of flammable liquids and gases into non-hazardous areas and systems.

Loss of instrument air or hydraulic supply (PALL) shall initiate a full production shutdown.

10.4.2 Process shutdown (PSD) valves

Shutdown valves on the liquid phase outlet from pressure vessels shall be located as close to the pressure vessel as possible, and the number of leak sources between the pressure vessel and shutdown valve shall be minimised. Shutdown valves shall have a fail-safe function under flowing conditions, i.e. normally fail-safe close. If the shutdown valve has a role 5.6.3.3related to fire design loads, it shall be defined as an ESD valve, reference is made to subclause 5.6.3.3.

10.4.3 Pressure safety valves (PSVs)

PSVs shall be designed, installed and maintained according to recognized international standards (API STD 520/521).

10.4.4 Alarms, automatic actions

Alarms shall support operator decision-making during upsets and accidental situations. Actions shall be initiated automatically when process or equipment protection limits are exceeded.

10.4.5 Response time

The maximum response time of a process safety function to reach safe state on demand in actual operation shall be defined according to process dynamic behaviour.

Typical response times that shall be complied with unless faster responses are required from dynamic analysis:

- Time from signal from sensor to start of PSD execution, e.g. de-energised solenoid valve, should be less than 2 seconds.
- PSD valve travel time (in service) should not exceed 2 seconds/inch (valve size) to reach safe state. For valves 8 inch or less, a typical travel time should be set to 15 seconds.
- New valves should have a design margin to allow for degradation during service life, typically 1 second/inch.

10.4.6 Logic solver

The logic solver (firmware, as standard manufacturer provision) shall be in compliance with IEC 61508/IEC 61511 and Norwegian Oil and Gas Association GL070.

10.4.7 Instrument based systems for secondary pressure protection

In the event instrument based systems need to be installed for secondary pressure protection, ref. scenarios described in NORSOK P-002, the solutions shall be designed such that the annual frequency of overpressure above the temperature adjusted test pressure shall be less than 1×10^{-5}.

The annual frequency of overpressure above the code's accepted pressure shall be less than 1×10^{-3}.

When applying the above requirements, the following leak frequencies should be applied:

1) for pressure lower than the code's accepted pressure: p(leakage) = 0 (zero);
2) for pressure between the code's accepted pressure and test pressure p(leakage) = 1×10^{-2};
3) for pressure above test pressure p(leakage) = 1.

The secondary pressure protection system shall be realized independently from both the PSD and ESD systems.

Where a PSV is installed for leak protection of secondary instrument protection of riser/ pipeline/ flowline, reference is made to 8.4.4.

10.5 Survivability requirements

The logic solver and essential utilities should be located as safe as possible in the accommodation or utility area. If located in LER outside of the accommodation or utility area, consideration shall be made to the consequences of loss of process feedback signals, e.g. valve position, pressure and temperature, due to ignition source isolation of the LER. Reference is made to 6.4.1.

In case of RIO cabinets installed in hazardous areas, they should be located as safe as possible.

11 Emergency shutdown (ESD)

11.1 Role

The purpose of the ESD system is to prevent escalation of abnormal conditions into a major hazardous event and to limit the extent and duration of any such events that do occur.

11.2 Interfaces

ESD system has interfaces with the following safety systems and barriers:

- Process safety system (Clause 10);
- Emergency Depressurisation and Flare/Vent System (Clause 12);
- Gas detection (Clause 13);
- Fire detection (Clause 14);
- Ignition Source Control ISC (Clause 15);
- Public address (PA), alarm and emergency communication (Clause 18);
- Passive fire protection (PFP) (Clause 20).

In addition, ESD initiations will activate, directly or indirectly, safety functions such as HVAC, emergency power and lighting, PA, subsea control, offshore cranes, drilling and well intervention and marine systems.

11.3 Required utilities

ESD system performance is dependent on:

- uninterruptible power supply (UPS) to keep the ESD system operational upon loss of main electrical power;
- hydraulic supply including back-up hydraulic accumulators for closure of double acting valves;
- instrument air supply (local accumulators, if necessary);
- HVAC to ensure overpressure and temperature control of LER/LIR.

11.4 Functional requirements

11.4.1 Manual ESD activation

Manual activation of the ESD system shall be possible from strategically positioned stations where accessibility and manning in a hazard situation is taken into account.

Possibility for manual activation should be provided at strategic positions such as:

- CCR (APS/ESD1/ESD2);
- helideck (APS);
- muster areas/lifeboat stations (APS);
- bridge connections (ESD2);

- drilling areas (driller shutdown and ESD2);
- exits from process and wellhead areas (ESD2);
- strategic located stations along escape routes (ESD2).

APS activation possibility to be considered at bridge landings in addition to CCR.

Manual activation buttons shall be protected against inadvertent activation, e.g. with protective covers or rotary switch and duplicated buttons for APS. Each activation button shall be clearly marked, and a consistent colour coding shall be applied for the activation buttons, e.g. black with yellow stripes for APS and yellow for ESD2.

Isolation of emergency power supplies i.e. UPS upon APS shall be executed via a timer independent of the logic solver, normally 30 min to ensure that necessary safety critical equipment is in operation during escape and evacuation. Separate function(s) shall be provided allowing bypassing timer based APS countdown.

An independent function, e.g. disconnecting the power to the ESD logic solvers, shall be included allowing safe shutdown upon failure of programmable logic. The function may be realized by setting the installation in a safe state, i.e. initiating emergency depressurization and shutdown equivalent to an ESD1 level.

Special consideration shall be made to disconnection of centralised escape lights such that no single fault shall result in disconnection of all escape lights.

11.4.2 Emergency shutdown (ESD) final elements

ESD valves shall isolate and sectionalise the process segments in a fast and reliable manner to reduce the total amount of released hydrocarbons in the event of a leak. ESD valves shall limit ESD segment volume in accordance with subclause 5.6.3.3 ESD valves are not necessarily required at the fire divisions between fire areas. The valve arrangement shall be able to isolate at design flow conditions including consideration of increased flow from possible external leak, e.g. well flowline leak/breakage immediately downstream WV or platform side of ESD riser valves.

The following shutdown valves shall always be categorised as ESD valves:

- valves located in, or are the nearest shutdown valve to, a hydrocarbon riser;
  - chemical injection to subsea wells do not require ESD valves topside provided that two independent well barrier elements in accordance with NORSOK D-010 are installed;
  - chemical injection subsea at riser base, e.g. MEG and methanol for hydrate prevention during shutdown, shall be subject to special considerations and may require topside ESD or block valve (normally closed);
- valves located on the liquid outlet of large liquid vessels, such as separators and coalescers, see 10.4.2 for location of valves;
- valves located in a utility system where the consequences of valve failure with respect to safety may be significant, shall be subject to special consideration;
- well isolation valves (DHSV, MV, WV, ASV, chemical injection, actuated annulus valves on gas lifted wells;
- actuated SSIV (tagged as ESD valve). Reference is made to subclause 8.4.4 for evaluations on need for.

For bridge connected installations with flow lines between the installations, considerations shall be made with respect to need for ESD valves related to worst credible process fire to stop flow between the installations. Location of such valves should be considered with respect to area classification and should preferably be installed in hazardous area (process/wellhead area).

An ESD valve may be used as a PSD valve. The main valve including actuator and related accessories such as pilot valve ("boost/quick dump") and travel speed restrictor will be common, but shall have physically separate ESD/PSD activation signals and solenoids. The valves shall be tagged as ESD valves.

ESD valves shall have either spring return or local accumulators to ensure fail-safe function under flowing conditions, i.e. normally fail-safe close. Spring return type of valves shall be used when required size is available, normally 24 inches or less, as this is a more reliable fail-safe function compared to double acting valves. Local accumulators shall have 300 % capacity and should be placed as close as possible to the valve.

ESD valves shall have defined criteria for leakage rates based on a study reflecting valve criticality. There shall be facilities for testing of internal leakage rate in the direction(s) the valve has a role.

ESD valves, shall have local reset function. e.g. local reset of solenoid valve (may not be required for remote operated platforms). ESD valves shall be equipped with both remote and local position indication. It is acceptable that the position indicator signal is routed to PCS for monitoring of valve action at a shutdown.

Manual valves in safety control circuits (e.g. hydraulic return and accumulator supply or means for valve travel time adjustment) shall be secured in correct position, e.g. by use of lock nuts.

11.4.3 Emergency shutdown (ESD) actions

The ESD system shall activate all actions in accordance with the Safety Strategy. Consideration shall be given to interrelations between interconnected installations, e.g. by pipelines or control systems.

The ESD functions shall be arranged in a tree-structured hierarchy, APS, ESD1 and ESD2. General principles are shown in Figure 4 and should be used as basis for the facility specific safety strategy. The ESD hierarchy should be simple and unambiguous minimizing number of sub-levels. A higher ESD level shall initiate lower levels including PSD. A signal on a certain level should never initiate shutdowns or actions on higher levels.

ESD actions shall include depending on ESD level (see Figure 4):

— shutdown of dry well trees, riser valves and subsea well trees when wells are located within the platform safety zone.

NOTE with reference to Figure 4, shutdown will include closure of DHSV and/or SSIV for specific scenarios;

— initiate stop of subsea pipeline and flowlines connected to the installation outside of the platform safety zone. The closure signal for both subsea wells and other imports can be realized in subsea control system, except upon APS and F&G detection in riser area where isolation is performed by ESD power cut to subsea facility, ref 11.4.5. For other imports, the ESD system submits a PSD signal (or by fail to safe PCS signal) to the connected sources (riser valves), ref. subclause 10.4.1;
— shutdown and sectioning of the hydrocarbon process facilities;
— initiation of EDP;
— ignition source isolation;
— shutdown of main power generation;
— start/stop of emergency power generator via voltage sensor;
— shutdown of drilling, intervention and work-over equipment not required for well control.

Any shutdown, spurious or intended, shall require a manual reset from CCR.
During well intervention DHSV and master valves shall be disconnected from the platform ESD system. It shall be possible to operate the DHSV and master valves in accordance with subclause 26.5.

Loss of ESD signals between an NNMI and remote control centre shall shutdown the NNMI upon a time delay. The time delay should not exceed 10 min.

ESD of the remote control centre shall result in shutdown of the NNMI.

When installed, remotely operated Subsea Isolation Valves (SSIV) shall as a minimum be automatically closed upon APS activation and confirmed fire or gas detection in riser area.

The X-mas tree valves part of the ESD function of well stream isolation shall, for subsea installations, apply a fail-to-safe principle for both electrical and hydraulic power supplies.

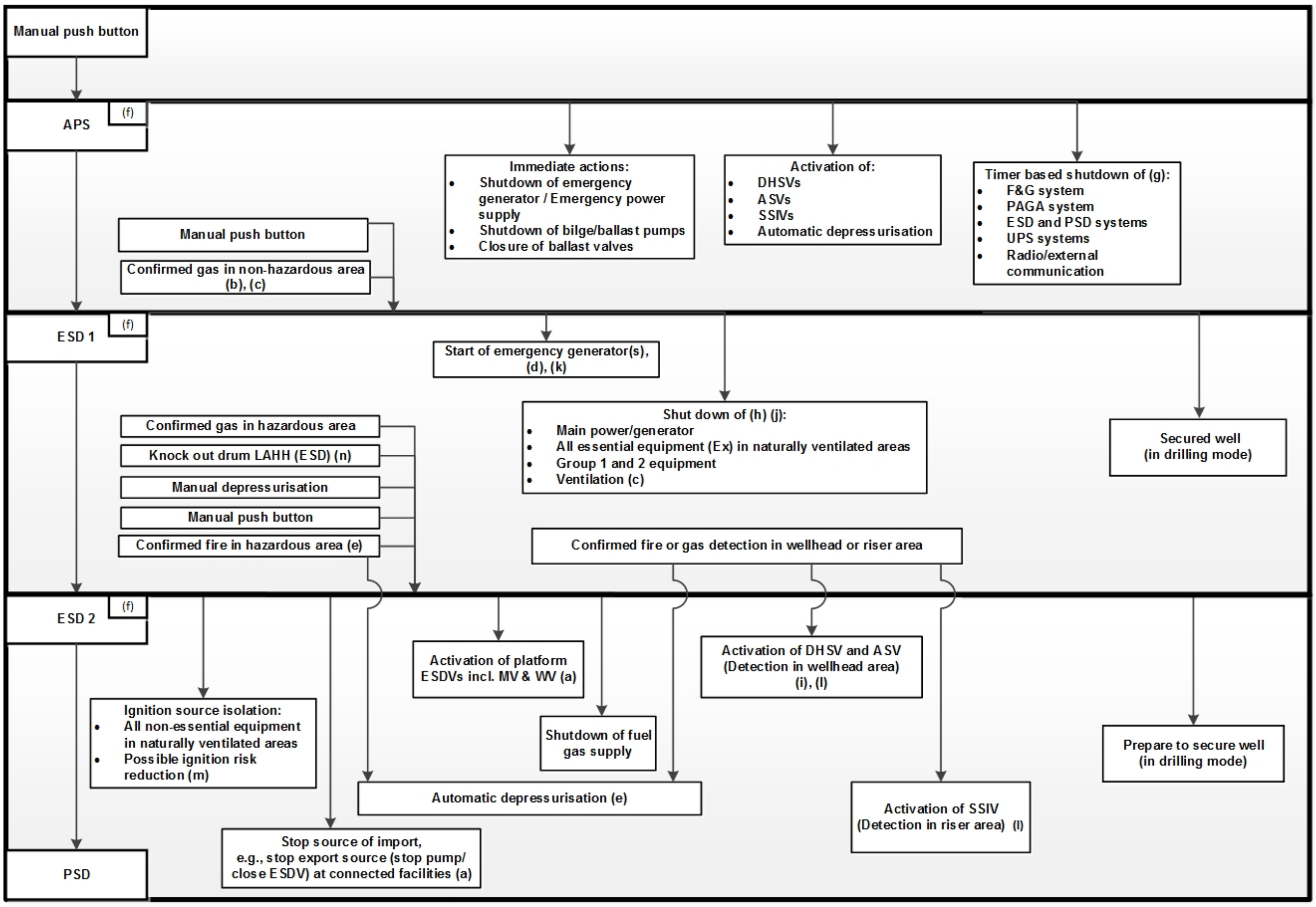

Figure 4 — Emergency shutdown (ESD) (principal hierarchy – more detailed and other requirements apply)

Notes

(a) The closure signal for both subsea and other imports can be realized in PCS, except upon F&G detection in riser area where isolation is performed by ESD (power cut to subsea facility, ref 11.4.5) or PSD (other imports).

(b) Alternative to ESD1 can be ESD2 and selective electrical isolation disconnection depending on location, e.g. located in close proximity to process, wellhead or drilling areas.

(c) Dampers closed/fans stopped on single gas alarm in ventilation intake.

(d) The start function shall be inhibited if gas has been detected in air intakes to generator, or generator has previously been tripped due to overspeed. Inhibit start of emergency generator may be also considered due to ISC. For power supplied from subsea cable, the emergency generator only to start upon loss of all cable supplied power.

(e) Activation of firefighting systems manually via deluge release pushbutton (not via pressure transmitter feedback, see subclause 21.4.4) shall only initiate ESD2 and not automatic depressurization. Automatic

EDP at confirmed gas detection shall be evaluated as a mean to limit extent and duration of possible gas leaks, ref subclause 12.4.2.

(f) Annunciation (alarm and personnel warning) shall be given together with relevant shutdown level.
(g) Immediate shutdown of equipment can be required, see subclause 15.4.4.
(h) Shutdown of main generator will also include essential generator, if installed (trip both production and drilling). Main power generation until ESD1 premises dual fuel generators.
(i) Activation of DHSV and ASV on detection in wellhead area refers to topside wells. Refer to key (a) for subsea wells.
(j) Main power switchboard if power is supplied from subsea cable. Emergency board should be operative as long as possible to avoid need for start-up of emergency generator, ref. key (d).
(k) For typical emergency consumers in drilling mode, refer to clause 15 and NORSOK D-001.
(l) On confirmed gas unless otherwise specified in Safety Strategy (see Clause 13, Table 2).
(m) With respect to possible ignition sources (Ex equipment), see subclauses 15.4.1, 15.4.2 and 15.4.3.
(n) The intention of the LAHH on ESD2 level is to provide a secondary instrumented process protection level. As an alternative to initiation of ESD2, shutdown of relevant ESD valves (using the ESD solenoid valves) and initiation of PSD is acceptable. PSD does not initiate general alarm, stop of fuel gas and ignition source isolation.

11.4.4 Emergency shutdown (ESD) alarm annunciation

ESD system status shall continuously be available in CCR, and the system shall raise alarms in CCR for operator awareness or actions, considering:

- ESD level initiation;
- ESD function failure to execute actions upon demand;
- ESD function (sensor, logic solver or final element) defect or failure.

Personnel shall be warned to ensure safe escape and evacuation, ref. clause18. Prepare to abandon alarm (at APS level) shall be initiated manually. Upon any confirmed ESD (auto or manual), general alarm shall be automatically initiated. Manual initiation of ESD1 or ESD2 level shall as a minimum initiate general alarm on affected platform. In addition the F&G system shall initiate automatic general alarm as described in clause 13 (Table 2) and clause 14 (Table 3).

An ESD alarm shall be alerted in other strategic locations, and announcement shall be made by means of and at typical locations such as:

- Visual display of ESD alarms in drilling control room (driller's cabin);
- Visual display of ESD alarms in well intervention control station;
- Visual display of ESD alarm (ESD2) in crane cabin.

11.4.5 Emergency shutdown (ESD) response time

Response time of all equipment and components included in the ESD function shall be defined.

Standardised response times shall be defined for groups of similar ESD functions except when individual ESD functions require exceptional response time to meet intended functionality.

Typical response times that should be complied with are:

- Time from activation (ESD node receives signal) to start execution, e.g. de-energised solenoid valve, should normally be less than 2 seconds.
- The total response time for closure of dry well tree (MV&WV) should not exceed 45 seconds.
- With reference to topside ESD valves' characteristics, the travel time (during lifetime) should not exceed 2 second /inch (valve size) to reach safe state. For valves 8" or less, a typical travel time of 15 seconds should be used. Reference is also made to subclause 10.4.5 regarding maximum travel time for PSD valve.

- New valves should have a design margin to allow for degradation during service life, typically 1 second/inch.

For subsea facilities extended valve travel times are accepted due to special subsea design conditions:

- The total response time for closure of wet well tree (MV&WV via sequential closure) should not exceed 60 seconds.
- The ESD shutdown should be delayed in order to allow a sequential closure of the well valves via subsea control facilities prior to the ESD disconnection of electrical power supply applying power cut and bleed off via normally energized “Quick dump” hydraulic valve. The time from ESD initiation to all XT barrier valves are in closed position (by sequential closure followed by power cut) shall be less than 4 minutes. Such delays shall however not be applied for wells located within the defined safety zone of the platform or if risk analysis has required well closure time which is shorter than achieved by the delay and ESD actuation time.
- The total response time for closure of SSIVs should be maximum 2 minutes unless risk analysis has required a shorter valve closure time.
- Applied time delays associated with an ESD action to achieve safe state shall be clearly identified in relevant documentation, e.g. C&E diagrams and SRS.

11.4.6 Logic solver

The logic solver (firmware, as standard manufacturer provision) shall be in compliance with IEC 61508/IEC 61511 and Norwegian Oil and Gas Association GL070.

11.4.7 Emergency shutdown (ESD) independence

The ESD system shall operate as an independent system. Prerequisites to fulfil the independence requirements are:

- ESD safety related functions shall be realised in addition to and independent of the PSD and PCS functions, but the ESD system units (logic solver) can be an integral node of the overall SAS.
- ESD system units (logic solver) shall only be used for ESD related safety functions.
- ESD sensor loop including accessories (e.g. process tapping, impulse lines, air supply branch-off and power fuses) shall be separate from other functions, directly connected to ESD system unit.
- ESD final element shall be operated directly from ESD system unit, but such devices may in addition be operated by other safety related systems if they have separate activation devices e.g., ESD valves used for PSD.
- An appropriate level of independency shall be obtained for ESD functions (final element) if they are integrated within remote/local panels, e.g.:
    - ESD functions operate independent of well control and PSD in well control panel;
    - ESD of electrical equipment;
    - ESD of turbines, compressors etc.

The ESD can be realised in a common HMI and network arrangement (i.e. of the SAS) provided that any failures in any systems connected within the same arrangement do not adversely affect the intended ESD safety functions. This realisation shall be subject to given prerequisites as described in Norwegian Oil and Gas Association GL070.

Status feedback and deviation reporting/alarm (e.g. ESD limit switches, valve closure time) is not safety critical functions.

11.5 Survivability requirements

System and incorporated components shall resist the design accidental loads to which they may be exposed until they have fulfilled their function.

The logic solver and essential utilities shall be located as safe as possible in the accommodation or utility area. Reference is made to 6.4.1. With respect to retrofits and extensions, the ESD system, logic solver and essential utilities shall not be located less safe than existing logic solvers, i.e. accommodation or utility area.

Final elements shall resist accidental loads such as explosion, fire and falling loads where applicable, e.g.:

— ESD valves including equipment such as electrical cables, pneumatic and hydraulic tubing necessary for activation of valves, until the 'shutdown' sequence is completed.
— With respect to location of riser ESD valves, see subclause 6.4.2.
— ESD valves shall remain in safe position throughout the duration of the accidental scenario, i.e. valves to be designed to stay in safe position on loss of actuated power supplies.

ESD valves shall be in accordance with recognized standard regarding fire resistance, e.g. ISO 10497 and EN 12266-all parts. Fire protection may be required to withstand the design accidental load.

12 Emergency depressurisation and Flare/Vent system

12.1 Role

The purpose of the emergency depressurisation system is to:

— reduce the pressure and inventory in a process segment in case of a fire exposing the segment in question. A reduction in pressure implies reduced material stress and, hence, reduced risk of rupture due to heating caused by the fire;
— reduce the leak rate and leak duration from a leaking process segment, and, hence, also reduce the explosion and fire risk in case the leak is ignited.

The purpose of the flare/cold vent and atmospheric vent system is to:

— provide safe disposal of releases from pressure relief, depressurisation, process vents and spill-off flaring from control valves;
— route gas from atmospheric vent lines to a suitable location without hazard to the personnel (including occupational health) or the installation.

12.2 Interfaces

Depressurisation and Flare/ Vent System have interfaces with the following safety systems and barriers:

— Layout (Clause 6);
— Process safety system (Clause 10);
— Emergency shutdown (ESD) (Clause 11);
— Gas detection (Clause 13);
— Fire detection (Clause 14);
— Human – machine interface (HMI) for CCR systems (Clause 16);
— Passive fire protection (PFP) (Clause 20);
— Active Fire protection (Clause 21).

Automatic EDP functions are normally realised through the ESD system.

12.3 Required utilities

The EDP performance is dependent on:

— uninterruptible power supply (UPS) to keep the ESD and EDP system operational upon loss of main electrical power;
— instrument air supply (local accumulators if necessary) alternatively hydraulic supply.

12.4 Functional requirements

12.4.1 Emergency depressurisation

The EDP system shall ensure that the process is depressurised in a fast and reliable manner in order to avoid unacceptable rupture and to minimize leak durations. The EDP shall in combination with all other risk reducing measures, contribute to a reduction of the fire and explosion risk to:

— avoid instantaneous release (rupture and leakage) of large volumes of flammables;
— avoid escalation of fire between areas/units and during escape/rescue by reducing internal pressures, fire load and duration.

The EDP rate and times shall be set based on a study reflecting the risk on the specific installation and principles in API STD 521. EDP times shall be in accordance to specified requirements for protection of pressurised systems exposed to fire. Analysis regarding material capacity versus EDP should be performed as specified in "Guidelines for protection of pressurised systems exposed to fire", Report 27.101.166/R1 Scandpower Risk Management AS [2] or similar methods. Reference is also made to subclause 5.6.3.4.

The following aspects shall be considered in the design process:

— damage to internals of equipment (e.g. trays, packing supports), entrainment of packing or catalyst into the depressurization system;
— the depressurisation rates shall be maximized within a defined level of flare system utilisation to reduce risk further and minimize the need for passive fire protection. 100 % utilisation is normal. For some installations, the flare system capacity may be very large due to relief cases like choke collapse and mal-operation of inlet valves. Then a lower utilisation of the flare system for emergency depressurisation may be correct since this will reduce noise, radiation and pipe stress at depressurization.

Failure of a segregation valve impacting EDP segments shall not result in overpressure of the flare system.

In case sequential EDP is required, the time delay and/or sequence to open EDP valves shall ensure that the flare system capacity is not exceeded and failure in the sequence shall not lead to rupture of the flare system. However, exceeding the radiation levels due to failure in sequence may be acceptable provided that the escape from exposed work areas are not impaired. Reference is also given to API STD 521.

The EDP valves shall be treated similarly to ESD valves with respect to logic, tagging, response time etc. except local manual reset. The EDP valves shall be equipped with position indication (remote and local) and have fail-safe open function.

The objective is generally to avoid shut in volumes without EDP, and to minimize their volumes by proper location of valves. All pressure vessels and piping segments, which during shutdown contain more than

1 000 kg of hydrocarbons (liquid and/or gaseous), shall be equipped with a depressurising system. For pressure vessels and piping segments without a depressurising system, containing gas or unstabilised oil with a high gas/oil-ratio, the maximum containment should be considerably lower, typically less than 100 kg. Segments in this context mean volumes that are isolated by automatic shutdown valves (PSD/ESD valves) and non-return valves or control valves.

A blowdown orifice may act as a weir. Liquid that may accumulate between the EDP valve and the orifice shall not freeze.

Block valves in EDP lines shall be secured open.

All process segments without EDP shall be clearly marked on the P&IDs.

12.4.2 Activation of emergency depressurisation (EDP)

EDP shall be automatically initiated upon confirmed fire detection in hazardous areas (process, riser and wellhead areas), on fire and gas detection in riser and wellhead areas and on gas detection when deluge is activated (a gas leak is almost impossible to locate when deluge is released). Any delay of opening of EDP valves shall be accounted for in evaluations of rupture of process equipment due to fire exposure.

Full platform depressurisation shall be possible in CCR (operator station and dedicated push button in CAP). Manual push buttons shall be protected against inadvertent activation, e.g. protective covers. Use of the dedicated push buttons shall also initiate ESD2.

Automatic EDP at confirmed gas detection shall be evaluated as a mean to limit extent and duration of possible gas leaks. This will reduce ignition probability, and in case of an ignition, also the probability for rupture of process equipment.

12.4.3 Flare, vent and knock out drum

Reference is made to NORSOK P-002 Process System Design with respect to flare, vent and knock out drum requirements.

Flare:

Flare shall be located and designed to ensure that the heat radiation level at maximum or continually release rate will be within acceptable limits in all areas of the installation. The permissible radiation levels for personnel exposure shall be in accordance with API STD 521. Consideration should be made to effect of clothing.

Cold and local vents:

Vents shall be terminated at a safe location, normally verified by gas dispersion simulations. Operational conditions that may give gas heavier than air shall be included.

Gas concentrations from vents (or extinguished flare) shall not exceed 20 % LEL in any area on the installation where ignition of the release is possible. Helicopter flight paths shall be optimized and based on dispersion studies of release from extinguished flares, ref. CAP 437 “Standards for Offshore Helicopter Landing” regarding LEL levels and management system for alerting helicopter pilots.

Unintentional ignition of the vents shall not give unacceptable heat loads.

Local venting of hazardous gases should not be permitted unless it can be done without hazard to the personnel (including occupational health) or the installation.

12.5 Survivability requirements

The flare system shall withstand explosions and fires for the required period of time to minimum maintain integrity to avoid unacceptable rupture, ref. subclause 5.6.3.4. Special consideration shall be given to flanges, pipe supports, pipes with no flow during EDP (e.g. pipes downstream PSVs) and valves and control circuit with delay function. Use of pipe specification that can resist the loads should be considered as an alternative to avoid PFP.

13 Gas detection

13.1 Role

The gas detection system shall monitor continuously for the presence of flammable or toxic gases, to alert personnel and allow control actions to be initiated manually or automatically to minimise the probability of personnel exposure, explosion and fire.

13.2 Interfaces

Gas detection system has interfaces with the following safety systems and barriers:

- Layout (Clause 6)
- Emergency shutdown (ESD) (Clause 11)
- Emergency depressurisation and flare/vent System (Clause 12)
- Ignition source control (ISC) (Clause 15)
- Human – machine interface (HMI) for CCR systems (Clause 16
- Natural ventilation and heating, ventilation and air condition (HVAC) (Clause 1717)
- Public address (PA), alarm and emergency communication (Clause 18)
- Emergency power and lighting (Clause19)
- Active fire protection (Clause 21)

13.3 Required utilities

Gas detection system performance is dependent on uninterruptible power supply (UPS) to keep the gas detection operational should main electrical power supply fail. Instrument air supply can be required if aspiration systems are applied.

13.4 Functional requirements

13.4.1 Design coverage

The gas detection function shall provide reliable and fast detection of flammable and toxic leaks before a gas cloud reaches a concentration and size which could cause risk to personnel and installation.

Actual design principles for gas detection (e.g. type and location of detectors) shall be established according to relevant gas characteristics (e.g. light/heavy, vapour, flammable, toxic).

Detectors shall be installed based on a study of gas leakage scenarios within each area considering leakage sources and rate, dispersion, equipment arrangement and environmental conditions such as ventilation, and the probability of detection of small leakages within the area.

The following principles should be applied for determination of location of detectors:

- Natural flow 'corridors', e.g. access ways/walkways along flow direction, shall be covered.
- Where relevant, detectors shall be positioned at different heights in an area including coverage of different natural flow paths.
- Consideration shall be given to gases both lighter and heavier than air including temperature effects from the release.
- Location and necessary protection in view of environmental impacts such as snow, fog, sun, and rain/wind.
- Equipment enclosures, e.g. for noise suppression, shall be subject to special consideration.

A combination of open path/line detectors and point detectors shall be used to optimize the coverage and detection probability.

- Hydrocarbon detectors, preferably IR detectors, with provisions of self-diagnostics and suited for the gas to be detected shall be used.
- Catalytic detectors should only be used if proper detection performance by other types is not achieved.

Detector coverage should primarily be achieved using open path / line detectors and supplied with point detectors where adequate coverage cannot be achieved with open path / line detectors. For conversion between open/path line and point detectors the following formula may be applied:

$$N_p = (L_s * C_{LEL}) / (LEL_m * 100)$$

Where

N_p	Number of point detectors
L_s	Length of line of sight (m)
C_{LEL}	Low alarm limit point detectors (% LEL)
LEL_m	Low alarm limit open path/line detectors (LELm)

For confirmed detection of flammable gases in hazardous areas, using 20 % LEL level, a gas cloud of 10 meters in diameter should be detected anywhere in the area. As a practical approach for point detectors this can correspond to a distance of 7 meters between gas point detectors when voting is applied for confirmed detection.

The basis and assumptions used for detector selection and location shall be documented. Dispersion studies should be performed for verification and optimization of location and number of detectors.

The detector grid coverage described above may be optimized, typically in wellhead and process areas, possibly achieving a reduction in no of detectors, by applying the following method and target:

Target: A gas cloud equal to the volume of the dimensioning gas cloud (explosion loads) shall be detected with a 95 % probability for confirmed detection on two detectors. The number of point detectors required per module is as shown in Figure 5.

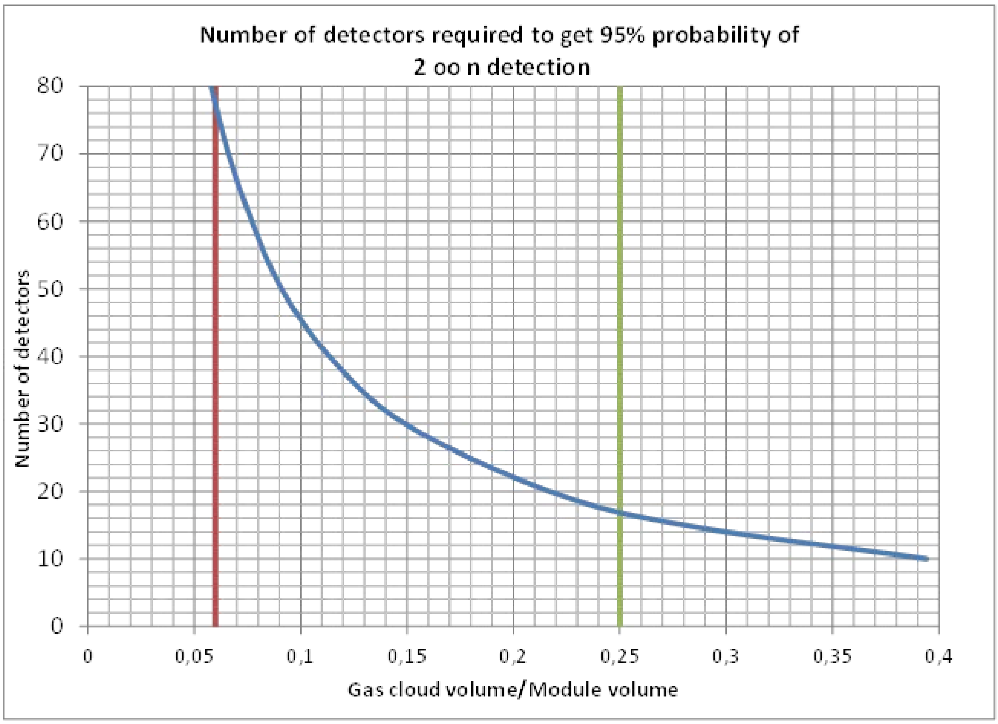

Figure 5 — Number of gas point detectors as a function of gas cloud volume

This figure shows number of point type detectors required to obtain 95 % probability for confirmed detection on two detectors as a function of the detectable gas cloud volume relative to the volume of the module. To determine the necessary number of point detectors in an area, the size of the dimensioning gas cloud should be used. The vertical lines at 0,06 and 0,25 represents typical upper and lower gas cloud sizes.

In addition, the objective shall be to provide effective detection of smaller leaks than above to give a warning (alarm), typically a leakage rate of 0,1 kg/s.

For detection of vapours from process liquid releases, the following principles should apply;

— low-level detectors (heavy gas), but normally not located lower than 0,5 meters above ground level;
— detectors arranged in 5 meters triangular grid around potential source of release.

Note that a liquefied gas release, which is relatively dense and cold, can be entrained into local air movements and warmed sufficiently to lift off downwind.

Separate sensors and alarm handling shall be provided for detection of toxic gases (e.g. H_2S, CO, CO_2, NH_3). For such detection, attention shall be given to the fact that hazardous effects to people and explosion hazard may be directly linked to both concentration and exposure time.

In wellhead and process areas, H_2S presence is related to a process (HC) gas leak. Dedicated H_2S detectors can be omitted for H_2S concentrations lower than 1500 ppm in the well/process flow as the installed HC gas detectors can measure H_2S presence indirectly. (Activation of low HC gas alarm (e.g. 20 % LEL) will be representative of an H_2S concentration of 15 ppm i.e. corresponding to an approximate content of H_2S of 1500 ppm.)

Temporary units and equipment shall be covered by gas detection in accordance with the principles in this document. Areas where such equipment will be located shall have connections to the platform's Fire & Gas system.

13.4.2 Gas detection location – Areas requiring gas detection

Gas detectors shall be provided in all areas where potentially dangerous/toxic gas concentrations may be present.

As a minimum the following areas shall be covered by HC detectors:

- zone 1 and zone 2 areas;
- ventilation air inlets;
- ventilation outlet from hazardous areas (except paint containers and small noise enclosures)
- combustion air intakes and turbine hoods/enclosures air inlet/outlet;
- rooms that contain possible ignition sources and are arranged with openings towards a hazardous area, ref. 15.4.3 for further details;
- in sheltered or enclosed areas if gas can be trapped, e.g. noise enclosures;
- rooms containing group 3 safety critical equipment (potential ignition sources), ref. 15.4.4 for further details;
- for floating units such as FSU and FPSO, gas detection shall be provided in areas such as ballast tanks and cofferdams where gas may migrate through small cracks towards cargo tanks etc. Aspiration gas detector systems shall be considered for such applications.

H_2 detection shall be installed in battery rooms unless it can be documented that sufficient quantities of hydrogen cannot be generated to pose a danger.

Oxygen deficiency detection shall be provided in areas where a low O_2 concentration may be present, e.g areas where nitrogen atmosphere may develop.

Oil mist detectors (optical obscuration) shall be considered used in areas with a risk of leak from pressurised liquid utility systems like diesel oil, hydraulic oil, lube oil etc.

Arrangements and actions associated with gas detection should be implemented as described in Table 2.

13.4.3 Gas detection actions and voting

The gas detection system shall initiate actions in accordance with the principles below and the Safety Strategy.

Automatic initiation of actions shall include:

- emergency shutdown (confirmed gas detection);
- ignition Source disconnection;
- HVAC shutdown (single low gas detection at air intake);
- deluge activation in naturally ventilated areas to reduce explosion overpressure/drag forces if specified in Safety Strategy (confirmed gas detection);
- EDP activation if specified in safety strategy (confirmed gas detection in hazardous area);
- start of fire water pump when used for explosion mitigation (low gas detection);
- general alarm (confirmed gas detection).

See Table 2 for further details of principles.

Confirmed gas detection and applied voting principles shall comply with the following:

- 2ooN detector to reach specified alarm limit when N ≥ 3 should be based on low alarm limits (ref. 13.4.5). See 0 for air intakes.
- Voting should include all detectors within a detection area (any type of detectors). Voting between detectors in different detection areas (intelligent voting) may be applied.

— Confirmed gas detection on single detector 1ooN and N > 2 may exceptionally be used provided failure probability is documented to be sufficiently low and consequences of single detector failure is tolerable.

In order to ensure optimized use of release of deluge to reduce explosion effects, initiation may be realized by confirmed gas detection on several detectors, e.g. by reaching low alarm limit on 6 detectors. When deluge is automatically released, EDP should also be automatically activated.

The number of detectors that may simultaneously be inhibited or in fault shall be assessed addressing issues such as area risk, area detection coverage, out of operation duration and compensatory measures including local area safety guards. Alternatively, when using a 2ooN configuration, an inhibited or faulty detector can be logically treated as (a) gas alarm or (b) imposing automatic reconfiguration, e.g. from 2oo3 to 1oo2. Prerequisites and measures required in the case of detectors are inhibited or faulty shall be part of the operating instructions.

1oo1 detection principle should only be used for area monitoring and alarms.

Arrangements and actions associated with gas detection should be implemented as described in Table 2.

Table 2 — Gas detection recommended practices

Area/room	Detector location	Gas detection *(note f)*	Alarm type *(note d)*	Automatic Shutdown	HVAC action	Comments
Wellhead area (naturally ventilated) note a)	Area	Alarm	CCR	ISC subclause 14.4.2, non-essential(A)	NA	(A) Start FW pump(s) if specified in Safety Strategy (used for explosion mitigation) (B) Release deluge if specified in Safety Strategy and used for explosion mitigation see note e) (C) Emergency depressurisation (EDP) in accordance with 12.4.2
		Confirmed	CCR + GA	ESD2 + DHSV + ASV + AFP(B) + EDP(C) ISC, note b)	NA	
Riser area note a)	Area	Alarm	CCR	ISC subclause 14.4.2, non-essential(A)	NA	(A) Start FW pump(s) if specified in Safety Strategy (used for explosion mitigation) (B) Release deluge if specified in Safety Strategy and used for explosion mitigation see note e) (C) Emergency depressurisation (EDP) in accordance with 12.4.2
		Confirmed	CCR + GA	ESD2 + SSIV + AFP(B) + EDP(C) ISC, note b)	NA	

Area/room	Detector location	Gas detection _(note f)_	Alarm type _(note d)_	Automatic Shutdown	HVAC action	Comments
HC process area (naturally ventilated)	Area	Alarm	CCR	ISC subclause 14.4.2, non-essential(A)	NA	(A) Start FW pump(s) if specified in Safety Strategy (used for explosion mitigation) (B) Release deluge if specified in Safety Strategy and used for explosion mitigation see note e) (C) Emergency depressurisation (EDP) if specified in Safety Strategy and if deluge is released in the area, see note e)
		Confirmed	CCR + GA	ESD2 + AFP(B) + EDP(C) ISC, note b)	NA	
HC process area (mech. ventilated)	Area Inlet Extract	Alarm	CCR	ISC subclause 14.4.2, non-essential(A)	Continue ventilation (D)	(A) Start FW pump(s) if specified in Safety Strategy (used for explosion mitigation) Consider time delayed ESD2 upon loss of mechanical ventilation (B) Release deluge if specified in Safety Strategy and used for explosion mitigation see note e) (C) Emergency depressurisation (EDP) if specified in Safety Strategy and if deluge is released in the area, see note e) (D) If gas is detected in inlet; close damper and fans
		Confirmed	CCR + GA	ESD2 + AFP(B) + EDP(C) ISC, note b)	Continue ventilation(D)	
Utility areas (non-hazar-dous naturally ventilated)	NA	NA(A)	NA	NA	NA	(A) Areas not normally covered with gas detection. Gas detection may be implemented for ignition source control purposes and initiate ESD1
Non-hazar-dous mech. ventilated	Inlet	Alarm	CCR	ISC subclause 14.4.2, non-essential.	Close damper and fans	(A) Electrical disconnection of all essential (and non-

Area/room	Detector location	Gas detection *(note f)*	Alarm type *(note d)*	Automatic Shutdown	HVAC action	Comments
areas/rooms incl. turbine/ generator hall, utility rooms, etc.		Confirmed	CCR + GA	ESD1(A)/(B)	Close damper and fans	essential) equipment in naturally ventilated area and Gr. 1 & 2 equipment in the room. (B) ESD2 + selective isolation may exceptionally be appropriate.
Non-hazar-dous mech. ventilated areas/rooms containing Group 3 equipment	Inlet	Alarm	CCR	ISC subclause 14.4.2, non-essential.	Close damper and fans	(A) Electrical disconnection of all essential (and non-essential) equipment in naturally ventilated area and Gr. 1 & 2 equipment in room. (B) ESD2 + selective isolation may exceptionally be appropriate. (C) Manual electrical disconnection of Group 3 equipment
		Confirmed	CCR + GA	ESD1(A)/(B)	Close damper and fans	
	In room	Alarm	CCR	None (C)	None	
Rooms non-hazardous by ventilation e.g. LER note c)	Inlet (or air lock if applied)	Alarm	CCR	ISC subclause 14.4.2, non-essential.	Close damper and fans	(A) Electrical disconnection of all essential (and non-essential) equipment in naturally ventilated area and Gr. 1 & 2 equipment in room. (B) ESD2 + selective isolation may exceptionally be appropriate.
		Confirmed	CCR + GA	ESD1(A)/(B)	Close damper and fans	
Drill floor/well intervention area	Area	Alarm	CCR(A)	ISC subclause 14.4.2, non-essential.	NA	(A) And drillers cabin and office (B) Manual drillers shutdown to be considered (also to include isolation of all essential equipment)
		Confirmed	CCR(A) + GA	ESD2(B) ISC, subclause 14.4.2 note b)	NA	
Driller's cabin	Inlet	Alarm	CCR(A)	ISC subclause 14.4.2, non-essential.	Close damper and fans	(A) And drillers cabin and office

Area/room	Detector location	Gas detection (note f)	Alarm type (note d)	Automatic Shutdown	HVAC action	Comments
		Confirmed	CCR(A) + GA	ESD2 + selective isolation of affected area(B)	Close damper and fans	(B) Selective disconnection of essential (& non-essential) equipment in naturally ventilated area, and disconnection of Gr. 1 & 2 equipment in room.
Drilling and mud service areas (Hazardous mech. ventilation)	Area Extract	Alarm	CCR(A)	ISC subclause 14.4.2, non-essential	Continue ventilation	(A) And drillers cabin and office. Internal alarm in drilling areas to be considered
		Confirmed	CCR(A)	Manual action	Continue ventilation	
	Inlet	Alarm	CCR (A)	ISC subclause 14.4.2, non-essential	Close damper and fans	(A) And drillers cabin and office (B) Selective isolation of Ex equipment in affected area can be considered.
		Confirmed	CCR (A)+ GA	ESD2 ISC, note b) (B)	Close damper and fans	
Shale shaker room	Area Extract	Alarm	CCR(A)	None	Continue ventilation	(A) And drillers cabin and office. Internal alarm in drilling areas to be considered (B) Local drilling non-essential equipment can be considered (C) Selective isolation of non-essential / essential equipment in affected area as a minimum.
		Confirmed	CCR(A)	ISC subclause 14.4.2, non-essential (B)	Continue ventilation	
	Inlet	Alarm	CCR (A)	ISC subclause 14.4.2, non-essential	Close damper and fans	
		Confirmed	CCR (A) + GA	ESD2 ISC, note b) (C)	Close damper and fans	
Drilling and mud service areas (Non-hazar-dous mech. ventilated)	Inlet	Alarm	CCR(A)	ISC subclause 14.4.2, non-essential	Close damper and fans	(A) And drillers cabin and office (B) Selective disconnection of essential (and non-essential) equipment in naturally ventilated area, and disconnection of Gr. 1 & 2 equipment in room.
		Confirmed	CCR(A) + GA	ESD2 + selective isolation of affected area(B)	Close damper and fans	
Turbine hood and	Inlet	Alarm	CCR	ISC subclause 14.4.2, non-essential	None	(A) Trip turbine, close fuel valves including

Area/room	Detector location	Gas detection (note f)	Alarm type (note d)	Automatic Shutdown	HVAC action	Comments
combustion inlet		Confirmed	CCR + GA	Turbine shutdown (A) ESD1/ESD2(B)	Close damper and fans	depressurization of relevant fuel system. (B) ESD1 for turbines in utility area, ESD2 for turbines in process area.
Turbine hood	Extract(A) Area(C)	Alarm	CCR	None	Continue/increase ventilation	(A) Inlet detection take precedence over area/extract detection (B) Trip turbine, close fuel valves including depressurization (C) If installed
		Confirmed	CCR	Turbine shutdown (B) ISC, note b)	Continue/increase ventilation	
Analyser cabinet/ house (enclosed)	Cabinet/ house	Alarm	CCR	ISC subclause 14.4.2, non-essential. (A)	NA	(A)Electrical disconnection of all essential (and non-essential) equipment in naturally ventilated area.
Fire Water pump (self-contained and located in protected area)	HVAC inlet	Alarm	CCR	ISC subclause 14.4.2, non-essential.	Close damper and fans	(A) Electrical disconnection of all essential (and non-essential) equipment in naturally ventilated area. (B) Continued Fire water pump operation
		Confirmed	CCR + GA	ESD1(A)/(B)	Close damper and fans	
Room with combustion engine (emergency generator, etc)	HVAC inlet	Alarm	CCR	ISC subclause 14.4.2, non-essential.	Close damper and fans(A)	(A) Time delayed shutdown of engine unless unit has room / engine cooling independent of HVAC (B) Electrical disconnection of all essential (& non-essential) equipment in naturally ventilated area and disconnection of Gr. 1 & 2 equipment in room. (C) ESD2 + selective isolation may exceptionally be appropriate. (D) Shutdown of unit unless inlet is provided with flame arrestor
		Confirmed	CCR+GA	ESD1(B/C)	Close damper and fans	
	Combustion inlet	Alarm	CCR	ISC subclause 14.4.2, non-essential.	Close damper (D)	
		Confirmed	CCR+GA	ESD1(B/C)	Close damper	

Area/room	Detector location	Gas detection (note f)	Alarm type (note d)	Automatic Shutdown	HVAC action	Comments
Battery room	Extract(A)	Alarm	CCR	Trip boost charging	Continue ventilation	(A) If H_2 can be produced
LQ, incl. CCR, LIR and LER	Inlet	Alarm	CCR	ISC subclause 14.4.2, non-essential.	Close damper and fans	(A) Electrical disconnection of all essential (& non-essential) equipment in naturally ventilated area and Gr. 1 & 2 equipment in room.
		Confirmed	CCR + GA	ESD1(A)	Close damper and fans	
Crane (engine and cabin)	HVAC and combustion inlet	Alarm	CCR + Crane cabin	ISC subclause 14.4.2, non-essential.	Close damper and fans	(A) Sec. 14.4.7 for different modes of crane operations. (B) ESD2 + selective area disconnection to be considered
		Confirmed	CCR + Crane cabin + GA	ESD1(A)/(B) ISC, note b)	Close damper and fans	
Turret area	Area	Alarm	CCR	ISC subclause 14.4.2, non-essential. (A)	NA	(A) Start FW pump(s) if specified in Safety Strategy or used for explosion mitigation (B) Emergency depressurisation (EDP) unless otherwise specified in Safety Strategy and if deluge is released in the area, see note e) (C) Release deluge if specified in Safety Strategy and used for explosion mitigation, see note e)
		Confirmed	CCR + GA	ESD2 + MV + WV + EDP(B)/(C) + SSIV ISC, note c)	NA	
Ballast tanks and cofferdams (typical FPSO/FSU)	Area	Alarm	CCR	ISC subclause 14.4.2, non-essential (A)	NA	(A) Action on confirmed gas to be specified in safety strategy

Area/room	Detector location	Gas detection (note f)	Alarm type (note d)	Automatic Shutdown	HVAC action	Comments

Notes

a For mechanically ventilated areas special consideration shall be made, ref. HC process area (Mech ventilated) for guidance.
b According to 14.4.1, perform a review of potential measures which may reduce ignition likelihood, as an example making selective disconnection of essential equipment (Ex, e.g. zone 2) and Gr.1 equipment. Analyse such measures for implementation with due emphasis to be given on practicability for realisation, both for design as well as operation.
c Group 3 equipment shall not be located in rooms safe by ventilation, ref. clause 6.4.1. Special consideration shall be made for LER in turret area. Group 3 equipment in such rooms shall be fitted with air locks and as a minimum be disconnected upon loss of ventilation in combination with gas detection in air lock.
d Alarms presented in CCR shall also be presented as a not area specific general gas alarm in other strategic location such as crane cabin, drillers cabin and office and jack-ups.
e In order to ensure optimized use of release of deluge to reduce explosion effects, initiation may be realized by confirmed gas detection on several detectors, e.g. by reaching low alarm limit on 6 detectors. When deluge is automatically released, EDP should also be automatically activated.
f Lifts shall not be considered as a part of escape routes. However, it shall be possible to escape from the lift at any elevation. Lifts shall automatically go to next floor level and stop upon single gas detection

13.4.4 Requirements for HC gas detection at air intakes

Air intakes shall be monitored for presence of gas, preferably by IR type detection.

The number and location of detectors shall be selected and installed to cover the cross-sectional area of the air intake or air inlet channel since gas concentration may not be homogenous over the inlet / channel cross-sectional area. This implies that large air intakes (as turbine enclosures) may require installation of minimum three gas detectors.

Applied low gas alarm shall be equal to or lower than 10 % LEL (or equivalent for open path detectors, i.e. detection distance x 10 % LELm - not > 1 LELm).

Applied high gas alarm shall be equal to or lower than 30 % LEL (or equivalent for open path detectors, i.e. detection distance x 30 % LELm - not > 2 LELm).

Low gas alarm (single detector) at the intake shall initiate shutdown of fans, dampers and electric heaters. See 17.4.7 Dampers with respect to response time.

Confirmed gas detection (2ooN) should be based on one detector at low alarm and one detector at high alarm, i.e. minimum three detectors to be installed in the air intake.

13.4.5 Gas detection set-points

General alarm limits for HC and H_2 gas detection shall be equal to or lower than:

— Low alarm set-point for point detectors shall be maximum 20 % LEL. For turbine enclosure detection (extract and area) the alarm limit shall be 10 % LEL.
— Low alarm set-point for IR open path / line detector shall be maximum 1 LELm.
— High alarm set-point for point detectors shall be maximum 30 % LEL. For turbine enclosure detection the alarm limit shall be 15 % LEL (extract and area).
— High alarm set-point for IR open path/line detector shall be maximum 2 LELm.

If toxic gas detection is required, separate outputs for annunciation of toxic gas alarm shall be provided. The following alarm limits for toxic gas shall be used:

H_2S gas detection:

- Low alarm set point shall be maximum 5 ppm (assume area inspection and reporting within 15 minutes).
- High alarm set point shall be maximum 50 ppm (immediate area evacuation, 50 % of standard IDLH value).

CO_2 gas detection:

- Low alarm set point shall be maximum 5 000 ppm.
- High alarm set point shall be maximum 15 000 ppm.

CO gas detection:

- Low alarm set point shall be maximum 100 ppm (assume area inspection and reporting within 15 minutes, reference standards allows 25 ppm for 8 hours).
- High alarm set point shall be maximum 600 ppm (immediate area evacuation, 50 % of standard IDLH value).

O_2 deficiency detection (see IEC 60079-29-2):

- Low alarm set-point shall be minimum 19,5 vol %.
- Low-low alarm set-point shall be 19,0 vol %.

13.4.6 Gas detection alarms

F&G system status shall be continuously available in CCR, and the system shall raise alarms in CCR for operator awareness or action, considering:

- Gas detection
- Failure to execute action upon demand
- Function (sensor, logic solver, final element) defect or failure.

Status/alarm parameters for each individual gas detector shall be identifiable in the CCR.

Gas alarms shall also be announced at other strategic locations, e.g.:

- drillers cabin and office
- crane cabin
- jack-ups.

For alarms from detectors located in drilling areas the information presented in CCR should be mirrored in drillers cabin and drillers control office.

13.4.7 Gas detection response time

Maximum response time of the gas detection function shall be defined in order to ensure that total reaction time for each safety function can be fulfilled.

Typical response times that should be complied with unless faster responses are specified elsewhere:

- IR detector response time (T90) should be less than 5 s for general area applications, and less than 2 s if used in HVAC ducting.
- the time from detector alarm limit is reached until alarm is presented on operator station and start of action should be less than 2 s.

There shall be no predefined delays of actions initiated upon gas detection unless a delay is safer. In such a case, this shall be clearly identified in relevant documentation such as FPDS and C&E diagrams.

For gas detection in ventilation inlets IR type detector shall be located as close as possible to the inlet to ensure fast detection. For damper and ventilation shut off response time reference is made to 17.4.7.

13.4.8 Gas detection logic solver

The logic solver (firmware, as standard manufacturer provision) shall be in compliance with IEC 61508/ IEC 61511 and Norwegian Oil and Gas Association GL070.

13.4.9 Independence

The F&G safety related functions shall fulfil their intended role independently of other control - and safety related control systems. Prerequisites to fulfil the independence requirements are:

— F&G safety related functions shall be realised in addition to and independent of installation basic control systems.
— F&G system units (logic solver) shall only be used for F&G related safety functions.
— F&G sensor loop including accessories (e.g. air supply branch-off and power fuses) shall be separate from other functions that are directly connected to F&G system unit.
— F&G final element shall be operated directly from F&G system unit. Disconnection of ignition sources should be realized through the ESD system.

A common SAS data network and operator stations may be used allowing F&G operator interface activities to be executed such as inhibit and override, status and alarm handling, annunciation, logging and printing. “All action signals, except release of firefighting systems (deluge, foam, watermist etc), shall be normally energized.

13.5 Survivability requirements

The logic solver and essential utilities shall be located as safe as possible in the accommodation or utility area. Reference is made to 6.4.1. With respect to retrofits and extensions, the, logic solver and essential utilities shall not be located less safe than existing logic solvers, i.e. accommodation or utility area.

14 Fire detection

14.1 Role

The fire detection system shall monitor continuously for the presence of a fire to alert personnel and allow control actions to be initiated manually or automatically to minimise the likelihood of fire escalation and probability of personnel exposure.

The early fire detection system shall, relevant to specific equipment and areas, monitor continuously for the presence of an incipient fire condition to alert personnel and allow control actions to be initiated manually to minimise the probability of a fire condition to develop.

14.2 Interfaces

Fire detection system has interfaces with the following safety systems and barriers:

— Layout (Clause 6);

- Emergency shutdown (ESD) (Clause 11);
- Emergency Depressurisation and Flare/Vent System (Clause 12);
- Ignition source control (ISC) (Clause15);
- Human – machine interface (HMI) for CCR systems (Clause 16);
- Natural ventilation and heating, ventilation and air condition (HVAC) (Clause 17);
- Public address (PA), alarm and emergency communication (Clause 18);
- Emergency power and lighting (Clause 19);
- Active Fire protection (Clause 20);
- Well integrity (Clause 26).

14.3 Required utilities

Fire detection system performance is dependent on uninterruptible power supply (UPS) to keep fire detection operational should main electrical power supply fail.

14.4 Functional requirements

14.4.1 Design coverage

The fire detection function shall provide reliable and fast detection of a fire by adequate type, number and location of fire detectors and shall ensure timely alarm and initiation of control actions.

Detectors shall be provided based on an evaluation of fire scenarios within each area considering potential fire sources and characteristics, consequences, area and equipment arrangement and environmental conditions. For fire detector requirements reference is made to EN 54 all parts.

Fire detection coverage in each area shall be based on flame size, smoke characteristics and temperature (heat) rise.

The target for critical fire (jet or pool) detection in hazardous areas:

- A flame size of 0,5 m in diameter and length of 1 m to be detected by at least one detector.
- A flame size of 1 m in diameter and length of 3 m to be detected by at least two detectors (corresponding to an ignited jet gas leakage rate of 0,1 kg/s).

When suitable according to area conditions and fire characteristics, flame detectors shall be given preference over heat sensors.

Early warning smoke detection systems, sensitive to small concentration of combustion products, should be considered in rooms containing live electrical equipment and where firefighting is based upon local inspection and manual intervention including disconnection of relevant electrical equipment.

The basis and assumptions used for detector selection and location shall be documented. One detector should be located at the HVAC extract points. The location of smoke detectors in LERs and critical rooms shall be confirmed by smoke dispersion tests for actual conditions inside the rooms with ventilation operative. Scenarios to be detected and performance requirements shall be defined in the Safety Strategy.

Equipment enclosures, e.g. for noise suppression, shall be subject to special consideration. See subclause 6.4.1.

14.4.2 Fire detection location – areas requiring fire detection

All areas on the installation shall have suitable means of fire detection. Fire detection shall as a minimum be in accordance with Table 3.

Flame detectors should be the primary means for detection of fires in hazardous areas.

Detectors in one fire area shall not detect fires in adjacent fire areas and thereby cause unintended automatic release of fire water which may exceed the dimensioning fire water capacity.

Flame detectors shall be located in a manner that minimises the likelihood of false fire alarms being initiated, e.g. avoiding direct exposure to flame radiation from sources such as flares or reflections from shiny surfaces.

14.4.3 Manual call points

Manual Call Points shall be located strategically, and in locations such as:

- along escape routes;
- inside buildings such as offices etc.;
- exits from process areas and rooms;
- exits from technical rooms;
- at fire stations;
- refrigerator and freezer rooms/containers.

The maximum walking distance to a manual call point should not exceed 30 m.

Manual call points should be protected against inadvertent activation.

Manual call points are used to alert CCR for accidents or situations also other than fire and where the attention and action of CCR is required. Release of firefighting equipment is realized via dedicated stations, ref. clause 21.

14.4.4 Characteristics and calibration

Detector characteristics and calibration (pre-set sensitivity) shall ensure detection of a fire condition at an early stage, and the detector shall be capable of operating under the conditions at the time that fire detection is needed.

Fire detectors shall be self-monitoring and should include provisions of self-diagnostic to the extent available.

Flame detectors shall comply with actual fire potential and environment conditions within the relevant area e.g.:

- IR or UV where flame is predominating and according to flame wave radiation characteristic;
- sensor range and cone of vision. Based on a typical flame detector characteristic, the distance between flame detectors and targets monitored should not exceed 26 m;
- sensor direction and angle;
- sensitivity to external impact such as arc welding and burner boom.

Heat point detectors (electrical) characteristics shall comply with actual fire potential and environmental conditions within the relevant area, e.g.:

- normally limited use, i.e. specific high-risk areas and where other detection principles are not suitable;
- maximum coverage in naturally ventilated area approximate 24 m^2, maximum distance between sensors 7 m and maximum distance from wall 4,5 m and minimum 0,5 meters away from outside wall or dividing partition;

— maximum coverage in mechanically ventilated area approximate 37 m^2, maximum distance between sensors 9 m and maximum distance from wall 4,5 m.

Smoke detectors characteristics shall comply with actual fire potential and environmental conditions within the relevant area, e.g.:

— optical detectors used for smouldering fires;
— combined heat and smoke detectors used for energy intensive smoke generating fires, e.g. explosive fire in high voltage switchgear;
— smoke detectors located in areas such as suspended ceilings and raised floors shall have remote indication on VDU;
— early warning sensor specified with higher sensitivity (0,4 % to 0,8 % light obscuring per metre) than norm recommendation;
— maximum distance between sensors 11 m, maximum distance from sensor to bulkhead 5.5 m and minimum 0,5 m away from outside wall or dividing partition.

14.4.5 Fire detection actions and voting

Main principles for actions initiated upon fire detection are as follows:

— ESD2 (confirmed fire in hazardous areas);
— emergency depressurisation (confirmed fire in hazardous areas);
— HVAC and fire damper shutdown except for areas subject to smoke control (confirmed fire);
— activation of Firefighting Equipment (confirmed fire);
— General Alarm (confirmed fire detection);
— Start Fire Water Pump (fire alarm in areas requiring fire water).

See Table 3 for further details.

A fire alarm shall be raised upon activation of any fire detector, and confirmed fire should be based on voting between two or more fire detectors in alarm. Confirmed fire detection and applied voting principle for automatic actions shall be defined in the Safety Strategy. Manual release of deluge from pushbutton may be regarded as confirmed fire apart from initiation of EDP, ref. Figure 4 in subclause 11.4.3.

The following voting principles should generally apply:

— Smoke (except areas such as accommodation):
    o 2ooN detectors to reach specified alarm limit when N ≥ 3

NOTE Smoke detectors are less likely to be used together with other types of fire detectors, and applications that require voting are not common. Smoke detectors covering enclosures and their HVAC inlets shall not be voted together.

— Flame:
    o 2ooN detectors to reach specified alarm limit when N ≥ 3
— Heat:
    o 1ooN detectors to reach specified alarm limit when N ≥ 2

Voting should include all fire detectors within a detection area exposed to the same fire scenario.

The number of detectors that may simultaneously be inhibited or in fault shall be assessed addressing issues such as area risk, area detection coverage, out of operation duration and compensatory measures including local area safety guards. Alternatively, when using a 2ooN configuration, an inhibited or faulty detector can be logically treated as fire alarm imposing automatic reconfiguration, e.g., 2oo3 to 1oo2.

Prerequisites and measures required in the case of detectors are inhibited or faulty shall be part of the operating instructions.

1oo1 detection principle should only be used for area monitoring and alarms.

Arrangements and actions following associated with fire detection should be implemented as described in Table 3.

Table 3 — Fire detection principles

Area/room	Type of detection (note a)	Alarm type (note b)	Automatic shutdown/ EDP	Automatic AFP	HVAC interface	Comments
Wellhead area (Naturally ventilated)	Flame Alarm	CCR	None	Start FW pump	NA	
	Flame Confirmed	CCR + GA	ESD2 + EDP + ASV + DHSV	Release deluge		
Riser area	Flame Alarm	CCR	None	Start FW pump	NA	
	Flame Confirmed	CCR + GA	ESD2 + SSIV +EDP	Release deluge		
HC process area (Naturally ventilated)	Flame Alarm	CCR	None	Start FW pump	NA	
	Flame Confirmed	CCR + GA	ESD2 + EDP	Release deluge		
HC process area (Mechanically ventilated)	Flame Alarm	CCR	None	Start FW pump	No action	
	Flame Confirmed	CCR + GA	ESD2 + EDP	Release deluge	Close damper and fans	
Utility areas (Hazardous naturally ventilated)	Flame Alarm Flame Confirmed	CCR CCR + GA	None ESD2 (A)	Start FW pump Release deluge/sprinkler	NA	(A) ESD2 if not otherwise specified in Safety Strategy
Utility areas (Non-hazardous naturally ventilated)	Flame(A) Alarm	CCR	None	Start FW pump	NA	(A) For areas without flammable liquids other detection means such as camera or smoke detection should be considered. (B) ESD2 if not otherwise specified in Safety Strategy (C) If installed.
	Flame Confirmed	CCR + GA	ESD2 (B)	Release AFP(C)		

Area/room	Type of detection (note a)	Alarm type (note b)	Automatic shutdown/ EDP	Automatic AFP	HVAC interface	Comments
Utility areas (Hazardous mechanically ventilated)	Flame Alarm	CCR	None	Start FW pump	No action	(A) ESD2 if not otherwise specified in Safety Strategy (B) AFP may be deluge, sprinkler, water mist or gaseous systems.
	Flame confirmed	CCR + GA	ESD2 (A)	Release AFP(A)/(B)	Close damper and fans	
Utility areas (Non-hazardous mechanically ventilated)	Flame(A) Alarm	CCR	None	Start FW pump	No action	(A) For areas without significant flammable liquid volumes other detection means such as camera or smoke detection should be considered. (B) If installed. AFP may be deluge, sprinkler, water mist or gaseous systems. (C) For low risk areas maintaining ventilation for active smoke control may be considered.
	Flame(A) Confirmed	CCR + GA	To be evaluated	Release AFP(B)	Close damper and fans(C)	
Drill floor/well intervention area	Flame Alarm	CCR(A)	None	Start FW pump	NA	(A) And drillers cabin and office. (B) Manual drillers shut down to be considered. (C) Deluge and/or remotely operated monitors on drill floor and in well intervention areas.
	Flame Confirmed	CCR(A) + GA	ESD2(B)	Release AFP(C)	NA	
Drillers cabin	Smoke alarm	CCR	None	None	Maintain ventilation	Internal alarm in drilling areas to be considered.
Degasser room, shale shaker room, active mud tank room	Flame Alarm	CCR	None	Start FW pump	No action	Internal alarm in drilling areas to be considered. (A) If installed.
	Flame Confirmed	CCR + GA	ESD2	Release deluge/sprinkler(A)	Close damper and fans	
Sack/bulk storage area	Heat confirmed	CCR + GA	None	Start FW pump + release deluge/ sprinkler(A)	Close damper and fans	Internal alarm in drilling areas to be considered. (A) If installed.
Mud lab	Smoke alarm	CCR	None	None	Maintain ventilation	Internal alarm in drilling areas to be considered.
Cementing unit room	Flame alarm	CCR	None	Start FW pump	No action	Internal alarm in drilling areas to be considered.

Area/room	Type of detection (note a)	Alarm type (note b)	Automatic shutdown/ EDP	Automatic AFP	HVAC interface	Comments
	Flame Confirmed	CCR + GA	None	Release AFP(A)	Close damper and fans	(A) AFP may be sprinkler, water mist or gaseous systems.
Central control room (CCR)	Early detection smoke Alarm	CCR	None	None	Maintain ventilation	Smoke detection in cabinets, roof level and voids (false ceiling/floor) to be evaluated. Isolation of power to electrical equipment to be considered.
Instrument room adjacent to CCR	Early detection smoke Alarm	CCR	None	None	Maintain ventilation	Smoke detection in cabinets, roof level and voids (false ceiling/floor) to be evaluated. Isolation of power to electrical equipment to be considered.
Central tele equipment room	Early detection smoke Alarm	CCR	None	None	Maintain ventilation	Smoke detection in cabinets, roof level and voids (false ceiling/floor) to be evaluated. Isolation of power to electrical equipment to be considered.
Local equipment room (LER)	Early detection smoke Alarm	CCR	None	None	Maintain ventilation	Smoke detection in cabinets, roof level and voids (false ceiling/floor) to be evaluated. Isolation of power to electrical equipment to be considered.
Turbine hall (Non-hazardous mechanically ventilated) (Applicable for other engine rooms)	Flame(A) Alarm	CCR	None	Start FW pump	No action	For areas without significant flammable liquid volumes, e.g. low risk other detection means such as camera or smoke detection should be considered. (A) Consider smoke detection in relation to possible electrical equipment/switch boards. (B) Direct shut down action to be initiated to avoid shut down due to cascade effects, e.g. ESD1. (C) If installed. AFP may be deluge, sprinkler or water mist.
	Flame(A) Confirmed	CCR + GA	Turbine SD(B)	Release AFP(C)	Close damper and fans	
Turbine hall (Hazardous	Flame Alarm	CCR	None	Start FW pump	No action	(A) AFP may be deluge, sprinkler or water mist.

Area/room	Type of detection (note a)	Alarm type (note b)	Automatic shutdown/ EDP	Automatic AFP	HVAC interface	Comments
mechanically ventilated)	Flame Confirmed	CCR + GA	ESD2	Release AFP(A)	Close damper and fans	
Turbine hood	Flame alarm	CCR	None	None	No action	(A) Flame and/or heat. (B) AFP may be water mist or gaseous systems.
	Flame confirmed	CCR	Unit shut down	Release AFP(B)	Close damper and fans	
	Heat confirmed (A)	CCR	Unit shut down	Release AFP(B)	Close damper and fans	
Switch board and electrical room (including "dry" transformers)	Early detection smoke alarm(A)	CCR	None	None	Maintain ventilation	(A) Detectors to be suitable for smoke particle size, i.e. high-energy fires with "small" particles and smouldering fires with "large" particles. Smoke in cabinets, roof level and voids (false ceiling/floor) to be evaluated. (B) Manual or automatic to be decided.
	Smoke confirmed	CCR	Electrical power switch off (B)	None	Maintain ventilation	
Transformer (oil filled) rooms	Smoke (A) / Flame Alarm	CCR	None	None	Maintain ventilation	(A) Detectors to be suitable for smoke particle size, i.e. high-energy fires with "small" particles and smouldering fires with "large" particles. (B) AFP may be water mist.
	Smoke / Flame confirmed	CCR	Electrical power switch off	Release AFP(B)	Maintain ventilation	
Battery room	Early detection smoke Alarm	CCR	None(A)	None	Maintain ventilation	(A) Shut down boost charging.
Fire water pump room and emergency generator room with diesel engine	Flame Alarm	CCR	None	None	No action	(A) Automatic shutdown of emergency generator provided not required for critical drilling/well service activities. (B) Close diesel supply to day tank. (C) Consider manual shutdown of/ closure of fuel supply to fire water pump engine, ref. 21.4.3.
	Flame confirmed	CCR	None (A)/(B)/(C)	Release AFP	Close damper and fans	

Area/room	Type of detection (note a)	Alarm type (note b)	Automatic shutdown/ EDP	Automatic AFP	HVAC interface	Comments
Air compressor	Flame, smoke or heat[A] Alarm	CCR	Unit shut down upon confirmed detection	None	Maintain ventilation[A]	(A) Detection and protection to be evaluated based on location, type of prime mover, etc.
Mechanical workshop	Smoke or heat Alarm	CCR	None	Sprinkler	Maintain ventilation	
Instrument workshop	Smoke or heat	CCR	None	Sprinkler	Maintain ventilation	
Paint storage	Flame or heat Alarm	CCR	None	Sprinkler	Close damper and fans	
HVAC inlet LQ/CCR	Smoke Alarm	CCR	None	None	None	
	Smoke Alarm	CCR	None	None	Close damper and fans	
LQ (cabins, rooms, corridors)	Smoke Alarm	CCR	None[D]	None[B]	Maintain ventilation/ active smoke control[C]	(A) Voting may be across fire cells, e.g. two cabins and between cabin and corridor. (B) Provided amount of flammable material is sufficiently low, ref.20.4.6. (C) See NORSOK H-003. (D) Fire doors kept open with magnetic devices should be closed on single smoke in indoor areas
	Smoke 2ooN[A]	CCR + GA	None	None[B]	Maintain ventilation/ active smoke control[C]	
LQ (common areas)	Smoke Alarm	CCR	None[C]	None[A]	Maintain ventilation/ active smoke control[B]	(A) Provided amount of flammable material is sufficiently low ref.20.4.6. (B) See NORSOK H-003. (C) Fire doors kept open with magnetic devices should be closed on single smoke in indoor areas
Vent extract from galley	Heat Alarm and Confirmed	CCR	None	Release AFP[A]	Manual shutdown	(A) AFP may be foam, water mist or gaseous systems. Manual, release shall be possible in the fire scenario.
General galley area	Heat Alarm	CCR	None	None	Maintain ventilation	

Area/room	Type of detection (note a)	Alarm type (note b)	Automatic shutdown/ EDP	Automatic AFP	HVAC interface	Comments
Crane engine room	Alarm(A)	CCR + Crane cabin	None	None	None	(A) Smoke for electrical and flame for diesel engines (B) Applies to diesel driven engines if installed according to Safety Strategy.
	Confirmed (A)	CCR + Crane cabin	Shutdown crane	Release AFP (B)	Close damper and fans	
Hangar	Smoke or flame Alarm	CCR	None	To be considered	None	
Turret area	Flame Alarm	CCR	None	Start FW pump	Maintain ventilation(C)	(A) SSIV if installed. Including wing and master on subsea template upon confirmed fire. (B) Emergency depressurisation (EDP) if not otherwise specified in Safety Strategy (C) For mechanically ventilated areas
	Flame Confirmed	CCR + GA	ESD2 +EDP(B) +SSIV(A)	Release deluge	Maintain ventilation(C)	

Notes

a Number of detectors above alarm limit to initiate actions may depend of voting principle.

b Alarms presented in CCR shall also be presented as a not area specific general fire alarm in other strategic location such as crane cabin, drillers cabin and office and jack-ups.

14.4.6 Fire detection alarms

F&G system status shall be continuously available in CCR, and the system shall raise alarms in CCR for operator awareness or action, considering:

- detection of fire or activation of Manual Call Point;
- failure to execute action upon demand;
- function (sensor, logic solver, final element) defect or failure.

Status/alarm parameters for each individual fire detector shall be identifiable in the CCR.

An F&G alarm condition shall be alerted in other strategic locations, and announcement shall be made by available means of and at typical locations such as:

- drillers cabin and office;
- crane cabin;
- jack-ups.

For alarms from detectors located in drilling areas the information presented in CCR should be mirrored in drillers cabin and office.

Loss of communication with or defects of the fire detection central shall give alarm in CCR.

14.4.7 Response time

Response time of the fire detection function shall be considered and documented in the Safety Strategy.

Standardised response times shall be defined for groups of similar F&G functions except when individual F&G functions require exceptional response time to meet intended functionality.

There shall normally be no predefined delays of fire detection.

14.4.8 Logic solver

The logic solver (firmware, as standard manufacturer provision) shall be in compliance with IEC 61508/ IEC 61511 and Norwegian Oil and Gas Association GL070. Reference is made to13.4.9.

14.5 Survivability requirements

The logic solver and essential utilities shall be located as safe as possible in the accommodation or utility area. Reference is made to 6.4.1. With respect to retrofits and extensions, the, logic solver and essential utilities shall not be located less safe than existing logic solvers, i.e. accommodation or utility area.

Cabling of fire detectors shall be routed such that the likelihood of damage due to external accidental loads and simultaneous loss of detection in several detection areas is minimized. Fire resistant cables shall be applied.

15 Ignition source control (ISC)

15.1 Role

The ignition probability of flammable liquids and explosive gas atmospheres shall be minimized by rendering the sources of ignition harmless or reducing the likelihood of occurrence of effective ignition sources.

15.2 Interfaces

ISC automatic functions are normally realized through other systems such as the ESD system, and ISC interfaces are incorporated within the following safety systems and barriers:

- Layout (Clause 6);
- Emergency shutdown (ESD) (Clause 11);
- Gas detection (Clause 12);
- Fire detection (Clause 14);
- Human – machine interface (HMI) for CCR systems (Clause 16);
- Natural ventilation and heating, ventilation and air condition (HVAC) (Clause 17);
- Public address (PA), alarm and emergency communication (Clause 18);
- Emergency power and lighting (Clause 19).

In addition, ISC functions will affect (directly or indirectly) other equipment and operations such as cranes, well control, marine systems and position keeping.

15.3 Required utilities

No particular utilities are required for the ISC function.

15.4 Functional requirements

15.4.1 General

The technical requirements of subclause 15.4.2 to 15.4.4 below apply to ISC including different types of measures to reduce ignition probability of an explosive atmosphere occurring in both hazardous and non-hazardous areas.

Area classification shall be established in accordance with IEC 61892-7 and IEC 60079-10-1 or EI 15.

A systematic mapping of all potential ignition sources both electrical and non-electrical, shall be performed, including risk assessment and implementation of necessary risk reduction measures in order to reduce ignition probability of an explosive atmosphere occurring in both hazardous and non-hazardous areas. Reference is made to EN 1127-1. The equipment shall be categorized as non-essential, essential and safety critical equipment respectively.

Equipment shall be constructed, installed, operated and maintained in accordance with ATEX requirements (see FOR-1996-12-09-1242 [6]) and standards IEC 61892 and ISO 80079-36. The equipment shall be certified by an accredited test institution according to, as a minimum, the lowest explosion protection level accepted for use in the particular zone by the reference standard.

For Zone 2 areas (ATEX category 3), non-certified equipment that is constructed according to recognized manufacturing standards may be used. This is provided that in normal operation the equipment does not generate surface temperatures equal to or greater than the ignition temperature of the gas in question, nor produce arcs or sparks capable of causing an ignition of the gas. The foregoing is contingent upon the application of relevant standards such as IEC 60079-14 Annex I and EN 1127-1 and including an assessment of potential area risk. The equipment in question shall, as a minimum, be supported by a declaration of conformity which is verified by an independent documented review. However, this approach is an option only where certified equipment is not commercially available.

Equipment (electrical and non-electrical) installed in non-hazardous naturally ventilated areas and at ventilation inlets (e.g. fan, damper and heaters) and outlets shall, as a minimum, comply with a level of explosion protection according to hazardous area zone 2 requirements. If not available, the equipment shall be disconnected in accordance with the principles below.

Possible technical malfunction of Ex equipment shall be taken into account. To reduce explosion risk as far as practical, also Ex-equipment should be electrically isolated on relevant gas detection. The intent of this requirement may be met by measures such as disconnection / isolation of equipment compliant with 15.4.2 or 15.4.3 at an earliest possible stage of a hazard.

Combustion type of equipment that may cause an ignition hazard due to flames, hot gases or hot particles shall not be installed in hazardous areas. Irrespective of location, diesel engines shall be provided with flame arrestor in the combustion inlet, overspeed protection (close combustion air damper and fuel valve) and spark arrestor. Flame arrestor may be omitted for non-essential equipment located in utility area and tripped on single gas anywhere on the installation. Additional measures to consider are isolation of non-Ex protected components and maintaining hot surfaces below auto-ignition temperature (ref. subclause 15.4.5). If located in a mechanically ventilated room, the combustion air shall be taken from non-hazardous area outside the room and minimum 3 m from any zone 2 boundaries to reduce ignition probability.

Electrical isolation shall be defined as disconnection of the power feeder cable at the distribution boards. For simplification and reliability of the isolation function, the numbers of breakers to be tripped should be minimized, e.g. trip the inlet feeder.

Use of temporary equipment connected to EX socket outlets which is not subject to trip on low gas alarm/ESD 2, shall have appropriate marking to ensure that equipment is disconnected according to the principles in this clause.

Boost charging of batteries shall be stopped automatically upon loss of ventilation in the battery room or detection of hydrogen gas in the room. Hydrogen detection can be omitted if it can be documented that sufficient quantities of hydrogen cannot be generated.

15.4.2 Non-essential equipment (electrical and non-electrical)

15.4.2.1 General

This category consists of:

— non-ex equipment (group 1);
— ex equipment.

All group1 equipment located in hazardous and non-hazardous naturally ventilated areas shall be disconnected on single low gas alarm anywhere on the installation and on ESD2 initiation. This also includes welding sockets and sockets for non-essential temporary equipment. EX outlets that support temporary equipment which is not subject to trip on low gas alarm/ESD 2, shall have appropriate marking and use shall be governed by the permit to work system.

Non-essential Ex-equipment may also be disconnected on single gas detection, but shall as a minimum be disconnected on confirmed gas detection and ESD2 initiation.

15.4.2.2 Hazardous areas:

Ex equipment shall be used in accordance with the general principles in subclause 15.4.1.

15.4.2.3 Non-hazardous naturally ventilated areas:

Equipment shall minimum be suitable for Zone 2 in accordance with the general principles in subclause 15.4.1.

15.4.2.4 Non-hazardous mechanically ventilated areas:

Non-explosion protected equipment (Group 1), both electrical and non-electrical, installed inside non-hazardous, mechanically ventilated rooms shall be automatically tripped and electrically isolated as follows:

— On single gas detection in ventilation intake. However, if the room contains Group 2 equipment, Group 1 equipment can be disconnected on confirmed detection. If the room may be exposed to gas leaks, e.g. due to doors associated with workshops, the equipment shall be disconnected on single low gas alarm anywhere on the installation and/or ESD2.
— By defined ESD level (manually or automatically initiated, see 11.4.3 Figure 4).

15.4.3 Essential equipment (electrical and non-electrical)

15.4.3.1 General

This category will consist of:

- non-ex equipment (group 2);
- ex equipment.

15.4.3.2 Hazardous areas:

Ex equipment shall be used in accordance with the general principles in subclause 15.4.1.

Essential Ex equipment should be tripped on ESD 2 in order to reduce the ignition probability. If not tripped on ESD 2, it should be tripped on confirmed gas detection. Particular consideration should be made to possible negative consequences for equipment essential for drilling / well related activities.

15.4.3.3 Non-hazardous naturally ventilated areas:

Equipment shall minimum be suitable for Zone 2 in accordance with the general principles in subclause 15.4.1. If not available, such equipment shall be tripped on ESD2.

15.4.3.4 Non-hazardous mechanically ventilated areas

Non-explosion protected equipment (Group 2), both electrical and non-electrical, installed inside non-hazardous, mechanically ventilated rooms shall be automatically tripped and electrically isolated as follows:

- on confirmed gas detection in ventilation intake;
- by defined ESD level (manually or automatically initiated, see 11.4.3 Figure 4).

If equipment (inclusive Group 1) is installed inside rooms which are located inside or within 3 m of a hazardous area, the following additional requirements apply (note also 17.4.4 for general requirements to HVAC system):

- Rooms provided with air lock:
    - o Immediate disconnection of all ignition sources on confirmed gas in air lock. Note; all equipment within air lock shall be in accordance with the area classification outside.
    - o Delayed disconnection of all ignition sources on coincident loss of ventilation and single low gas alarm in adjacent areas.
- Rooms without air lock:
    - o Immediate disconnection on coincident loss of ventilation and single low gas alarm in adjacent area.
    - o Alarm to CCR upon loss of ventilation for immediate restoration of ventilation. If restoration cannot be realised within reasonable time, instruction and means shall be available for disconnection of ignition sources in the room.
- Instructions to restart power supply in room following loss of ventilation/electrical disconnection shall be available, e.g. secure that room does not contain any explosive gas atmosphere.

PCS nodes may be isolated in accordance with the principles of safety critical equipment when the PCS nodes are located together with Group 3 equipment, typically ESD, PSD and F&G nodes. All associated active field equipment, e.g. sensors and actuators, shall be minimum suitable for Zone 2 including those installed inside non-hazardous rooms.

15.4.4 Safety critical equipment (electrical and non-electrical)

15.4.4.1 General

This category will consist of:

- non-ex equipment (group 3);
- ex equipment.

Safety critical equipment not shutdown by an APS (after initiation plus time delay) shall irrespective of location comply with hazardous area zone 1 requirement if located outdoors. This includes escape lighting (also muster, lifeboat station and lifeboat drop zone) and navigation aids (sea and air) including battery/UPS supply. However, centrally located batteries/UPS power supplies and distribution system located in accordance with principles in 6.4.1 may comply with area zone 2 requirement. Alternatively, to zone 2 requirement for the UPS, is to arrange the two separate systems, A and B, such that the need for ignition source isolation of both systems is minimised. Consideration will then have to be made to the ventilation damper setup for the escape lighting battery rooms, individual dampers, to minimize probability of gas ingress.

The emergency generator shall be tripped immediately upon APS (no time delay).

Equipment supplied from UPS shall meet the following:

15.4.4.2 Hazardous area:

Equipment located in such areas shall meet relevant zone requirements and shall be tripped after time delayed APS.

15.4.4.3 Non-hazardous naturally ventilated areas:

Equipment located in such areas shall meet minimum zone 2 and shall be tripped after time delayed APS. Non-explosion protected safety critical equipment such as radars or antennas may need special consideration with respect to ignition source disconnection, e.g. based on local gas detection.

15.4.4.4 Non-hazardous mechanically ventilated areas:

Non-explosion protected electrical equipment (safety critical category – group 3) shall be installed in enclosed mechanically ventilated rooms. Such equipment should be located in accommodation or in utility area close to the accommodation area in order to minimize gas exposure during an accidental event. Typical examples are:

- F&G systems, except field equipment;
- PA/emergency communication systems, except field equipment;
- UPS;
- emergency switchgear;
- equipment in CCR required for the control of the APS situation (ESD/PSD).

All active field equipment such as detectors and loudspeakers shall be minimum suitable for Zone 2 including those installed inside non-hazardous rooms and areas such as LQ. Special provisions, e.g. gas detection and means for isolating ignition sources, may be required for ballast water and position keeping control (e.g. antennas).

Means for shutdown of safety critical equipment shall be provided as follows:

- by activation of APS with a predefined time delay;

— instantaneous disconnection by manual activation from manned area/room, i.e. if gas is detected inside rooms containing safety critical equipment, or by gas detection in surrounding areas.

Fire water pump arrangement including diesel engines, electrical generator and motors, shall:

— meet requirements for diesel engines given in 15.4.1,
— be automatically tripped only by overspeed (close damper and fuel supply valve) if not in test mode, and
— be stopped manually (local) only (shall not be automatically stopped by APS).

Emergency generator shall:

— meet requirements for diesel engines given in 15.4.1,
— be automatically tripped by overspeed (close overspeed damper and fuel supply valve),
— be automatically tripped by confirmed gas detection in combustion air inlet and close inlet F&G damper,
— be automatically tripped by confirmed gas detection in compartment ventilation inlet unless emergency generator cooling is self-sustained,
— be stopped manually (local and remote), and
— be stopped by APS.

Equipment required to secure a well in an emergency situation shall be defined for drilling and well intervention operations shall be minimum suitable for zone 2 or stricter in accordance with the area classification. Applicable equipment includes:

— BOP system;
— draw works;
— personnel winch;
— temporary well service equipment (safety critical);
— well kill equipment.

Well kill equipment (i.e. to ensure pumping and fluid capacity as stated in subclause 26.4) shall be suitable for operation in a hazardous area zone 2. This includes the cement unit and the transfer pumps of cement/kill mud, unless kill fluid can be supplied with gravity feed or the following is valid:

— The transfer pumps is dependent on an emergency power generator (with air intakes) located as safe as possible in the accommodation or utility area.
— Shut-down of the emergency generator due to gas exposure, impose that all personnel onboard should prepare for evacuation in accordance with installation specific barrier strategy or emergency preparedness plan.

Exhaust pipes from prime movers of emergency equipment shall neither emit sparks nor have a surface temperature which exceeds the ignition temperature of the gas mixture.

15.4.5 Hot surfaces

The surface temperature of equipment, piping and exhaust ducts etc. that can be exposed to leaks from flammable mediums shall not exceed minimum auto-ignition temperatures (AIT) for the hydrocarbon mixture in question. Insulating material shall, if applied, cover the entire hot surface. Necessary means of protection shall be provided to avoid that flammable medium can penetrate into the insulating material.

In open air where the gas can move freely the ignition temperature of gas can be higher than the auto ignition temperature (AIT). In such cases a higher maximum surface temperature may be accepted.

15.4.6 Static electricity

Objects that may collect an electric charge shall be connected to earth or bonded.

Equipment and material that may collect electric charge such as fibre-reinforced plastics shall conform to ISO 80079-36 or other relevant standard.

Objects shall be protected against electrical charges due to physical contact and then separation, or due to rapid flow of gases or liquids. Particular precautions may be required if non-conductive materials *(including surface coating)* are applied, i.e. connection to earth may not be sufficient. Static electrical sparks may be a problem in situations such as the following:

— fuelling operations;
— filling of containers, tanks and pressure vessels;
— high fluid velocities (high water sprays, gas jets);
— shot blasting;
— steam cleaning;
— vacuuming in tanks;
— shuttle tanker loading.

15.4.7 Cranes

All equipment within the crane which is or may become an ignition source (see 15.4.1 and ventilation shall be disconnected / shutdown automatically upon single low gas alarm anywhere on the installation when crane is not in use.

Shutdown of the ventilation can be realized through the local PLS as ignition sources will be disconnected via the SAS system. Dampers shall be closed when the ventilation is not running.

Cranes located in non-hazardous areas shall as a minimum comply with the following:

— External equipment shall be suitable for use in hazardous area zone 2. Crane boom movement may require zone 1 equipment.
— Internal/local equipment, if operative after crane shutdown and disconnection shall be suitable for use in hazardous area zone 2. Particular requirements may apply for equipment with internal battery supply.
— Diesel powered cranes shall be fitted with flame arrestor in the combustion inlet. Spark arrestor shall be fitted in the exhaust outlet, but flame arrestor is not required.

When the crane is in use the following requirements shall be complied with:

— Upon single gas alarm signal at any location on installation, the ventilation/dampers shall shutdown, and the crane operator shall immediately take the crane into a safe position, secure the load and initiate a manual shutdown that includes disconnection of ignition sources. Same actions shall apply on occurrence of an ESD situation.
— Electrical powered cranes shall upon confirmed gas detection in crane ventilation air intake initiate an automatic shutdown of crane (without time delay).
— Diesel powered cranes shall on confirmed gas detection in either the neighbouring process areas of the crane or the ventilation or combustion air intake, initiate an automatic shutdown of crane (without time delay) in order to ensure an efficient disconnection of ignitions sources.

Adequate means for crane operator warning and consistent operating procedures shall be available.

15.4.8 Anchor handling equipment

Anchor handling winches should be located in non-hazardous area. A protection system to prevent sparks from anchor handling operations during an emergency situation to ignite a hydrocarbon release should be considered, e.g. partial enclosure, fire water coverage spraying (deluge) or other relevant measures.

15.4.9 Temporary equipment

The platform shall be designed such that temporary equipment is shutdown according to the relevant ignition source groups and shall be performed by the platform ISC system as a minimum. All safety critical equipment and equipment in naturally ventilated areas shall be suitable for minimum zone 2.

Fire and gas detection and other alarms related to temporary equipment shall be given to CCR. Relevant actions shall be initiated. . Reference is made to NORSOK Z-015 Temporary Equipment.

15.4.10 Ignition source control independence and reliability

ISC shall be independent of power distribution control system and PSD.

The breakers should be fail-safe. If shunt trip principle is applied, a safety level similar to above shall be achieved considering design requirements such as dual control voltage, separate mini circuit breaker for shunt trip coil, redundant shunt trip coil and alarm on control voltage failure.

The electrical ignition sources, that are simultaneously isolated, should be fed by the same bus bar.

Switching devices used to isolate electrical ignition sources shall be provided with a safety margin versus maximum design current in order to ensure adequate reliability and avoid malfunction.

15.5 Survivability requirements

No special survivability requirements are defined for the ISC function with respect to fires and explosions.

16 Human – machine interface (HMI) for CCR systems

16.1 Role

HMI in CCR shall provide system information presentation and means for operator interactions. HMI provides the physical interface between systems and facility operator, maintenance technicians and other personnel operating and monitoring the facility, e.g. operator stations, large screen displays, and critical action panels present in control rooms, virtual operator stations and local control panels.

16.2 Interfaces

The HMI shall present safety related information for all systems, including:

- Process safety system (Clause 10);
- Emergency shutdown (ESD) (Clause 11);
- Emergency Depressurisation and Flare/Vent System (Clause 12);
- Gas detection (Clause 13);
- Fire detection (Clause 14);
- Ignition source control (ISC) (Clause 15);
- Natural ventilation and heating, ventilation and air condition (HVAC) (Clause 17);

- Public address (PA), alarm and emergency communication (Clause 18);
- Emergency power and lighting (Clause 19);
- Active Fire protection (Clause 21);
- Marine systems and position keeping (Clause 24);
- Avoidance of Vessel Collisions (Clause 25);
- Well integrity (Clause 26).

Interfaces to other facilities may be required, e.g. subsea facilities, leak detection, neighbouring and connected installations.

16.3 Required Utilities

Human Machine Interface performance is dependent on uninterruptible power supply, i.e. to ensure that the necessary safety related functionality is sustained during the period of time required to control any emergencies.

16.4 Functional requirements

16.4.1 General requirements for human-machine interface (HMI)

The HMI means shall include a main operating interface in CCR and in addition a CAP (a simplified safety matrix panel) allowing manual activation of critical safety functions.

The HMI in CCR shall provide the means for operator awareness and actions and be suitable during emergency situations.

The HMI shall be designed to prevent inadvertent operations due to operator misperception and unintended actions.

EN 62682 and EEMUA 191 should be used as basis for design of alarm functions.

16.4.2 Human-machine interface (HMI) status and alarm

The HMI facilities shall present system information in CCR such as:

- ESD hierarchy overview including status of ESD and EDP valves;
- PSD hierarchy overview;
- F&G overview, e.g. per main fire area;
- F&G geographical arrangement of detectors e.g. per detection area;
- Safety related HVAC functions, e.g. overpressure status.

The CCR shall include VDUs with presentation of safety system information as its primary function. Number of VDUs shall depend on the result of the function and work task analysis.

The HMI facilities shall include detailed safety system information such as input and output status, alarms, status of inhibit, override and suppression and system fault indication.

Failure to execute safety functions on demand shall initiate an alarm in CCR.

Temporary equipment should be integrated within the CCR HMI.

16.4.3 Human-machine interface (HMI) control functions

The HMI facilities at CCR shall include the following safety control functions:

- initiate ESD level;
- initiate PSD level;
- PSD level reset;
- inhibit and override;
- initiate manual depressuring;
- ESD level reset;
- F&G reset (e.g., per detection area);
- F&G common reset of inhibits and overrides (e.g., per detection area);
- ESD common reset of inhibits and overrides;
- manual control of ignition sources, according to ISC groups;
- fire water / foam pump start;
- firefighting release.

16.4.4 General requirements for critical action panel (CAP)

The Critical Action Panel (CAP) shall be independent of the visual display units and its associated data networks. The CAP functions may utilize network between SIS logic solvers provided it is dedicated and independent for SIS purposes only. Independent in this term means not to be influenced by non-SIS network, components or equipment.

The CAP shall encompass functions sufficient, in the absence of the main operator interface facilities, to bring the installation into a safe state.

With respect to failure of programmable logic, reference is made to subclause 11.4.1. This function may be realized outside of the CAP.

16.4.5 Critical action panel (CAP) status and alarm

The CAP shall include the following status capabilities:

- ESD level activated;
- start of FW/foam pumps called for;
- FW/foam pump running;
- FW/foam ring main pressure;
- active fire protection release activation status;
- active inhibition/override – ESD;
- active inhibition/override - F&G.

The CAP shall present the following alarms:

- FW/foam pumps unavailable warning;
- common fire alarm, (upon confirmed fire detection or release of fire protection means of the relevant area);
- common manual call point alarm, (upon any manual call point of the relevant area in alarm state);
- upon confirmed gas detection of the relevant area. When both flammable and toxic gas detection are provided, the alarm types shall be presented individually.

16.4.6 Critical action panel (CAP) control functions

The CAP shall include the following control functions:

- manual start of FW pumps;
- release of automatic firefighting systems;

— activation of ESD shutdown levels;
— activation of instant APS (ignition source isolation);
— activation of emergency depressurisation;
— F&G common reset of inhibits and overrides;
— ESD common reset of inhibits and overrides.

Additional requirements relevant for floating installations arranged for operation from CCR:

— emergency stop ballast pumps and closure of valves;
— closure of watertight doors.

16.5 Survivability requirements

There are no special survivability requirements.

17 Natural ventilation and heating, ventilation and air conditioning (HVAC)

17.1 Role

Natural ventilation shall

— dilute gas concentrations and reduce the size of flammable gas clouds;
— dilute harmful concentrations of smoke or toxic gases;
— ensure acceptable equipment environment.

HVAC shall, with respect to accidental events:

— provide pressurisation of rooms to prevent ingress of smoke or gas;
— provide smoke ventilation for internal fire conditions in low risk areas;
— ensure acceptable equipment environment;
— dilute and remove concentrations of flammable gas, smoke and toxic gases.

17.2 Interfaces

The HVAC system has interfaces with the following safety systems and barriers:

— Layout (Clause 6);
— Emergency shutdown (ESD) (Clause 11);
— Gas detection (Clause 13);
— Fire detection (Clause 14);
— Ignition source control (ISC) (Clause 15).

17.3 Required utilities

HVAC system performance is dependent on

— emergency power supply to maintain ventilation should main electrical power supply fail;
— instrument air supply (local accumulators, if necessary).

17.4 Functional requirements

Detailed design and fabrication requirements are found in NORSOK H-003 and ISO 15138. For analyser houses, reference is made to IEC 61285 – Industrial process control – Safety of analyser houses [3].

17.4.1 Natural ventilation in hazardous areas

Open hazardous areas with natural ventilation is the preferred solution for offshore installations.

Location and sizes for ventilation openings and louvers shall be optimised to maximize ventilation rates. Consideration shall in addition be made to maintain acceptable working environment /weather protection for personnel and equipment.

Ventilation rates in hazardous areas shall as a minimum be 12 AC/h for 95 % of the time. Stagnant zones should be avoided.

Natural ventilation shall be documented by studies and/or model testing. Thermal effects may be considered when calculating natural ventilation rates for hazardous areas.

Equipment enclosures, eg. for noise suppression, shall be subject to special consideration. See subclauses 6.4.1 and 17.4.6.

17.4.2 Mechanical ventilation in hazardous areas

A ventilation rate to ensure minimum 12 AC/h shall be provided. Stagnant zones should be avoided. Ventilation shall be maintained in the event of a gas leak.

The ventilation system shall ensure high availability, e.g., by using redundant fans.

Alarm shall be given in CCR upon loss of ventilation in individual areas.

Adequate ventilation shall be monitored by fan operation or low air flow in the ventilation duct to the individual areas. Time delayed ESD2 upon loss of mechanical ventilation may be considered.

Lower ventilation rates may be acceptable when possible leakages can be sufficiently diluted as documented in specific studies. When calculating the gas release rate resulting from an oil leak, the evaporation effect should be taken into account, and not only the flash release.

17.4.3 Mechanical ventilation in non-hazardous areas with internal leakage sources

Ventilation shall be maintained in the event of an internal gas leak. To maintain non-hazardous status ventilation rates shall correspond to the relevant area classification calculations in areas with an internal leakage source, e.g. turbine enclosures, battery rooms, gas analyser houses.

The ventilation system shall ensure high availability, e.g., using redundant fans of 2x100 % or 3x50 % capacity, duty/standby.

Turbine enclosures shall have a fixed over- or underpressure dependent on location (underpressure when located in an unclassified area and overpressure when located in a hazardous area).

Equipment not suitable for zone 2 in areas with high ventilation shall automatically be disconnected upon loss of ventilation. Monitoring and control to be realised as a SIF, e.g., by F&G system or as realised otherwise through ATEX certification.

Alarm shall be given in CCR upon low air flow monitored by adequate fan operation or low air flow measured in main ventilation duct.

17.4.4 Mechanical ventilation in non-hazardous areas with “openings” towards hazardous area

There shall be a reliable overpressure (should be minimum 50 Pa) in non-hazardous rooms (safe by ventilation) with doors or openings giving direct access less than 3 m away from hazardous area.

For arrangement and protection of non-hazardous rooms with access to hazardous areas, see IEC 61892-7. The self-closing door shall open into the non-hazardous room.

Alarm shall be given in CCR upon loss of ventilation. Alarm shall be given in CCR upon direct measurement of 25 Pa overpressure relative to surrounding classified areas. Alternatively, alarm shall be given both upon loss of airflow, corresponding to 25 Pa, and time delayed indication of open door. The flow or pressure differential signal shall be routed to the safety related part of SAS, initiating loss of ventilation alarm and if required activating automatic disconnection of ignition sources, see subclause 15.4.3.

The air change rate shall be minimum 5 AC/h with redundant fans.

17.4.5 Mechanical ventilation in areas non-hazardous by location

There shall be a positive airflow into mechanical ventilated areas non-hazardous by location. The ventilation should be balanced to an equivalent overpressure of min 50 Pa.

Upon loss of ventilation an alarm shall be given in CCR.

Special consideration can be applicable for ventilation of cranes. See 15.4.7.

17.4.6 Ventilation inlets and outlets

All ventilation inlets shall be located in non-hazardous areas, as far as practicable away from possible hydrocarbon leakage sources, and minimum 3 m from any zone 2 boundaries to reduce ignition probability.

Equipment in ventilation inlets and outlets shall be provided in accordance with clause 15 in order to ensure that such equipment does not become an ignition source during accidental events. Measures shall be taken, to avoid accumulation of ice and snow. Studies should be made to locate main ventilation inlets to minimize exposure to smoke and gas leaks.

The distance between air inlet and outlet from hazardous areas shall be such that:

- Gas from the outlet cannot enter the air inlet.
- Smoke from the outlet cannot enter the air inlet during active smoke control.

Considerations should be made when locating LQ ventilation outlets to prevent exposure of helicopter deck from exhaust smoke during active smoke control.

Ventilation systems serving hazardous and non-hazardous areas shall be independent of each other. All ventilation outlets from non-hazardous areas shall be into non-hazardous areas.

The inlet ducts should normally not pass through a hazardous area. Where this cannot be avoided, the supply fan unit should be located in the non-hazardous area (i.e at the inlet side) in order to secure that the pressure in the ducts supplying the room or equipment enclosure is higher than the external pressure, or adequate precautions should be taken to ensure that the ducts are free from leaks.

An exception may be made for ventilation intakes and outlets to smaller enclosures for process equipment that is located within a classified hazardous area. For these enclosures, it may be acceptable to take air from areas with the same classification, i.e. freestanding smaller noise-reducing enclosure for process equipment, analyser house, etc. see 6.4.1.

17.4.7 Dampers

Dampers shall provide quick, reliable and effective means to prevent ingress or spreading of gas or smoke.

A fire damper and smoke ventilation strategy shall be established for operation of dampers for both high and low risk areas, see NORSOK H-003.

Gas tight dampers shall be installed in HVAC inlets and outlets.

If gas and/or smoke are detected at ventilation air inlets, the ventilation fan in question shall be stopped, all inlet and outlet dampers shall be closed and the heating element shut off via F&G or ESD.

In rooms where ignition sources are kept energised, hydrocarbon gas detection in the ventilation inlets shall ensure that a possible gas cloud is detected and dampers closed before a dangerous concentration can reach the ventilated areas.

The total response time for closing of HVAC inlet dampers shall not exceed 6 s, i.e. from gas detector reaches alarm limit.

Dampers and fans shall be interlocked to avoid abnormal pressure configurations.

Ventilation (supply air and air outlet) shall continue upon internal fire in low risk areas.

Fire-dampers shall be closed automatically by signal from the F&G-system and by “fusible link” where specified. Confirmed closed fire damper position shall be monitored from the CCR.

17.4.8 Survivability requirements

The system and components shall be designed and protected to ensure that it will remain operative during incidents where the system has a role or form a safety barrier.

The need for ventilation in rooms containing safety critical equipment (e.g. UPS, emergency communication rooms, CCR) shall be determined, including considerations of aspects such as temperature rise in case of HVAC trip.

HVAC system having a safety role shall be fed by emergency power to cater for loss of main power supply. The safety role typically includes:

- the need to maintain overpressure;
- general ventilation of safety critical rooms, e.g. emergency communication room and CCR;
- temperature control of safety critical equipment e.g., UPS, emergency communication equipment and CCR equipment. Dedicated room cooling units may have to be used to ensure adequate temperature control upon loss of ventilation to the room.

18 Public address (PA), alarm and emergency communication

18.1 Role

PAGA (Public Address & General Alarm system) Alarm and communication systems for use in emergency situations (until evacuation of the installation) shall:

- alert, inform and guide personnel as quickly as possible in the event of a hazardous or emergency situation;
- provide two-way communication of information regarding emergency events to the Control Room (CCR) or Emergency Control Centre (ECC);
- provide communication of requirements for emergency action to all personnel, and provide two-way communication between the emergency controller and the emergency response team;
- allow the co-ordination of rescue, recovery and emergency assistance.

The below sub-clauses give the principle safety requirements and guidance. Reference is made to NORSOK T-001 and NORSOK T-100 for further details.

18.2 Interfaces

PAGA, alarm and communication systems for use in emergency communication have interface with the following safety system/functions:

- Layout (Clause 6);
- Emergency shut down (ESD) (Clause 11);
- Gas detection (Clause 13);
- Fire detection (Clause 14);
- Human – machine interface (HMI) for CCR systems (Clause 16);
- Emergency power and lighting (Clause 19);
- Escape and evacuation (Clause 22);
- Rescue and Safety Equipment (Clause 23).

Interfaces to other facilities may be required, e.g. neighbouring and connected installations.

18.3 Required utilities

The PAGA, alarm and emergency communication systems depend on emergency power systems (dedicated telecom battery supplies and/or installation UPS system). Batteries may be applied for satellite telephones and hand-held equipment provided arrangements for charging are adequately administered, e.g. preventive maintenance routines.

18.4 Functional requirements

18.4.1 PAGA, loudspeakers, alarm horns/sirens, bells and alarm lights

Layout and location of loudspeakers, horns/ sirens and bells shall be reviewed during design and verified during start-up and operation. This also applies to alarm/ flashing lights particularly with respect to areas with high noise level and possible toxic gas. PAGA voice intelligibility levels shall be reviewed and verified.

Alarm voice communication shall be heard in a surrounding noise level up to and including 85 dBA. Flashing light shall be installed in areas with noise levels exceeding 85 dBA. In emergency stations, the alarm voice communication level shall be approximately 10 dB above normal surrounding noise level including noise from flare to avoid affecting speech communication for the emergency team.

The system shall be designed to give appropriate access priorities.

18.4.2 Alarm signals

The alarm signals shall be in accordance with Table 4.

Table 4 — Alarm signals

Alarm type	Signal	Indicates
Prepare to abandon alarm (evacuation alarm)	Continuous audible signal of variable frequency. Yellow flashing light or rotating visual lamp	Prepare to abandon installation in accordance with station bill. Manual initiation.
General alarm (muster alarm in ISO 13702)	Intermittent audible signal of constant frequency. (1 s on, 1 s off). Yellow flashing or rotating visual lamp	Fire or gas leak or other serious situations. Personnel to muster in accordance with station bill
Toxic gas alarm [a]	Intermittent audible signal (0,1 s on, 0,1 s off). Red flashing or rotating visual lamp	Toxic gas, e.g. H_2S
Local alarm in rooms protected by CO_2 or other gases with lethal concentrations	Local red light at entrance. Local high frequency tone in room/area and in adjacent room/area providing access.	Gas released [b]
Inert gas protected rooms/areas	Local red light at entrance	Gas released [c]
Alert	Two level audible tone on PA system	Important announcement to follow on PA system

Notes

a At small local occurrences, local alarm may suffice.
b Pre-warning signal shall be used inside and at doors to rooms protected by gasses that could be lethal.
c Pre warning before release to be considered in inert gas protected rooms.

18.4.3 Internal emergency communication

The installation shall have necessary equipment for internal emergency communication so that emergency response teams can communicate with each other and with the CCR or the emergency preparedness management.

A telephone system shall be installed, so that personnel can alert the CCR. The number and location of telephone should be limited to strategic locations considering, layout, MCP and radio communication.

CCR operators shall be able to communicate with operators anywhere on the installation.

Two-way portable UHF radios shall be provided and used by the emergency response team. The system shall be able to handle emergency communication and the system shall be designed to give appropriate access priorities.

A “channel plan” and instructions/ practice for use of channels shall be established.

At least two different communication facilities shall be available at the muster stations. The main facilities shall be hand portable radios and telephones. A microphone station to access PA system shall be located nearby the APS switch.

The crane operator shall be able to communicate with the CCR, ships and operators on deck and have the sufficient equipment in crane cabin (e.g. maritime VHF, UHF radio, PA loudspeaker and telephone).

Installation equipment for internal emergency communication shall be powered from dedicated battery supplies or powered from installation UPS system.

Drillers intercom function shall provide two-way communication in drilling areas between the driller and drilling personnel. This may be driller intercom system or UHF radio system.

Drillers shall be able to communicate with the CCR according to emergency preparedness plans.

18.4.4 External emergency communication

The installation shall have necessary equipment for communications with external emergency response resources.

The communication systems shall allow communication with installations, helicopters, lifeboats, MOB boats, life rafts, vessels and shore. The system will include:

— radio (GMDSS);
— maritime VHF;
— aeronautical VHF radio;
— telephones (ordinary and with priority access and/ or hot-line function).

Equipment for external communication shall be powered from dedicated battery supplies and/or powered from installation UPS system.

18.4.5 Telecommunication system in an emergency situation

Telecommunication systems required to remain active in an emergency situation shall not create additional hazards.

Antennas located within non-hazardous, naturally ventilated areas shall be provided in accordance with the following requirements;

— explosion protection (electrical connections) suitable for use in zone 2, and
— (1) the maximum transmission power is 6 W or less, or (2) the antenna is located in accordance with a safe distance requirement to avoid induction and sparks in adjacent structures, e.g., for guidance see CENELEC CLC/TR 50427.

18.4.6 Automatic personnel registration system

Automatic Personnel Registration Systems can be installed on installations as a means to comply with the time requirement for POB control to give quick personnel overview and personnel registration in an emergency situation.

When used the automatic personnel registration system stations shall be installed at mustering stations, including mustering stations for emergency teams. It shall be possible to obtain personnel control by use of automatic personnel registration system in an emergency situation, also after activation of APS. This implies that all parts of the system required to obtain personnel control has to be in operation during timer based APS.

18.5 Survivability requirements

The central equipment room and batteries shall be located in accordance with requirements in 5.4.1 regarding location of safety systems.

The PAGA system shall be divided into two independent systems (A system and B system) and power supplies for the respective systems should be installed in separate rooms. If the A and B systems are installed in the same room, necessary mitigations shall be implemented to minimize risk that a single incident affecting one system will have impact on both systems. Such mitigation could be physical separation of each system to the extent possible and independent power isolation of each system.

Cabling of field equipment shall be routed such that the likelihood of damage due to external accidental loads and simultaneous loss of field equipment in several areas is minimized. Fire resistant cables shall be applied.

19 Emergency power and lighting

19.1 Role

The purpose of the emergency power system is to provide the following:

- source of electrical power intended to supply the emergency system in the event of loss / shutdown of the supply from the main source of electrical power, normally on ESD1;
- emergency electrical power supply for a specific period of time (timer based APS countdown) for systems required being in operation during or after a major hazard incident;
- sufficient lighting for evacuation and escape in an emergency situation.

19.2 Interfaces

Emergency power interfaces the following safety systems and barriers:

- Emergency shut down (ESD) (Clause 11);
- Gas detection (Clause 13);
- Fire detection (Clause 14);
- Ignition source control (ISC) (Clause 15);
- Human – machine interface (HMI) for CCR systems (Clause 16);
- Natural ventilation and heating, ventilation and air condition (HVAC) (Clause 17);
- Public address (PA), alarm and emergency communication (Clause 18);
- Escape and evacuation (Clause 22);
- Marine systems and position keeping (Clause 24);
- Well integrity (Clause 26).

19.3 Required utilities

Performance of systems for emergency power supply shall be independent on other utility system utilities. An exception can be made for water cooled emergency generators where the cooling water may be supplied from the sea water pumps powered by the emergency generator, and with backup water supply from the fire water system.

19.4 Functional requirements

19.4.1 Emergency power supply

The emergency power supply shall consist of a combination of UPS and a diesel engine driven generator. For fixed offshore units, a power cable from another independent unit may be considered as alternative to a diesel driven engine.

19.4.2 Uninterruptible power supply (UPS)

UPS shall have an operating capacity to supply the required emergency power to safety critical equipment as specified in accordance with the installation's Safety Strategy. The available capacity shall, at any time when needed, ensure that safety systems will be kept operational during periods of accidental events, evacuation and escape. Power capacity shall be in accordance with ISO 13702 Table C.1. For units where emergency consumption is limited, the UPS system can be used as source for the entire emergency power requirement, typically a NNMI (minimum capacity of 4 h).

Shut down of ventilation in UPS room and/or emergency switchboard room shall not cause temperatures above vulnerable components' tolerance within the required operating time of the relevant safety critical equipment. Room temperature may exceed the maximum allowed continuous ambient temperature for a short time period, provided that the safety functions are retained and life time consequence is evaluated and found acceptable.

It shall be possible to isolate UPS for ignition source control.

The UPS-system shall be monitored and raise critical status alarms in CCR.

19.4.3 Emergency power generator

The emergency power generator shall have a capacity of minimum 18 h at full load.

Upon zero voltage on the emergency switchboard, supply from the emergency power generator shall be established within 45 s.

The transition from main power to emergency power shall not cause operational problems for the emergency power users.

Emergency power distribution shall be designed to allow maintenance and functional testing on the system without production shut down.

For emergency generator(s) the following shall apply:

- The emergency generator system shall meet requirements stated in clause 15 Ignition Source Control such as flame arrestor in combustion inlet, and being tripped in accordance with requirements stated in subclause 15.4.4.
- It shall be possible to isolate the fuel supply to each diesel driven generator from outside of the generator room. The valve shall be secured in open position.
- The emergency generator system shall be self-contained. All necessary utilities shall fulfil the emergency system's autonomy requirements and be available for a blackstart situation if required.
- Each engine should have two independent starting systems, which do not need to be functionally different. Each system shall have a minimum capacity for six start attempts of minimum 5 s or longer if required by supplier.
- Air inlet shall be located such that exposure to possible gas leaks is minimized. The combustion air inlet shall be separated from the ventilation air inlet of the room in order to avoid vacuum in the room.

Exhaust pipes from prime movers of emergency equipment shall with respect to ignition source control comply with clause 15.4.5 Hot Surfaces.

The emergency power system shall be monitored and raise critical status alarms in CCR. Equipment modus (emergency/ test) shall be displayed. Start of the emergency generator shall be possible from CCR.

19.4.4 Emergency power consumers

It shall be identified which systems that are required to be operable during an emergency situation. These systems shall be supplied from emergency power.

The emergency power shall be limited to supply of emergency power to equipment and systems having a function during an emergency situation. Typically, the following equipment shall have emergency power supply:

- SAS;
- HVAC system(s) for:
  - areas containing group 3 equipment;
  - muster area(s);
  - LQ in order to manage the emergency situation and normalization after an incident.
- charging of UPS (including other battery chargers servicing emergency equipment if required in an ESD1 situation);
- emergency and escape lighting;
- auxiliary equipment (e.g. ventilation fans) required for run down of turbine generators after a shut down due to internal fuel gas leak;
- electrical deck cranes (power capacity required for operation of one crane);
- drilling and well related equipment for securing the well as specified in NORSOK D-001;
- purging systems;
- FW and foam systems (when emergency generators supply FW/foam pumps, the requirements for FW pump prime mover apply to emergency generators);
- other firefighting systems as required by safety strategy;
- helicopter landing and warning lights;
- lifeboats;
- PA, alarm and emergency communication systems;
- navigation aids;
- bilge and ballast pump(s) including power source for valve actuation;
- instrument air compressor;
- medical equipment;
- automatic Personnel Registration Systems.

19.4.5 Emergency and escape lighting

Emergency lighting is supplied from the emergency generator whilst escape lighting (including muster, lifeboat station and lifeboat / escape chute drop zone illumination) is supplied by battery power (internal or two UPS systems).

The operating capacity of escape lighting supply shall be sustained during the functional lifetime allowing a minimum of 60 minutes of illumination in accordance with EN1838, unless otherwise required in the Safety Strategy.

Emergency and escape lighting shall be provided in order to allow escape during emergency situations and provide sufficient lighting in areas which are manned during such events, e.g. accommodation spaces, control rooms, work locations, along all escape routes, on helideck and lifeboat stations.

Escape lighting levels shall be minimum 15 lux at high risk task areas and at emergency, muster and embarkation areas and 1 lux on escape routes. For other escape lighting reference is made to EN 1838.

In rooms which require manning in emergency situation the emergency lighting shall be defined through working environment studies.

Emergency exit signs shall either have an illuminated (local batteries only) or fluorescent type of design.

19.5 Survivability requirements

The emergency power systems shall be available outside initial accidental area located and/or protected against design accidental loads to ensure continuous operation. To achieve this emergency power and equipment rooms shall be located in accordance with requirements in 6.4.1. Emergency power generation shall be located in non-hazardous areas with a minimum exposure due to fire or explosion hazards. Emergency power switch boards and generator shall be separately located from main power.

The UPS system shall consist of two independent systems (A and B) and located in dedicated rooms to increase robustness both with respect to possible electrical fires or gas ingress.

If escape light fixtures without internal batteries are used, alternate fixtures shall be supplied from two different UPS systems and two well separated cable routes. The vulnerability of centralized UPS should be evaluated with respect to all faults and situations that can result in loss of all escape lighting, e.g. instant APS. Reference is made to 15.4.4 for zone classification and ignition source requirements.

20 Passive fire protection (PFP)

20.1 Role

Passive fire protection (PFP) shall ensure that relevant structures, piping and equipment components have adequate fire resistance with regard to load bearing properties, integrity and insulation properties during a design fire, and contribute in reducing the consequences in general.

20.2 Interfaces

No specific interfaces, but the extent and requirement for passive fire protection is dependent on the design and performance of the following safety systems and barriers:

- Layout (Clause 6);
- Structural integrity (Clause 7);
- Containment (Clause 8);
- Open drain (Clause 9);
- Emergency shut down (ESD) (Clause 11);
- Emergency Depressurisation and Flare/Vent System (Clause 12);
- Active Fire protection (Clause 21);
- Escape and Evacuation (Clause 22).

20.3 Required utilities

Passive fire protection performance is not dependent on any specific utility.

20.4 Functional requirements

20.4.1 Fire divisions

Fire divisions shall as a minimum separate the main areas, unless it is proven that separation by distance is sufficient. Fire division between drilling and wellhead area may be omitted if escape from drilling is ensured and activation and survivability of BOP is secured. However, well hatches shall be secured and withstand design explosion loads.

The extension of a fire division should be assessed with respect to exposure of personnel and critical equipment in neighbouring areas.

Areas with important safety functions and areas with a high fire risk shall be separated from the surroundings by adequate fire divisions. CCR, FW pump systems, LER/LIR with safety functions, emergency power supply with related distribution equipment and fuel tank shall be protected from the surroundings by minimum Class A-60 fire divisions. Cement units and associated equipment required for emergency operation (kill function) shall be protected from fire events to which they can be exposed.

Fire divisions between fires areas exposed to HC fires shall remain intact with regard to the thermal loads and their duration to which they are subjected in the event of a design fire and shall be rated according to H-class. LER/LIRs without a safety function can be separated with Class A-0 even if exposed to HC fires. Fire divisions shall withstand the design accidental load.

Generators (including prime mover), transformers, LER/LIR without safety function, rooms for ventilation equipment and equipment used for storage of flammable commodities or easily ignitable material shall be separated from the surroundings with at least Class A-0 fire divisions.

Penetrations, e.g. for ventilation ducts, piping, drain boxes, cables, beams as well as windows and doors in fire divisions, shall not reduce the fire and explosion integrity of such divisions. Penetrations do not need to be certified for fire durations exceeding two hours. Penetrations should be minimized in fire divisions between main areas. Doors in fire divisions shall be of a self-closing type.

For fire divisions without PFP, the unexposed side can become very hot in a fire situation. It shall be documented that the high radiation load that may result from this is acceptable.

If passive fire protection is used on only one side of a fire division, and that division is exposed from the unprotected side, the PFP will cause the temperature to become significantly higher than for an unprotected division. This means that PFP on only one side shall be avoided if there is a fire risk from both sides.

For horizontal divisions, PFP on the upper side may lead to practical problems. PFP on such divisions shall not be implemented without assessing the total risk impact. If PFP is needed for maintaining the integrity of such divisions, it may be sufficient to use PFP only on the girder system.

20.4.2 Load bearing structures

Load bearing structures/important elements shall have adequate fire protection to prevent unacceptable deformations or collapse during a design fire, reference is made to subclause 7.5.

Fire protection materials used in outdoor areas should be suitable for the environmental conditions it may exposed to.

If the contact area including the cross-sectional area inside hollow sections of an unprotected structural element is equal or larger than 1000 mm^2, or for several attachments with at total contact area of 1000 mm^2 per square meter of fireproofed (main) structural elements, the need for coatback shall be evaluated. It is not expected that the coatback distance in any case needs to be more than 150 mm.

20.4.3 Vessels and piping

Pressurized vessels, process equipment and piping including supports shall have adequate fire resistance to prevent unacceptable ruptures (see subclause 5.6.3.4). For such equipment and piping consideration shall be given to deformations / movement of deck, walls and structural elements caused by explosion and fire loads.

Analysis of rupture of process equipment and objects when exposed to fire due to overpressure and material weakening should be performed as specified in "Guidelines for protection of pressurised systems exposed to fire", Report 27.101.166/R1 Scandpower Risk Management AS [2] or similar methods.

Adequate protection of process equipment, piping and instrument tubing in a fire situation can be obtained by either one of or a combination of following measures: emergency depressurisation, increased wall thickness, material selection and passive fire protection.

Passive fire protection of process vessels and piping shall as far as possible be avoided, due to several negative aspects regarding safety such as corrosion problems, increased dimensions on equipment (increasing explosion pressures and drag loads) and maintenance issues.

The bolts and nuts of flanges are weak points, and the need for passive fire protection on these to avoid unacceptable ruptures, shall be evaluated. Bolts on flanges on liquid nozzles from large vessels, more than 4 tons of hydrocarbon liquid, should be protected. The protection of these shall be kept as inspection and maintenance friendly as possible.

Reference is made to subclauses 8.4.4 and 8.5 for fire protection to prevent escalation to risers.

20.4.4 Safety critical equipment

Equipment intended to function during a fire shall have adequate fire protection. This includes consideration of possible deflections of supporting structures.

Requirements for fire protection and the use of PFP shall be assessed in relation to safety criticality and the fire risk in the area. This applies to protection of equipment such as:

- safety critical cables, junction boxes and trays (to equipment which is to operate after ignited leaks, e.g. ESD system, fire detection of adjacent areas, FW pumps);
- safety critical pipe supports (such as active fire protection, flare/vent lines);
- safety critical ducting (needed during a fire);
- ESD and EDP valves and activation system;
- flare-/vent lines (to be considered according to subclause 20.4.3);
- dry fire water piping exposed to fire, ref. subclause 21.5.

20.4.5 Non-combustible materials

Materials used in areas that may be exposed to a hydrocarbon fire shall be non-combustible. If it is justified from safety point of view to make use of materials that do not meet the requirements to non-combustibility, such materials shall have limited flame-spread properties, low smoke development, heat generation and toxicity of gas emitted in the event of a fire. Documentation shall be available to support the basis for the decision regarding selection of materials. Reference is made to RISE Fire Research AS (previous SINTEF NBL) report A17 20307:1 [5] for guidance.

20.4.6 Living quarter and office/accommodation spaces

LQs with integrated offices etc shall be designed and protected to ensure that the safety critical functions can be maintained during design accidental events.

Outer surfaces of LQs and accommodation buildings shall be fitted with fire divisions of minimum A-60. If the surfaces can be exposed to a hydrocarbon fire a minimum class H-60 is required (from process or wellhead areas).

Choice of materials and interior design of the office/accommodation spaces shall be based on fire risk. If surface treatment of paint or other coating is used, the properties of the product with regard to flame-spread shall be considered. A corresponding evaluation shall also be carried out with regard to textiles. These evaluations are particularly important for LQ without water sprinkler protection. All materials shall have limited flame-spread properties, low smoke development, heat generation and toxicity of gas emitted in the event of a fire. Documentation shall be available to support the basis for the decision regarding selection of materials. Reference is made to RISE Fire Research AS (previous SINTEF NBL) report A17 20307:1 [5] for guidance.

Fire integrity of bulkheads and decks shall comply with clause 9 of the MODU Code. Where the MODU Code specifies steel bulkheads internally this shall be understood as A-0 divisions.

Additional principles and requirements relating to LQ are included in NORSOK C-001 and NORSOK C-002.

Penetrations through bulkheads and decks, e.g. pipes, tubing and cables shall be sealed with an approved fire protective method e.g. tested in accordance with division classifications and IMO FTP Code.

20.5 Survivability requirements

The passive fire protection system shall resist the design accidental loads (explosion) to which they may be exposed. Jet fire resistance should be documented by testing in accordance with ISO 22899.

21 Active fire protection

21.1 Role

The main purpose of the firefighting systems is to provide quick and reliable means for firefighting in addition to cooling of equipment and structures. Firefighting systems may be used to reduce explosion loads.

21.2 Interfaces

The firefighting systems has interfaces with the following other safety systems and barriers:

- Layout (Clause 6);
- Structural integrity (Clause 7);
- Containment (Clause 8);
- Open drain (Clause 9);
- Emergency shut down (ESD) (Clause 11);
- Gas detection (Clause 13);
- Fire detection (Clause 14);
- Human – machine interface (HMI) for CCR systems (Clause 16);
- Passive fire protection (PFP) (Clause 20);

- Escape and evacuation (Clause 22);
- Well integrity (Clause 26).

21.3 Required utilities

The performance of the firefighting systems typically depends on the:

- emergency power system (for electrical foam- and fire water pump systems without dedicated diesel drivers, i.e. power from emergency generator, other installation or shore);
- instrument air system (back-up instrument air for local accumulators, if necessary).

21.4 Functional requirements

21.4.1 General

Fixed firefighting systems shall be installed in areas representing a major fire risk, and particularly cover equipment containing significant quantities of hydrocarbons or other flammable materials.

The discharge effects from a fixed fire-fighting system shall be considered in selection of the system for particular areas (for example, the effects of water on electrical equipment).

21.4.2 Fire water supply system

The fire water system capacity shall be sufficient at any time to cover the area with the largest FW demand plus the adjacent fire area with largest demand, plus two hydrants and, when applicable, fire water / emergency generator cooling. This capacity shall be achieved with one pump out of operation. This will ensure sufficient capacity in the event that a pump fails to start and in addition that the fire water is released in the largest neighbouring fire area. Consideration shall also be made in the design for degradation of the pump performance to ensure sufficient pump system capacity at all times. The capacity requirement premises an optimized fire detection avoiding release in neighbouring areas, ref. 14.4.2.

The FW ring main shall be dimensioned for the demand of the largest fire area with one section of the ring main closed and for any FW pump configuration running, and for the demand of both the largest fire area and the largest neighbouring area without any sections closed off.

The FW ring main shall be water filled and pressurised in the standby mode. The pressure source, typically a jockey pump, shall have the capacity of flow through frost protection bleed lines plus two hydrant hoses. Consideration should be made to include capacity to helideck in order to meet the response time requirement, ref. subclause 21.4.9.

The FW ring main sectioning valves shall be installed ensuring supply to consumers from two different sections allowing maintenance of the firefighting systems. The valves shall be easily accessible, car sealed open and clearly marked.

If needed the FW ring main shall be equipped with two points (minimum 6 in) for connection to external water supply for commissioning. SOLAS international shore couplings should be used.

The magnitude and effects of pressure surges shall be minimised. Measures such as water filled FW pump risers, air relief valve and vacuum breakers shall be considered.

Screen at seawater inlet and strainer shall be installed upstream of ring main. The need for strainer between suction screen and pump shall be considered. The inlet arrangement shall be designed to ensure that the FW pumps also can function at 150 % of rated capacity.

Normally a system to inhibit marine growth is required, e.g. by injection of hypochlorite.

The system design shall comply with the field specific frost protection requirements, i.e. minimum water flow and/or heat tracing.

Carbon steel and galvanised steel shall not be used in the FW ring main system. For material selection, see Norwegian Oil and Gas Association Guideline No. 075.

For general piping requirements, see NORSOK L-001, NORSOK L-002 and NORSOK P-002.

The water supply system and level control arrangement in water filled structures shall meet the required reliability.

21.4.3 Fire water pump arrangement

The basis for prime mover and FW pump system design shall be NFPA 20. Fire water driver/pump systems shall be self-contained and be used for fire water purpose only. It shall be possible to start the FW system even if no other systems on the platform are operational.

Pumps powered through cable(s) from an external source shall be subject to special consideration for aspects such as reliability, configuration, ignition source control and survivability.

There shall be a starting sequence logic for the start-up of the FW pumps in accordance with NFPA 20. Duration of each start attempt does not have to comply with NFPA 20. This includes

— individual FW pump engine sequence logic (repetitive start attempts);
— start of duty pumps on single low gas detection when used for explosion mitigation;
— start of duty pumps on fire detection, see Table 3;
— start of FW pump upon loss of ring main system pressure. There shall be a minimum of two pressure transmitters in the FW ring main providing the low-pressure start signal to the FW pump system. The transmitters shall be located in different sections of the ring main;
— manual start of FW pumps from CCR and FW pump room.

Manual stop of the FW pump engines shall only be possible local to the engines. If flooding of e.g. buoyancy volumes on floating installations or shafts on fixed installations is a hazard, other means for stopping the engines may be evaluated.

Each engine should have two independent starting systems, which do not need to be functionally different. Each system shall have a minimum capacity for six start attempts of minimum 5 s or longer if required by supplier.

Start batteries for the FW pump engines and batteries for the diesel control system shall be located within the same room as the engines. The batteries shall be easily accessible and located above floor level.

A manual isolation switch/valve (car sealed) between the starter motor and the start battery/air bank shall be provided.

The FW pump engine start batteries shall be charged by the FW engine generator while running and in addition charged from main power supply.

Compressed air accumulator capacity and/or battery capacity for FW pump engines shall be in accordance with NFPA 20.

The fuel supply to fire water pump drivers shall be sufficient for a minimum of 18 hours operation at full load.

The fuel supply shut off valve to the diesel engine shall be operable from outside the room. The valve shall be secured in open position.

The FW pump engine cooling water and/or oil preheat function for diesel engines shall be in accordance with NFPA 20 requirements and supplier's recommendations.

It shall be possible to operate FW pump engines when ventilation to the room has been shut off.

In case of gas detection in air inlet to the fire water pump engine room, the room ventilation shall be automatically shut down, dampers closed and the cooling air shall be taken from the engine room itself. Cooling of the fire water pump engine room shall be by an air/fire water-cooling unit powered directly from the fire water pump engine. The combustion air inlet shall be separated from the ventilation air inlet of the room.

The combustion air inlet shall be equipped with a flame arrestor and an overspeed protection system. Automatic stop of FW pump engine driven FW pumps shall only be permitted due to overspeeding. Gas detectors in combustion air inlet are not required due to installation of flame arrestors.

Consideration shall be made to 100-year wave condition to ensure sufficient pump suction pressure on pump duty point.

A test valve for the FW pumps shall be installed to enable checking of the FW pump curve up to 150 % of design flow rate. The valve shall be able to regulate from zero flow up to 150 % capacity and shall be of low noise design. It shall be possible to measure capacities and pressures.

If the connection to CCR is lost, the fire-water pumps shall start automatically.

Fire detection at the fire water pump shall not stop the pump or inhibit the start of the fire water pump driver.

21.4.4 Deluge system

There shall be a quick and reliable fire water supply to applicable deluge/water spray systems with a rate sufficient to cover the minimum demand for the applicable area and at pressures within the nozzle pressure range requirement. The deluge system shall provide adequate coverage for the relevant fire and explosion scenarios, with respect to both volume and area and equipment coverage.

Where applicable, provide firefighting foam concentration according to the specification for the applicable foam type, ref. 21.4.6.

NFPA 13, NFPA 15 and NFPA 16 should be used as guideline for design of deluge systems.

A fire area may be covered by several deluge valves. All deluge valves covering a fire area should be released when fire is detected anywhere in the fire area. Very large fire areas, e.g. FPSO tank deck, may be excepted based on special considerations. This applies also for manual release of any deluge valve covering the fire area.

The FW system shall be designed and calibrated such that most remote deluge nozzles will receive water not later than 30 s after a confirmed fire signal has been given. This includes pump start and run-up time.

The minimum required densities of FW shall be

— 10 (l/min)/m^2 for process areas and equipment surfaces (including pumps and compressors). Not required with dedicated surface protection if vessel is insulated;
— 20 (l/min)/m^2 wellhead (including riser balconies, manifolds located on FPSO turrets etc.):

- with respect to tank decks on FPSOs, the application rate shall be minimum 6 l/min/m² of foam solution. Deluge systems to be provided to cover shadow areas due to blockage and monitor reach. Reference is made to 6.4.8 with respect to process deck requirement and requirement for ESDVs on liquid outlets from large vessels, ref. 11.4.2.

For other areas the protection should be in accordance the table in subclause 14.4.5. The application rates should be in accordance with ISO 13702 as relevant.

The deluge system piping and nozzle layout shall be such that it gives sufficient coverage (ref. application rates above) also accounting for obstructions and ensure overlap in the horizontal direction. Wind aspects shall be considered including nozzle location in deluge area periphery. High velocity deluge nozzles should be used for area coverage on fully open process and drilling areas as well as in areas where deluge is used for explosion suppression.

Deluge shall be automatically released upon confirmed gas detection in areas where effective for explosion mitigation.

It shall be possible to manually activate deluge valve locally, from CCR and via push buttons located along the escape routes outside the fire area itself.

Manual activation of deluge systems via pushbuttons shall trigger alarm in CCR, ESD2 and general alarm. Pressure transmitters fitted downstream deluge valves shall to provide confirmed flow signal to CCR, general alarm and initiate FW pump start. It is acceptable that this signal does not initiate ESD 2 automatically.

The information required at strategic locations (e.g., CCR, driller cabin) shall be considered in the design of the AFP system.

Deluge valves should be of a type which regulates the downstream pressure and which is not sensitive to pressure surges in the ring main. Deluge valve size should not exceed 10” in order to comply with response time requirement and avoid water hammer effects.

Deluge valve arrangement with interfaces shall be such that it can be function tested without release of water into the fire area, i.e. block valve installed on the downstream side of the deluge valve and provision of separate test line. For elastomeric deluge valves a full capacity test line shall be included. Isolation valves shall also be included upstream of the deluge valve skids. Manual valves in deluge skid control circuits shall be secured in correct position e.g. by car seal.

Deluge valves shall be provided with manual bypass including flow restriction to match flow through the valve. The deluge valve arrangement including bypass line shall be supplied from two different sections of the ring main ensuring FW supply also during maintenance situations.

Deluge valves shall fail in last position upon loss of signal from F&G logic which also provides deluge valve fault alarm in CCR. Upon loss of instrument air supply the deluge valve shall fail in open position.

For manned installations resetting of deluge, monitor and sprinkler control valves shall normally only be possible local to the valves.

Where applicable deluge valve stations shall have freeze protection systems according to project specifications. Piping downstream deluge and monitor skids shall be self-draining in accordance with Norwegian Oil and Gas Association GL075.

The need for strainers in deluge system shall be considered. Deluge nozzles should be without individual strainers.

Fixed or oscillating monitors may be used as an alternative to deluge coverage for the turret protection if adequate performance can be achieved.

Carbon steel and galvanised steel shall not be used in the deluge system. For material selection, see Norwegian Oil and Gas Association Guideline No. 075.

21.4.5 Sprinkler system

The sprinkler system shall provide adequate coverage for the relevant fire scenarios, with respect to area coverage on horizontal and vertical surfaces. NFPA 13 should be used as guideline for design of sprinkler systems. The protection areas should be in accordance with the table in subclause 14.4.5. The application rates should be in accordance with ISO 13702 as relevant.

Automatic sprinkler systems shall be connected to a pressurized water supply so that the system is capable of immediate operation and no action by personnel is necessary. The sprinkler control valve shall be a quick opening type valve.

It shall be possible to fully test the sprinkler system function by use of a suitably located test sprinkler and using fresh water. There should be a test and flush connection at the far end of the piping system and at the sprinkler valve(s). The connections shall be easy accessible from deck level and have a drain box located below the connection. Sprinkler valves arrangement shall be fitted with full capacity manual by-pass for the sprinkler valve to cater for sprinkler valve maintenance.

There shall be a pressure sensor downstream of sprinkler valve which provides sprinkler release feedback to CCR.

Carbon steel and galvanised steel shall not be used in the sprinkler system. For material selection, see Norwegian Oil and Gas Association Guideline No. 075.

21.4.6 Foam system

Foam supply shall be provided for all areas where hydrocarbon pool fires are likely to occur. The foam concentrate selected shall be suitable for use on the flammable liquids present in the area, in the expected environmental conditions and if appropriate through non-aspirating nozzles. Foam concentrate shall be compatible with sea water. The need for alcohol resistant foam protection shall be assessed in areas with large alcohol storage vessels.

For deluge systems with foam additives, simultaneous activation of firefighting foam and water shall be automatic for confirmed fire detection. If fire water is released upon confirmed gas detection, then foam should not be released. For release from CCR it shall be possible to select between water release only and water release together with firefighting foam. It shall be possible to stop the release of foam from CCR. For manual activation of deluge from push button locally, the release of foam should be automatic.

All foam systems shall provide a quick and reliable supply of firefighting foams to applicable deluge and other water/foam based firefighting equipment with a rate and pressure sufficient to provide the correct foam concentration.

The design of foam systems shall be based on recognized international standard, e.g. NFPA 11 and 16.

Foam pumps shall be equipped with minimum flow control and pump testing facilities. The foam pumps should be shutdown upon LALL in foam tank to prevent overheating.

To ensure positive injection of concentrates, the discharge pressure ratings of pumps at the design discharge capacity shall be in excess of the maximum water pressure available under any condition at the point of concentration injection. The pressure in the foam concentration ring main shall be presented in CCR. A system shall be installed which is capable of providing sufficient foam system standby pressure.

Foam injector, ejector or proportioner shall provide a pre-determined foam concentration corresponding to the applied foam concentrate type. Foam shall be injected downstream deluge and monitor control valves to prevent ingress of foam into the FW ring main system.

Block valves in the foam supply lines and foam ring main shall be secured open, e.g. by car sealing.

For centralised foam systems, the total foam concentrate capacity shall be sufficient for minimum 30 min simultaneously supply to the largest fire area and the largest neighbouring area requiring foam.

For local foam systems the total foam concentrate capacity in each local holding tank shall be sufficient for 30 min supply to the applicable deluge valve skid.

Foam release valves shall fail in last position upon loss of signal from F&G logic supplied with diagnostics alarm to CCR.

To avoid foaming and contamination, it shall be possible to drain the foam concentrate tanks into transport tanks.

21.4.7 Manual firefighting

21.4.7.1 General

Manual firefighting appliances, such as monitors, hydrants, hose reels, dry chemical equipment, dual agent hose reels and mobile and portable extinguishers shall provide a reliable and effective tool for firefighting by manual intervention.

The facility shall be equipped with sufficient manual firefighting appliances to ensure effective firefighting of fires in the beginning stages and to prevent escalation.

Working pressure and flow shall be in accordance with supplier's equipment data sheet and equipment performance requirements and where applicable; in accordance with criteria for manual operation.

The arrangement of the isolation valves shall be such that not more than 50 % of the water hoses and hydrants for one area is affected if one section of the fire water ring main is unavailable.

The equipment shall have adequate frost protection in accordance with project specifications, e.g. heat tracing and/or drain possibilities as applicable.

Monitors, hydrants, hose reels and dual agent hose reels intended for protection in one particular area shall not be fed from the same ring main section as for the deluge/sprinkler system for that same area.

It shall be possible to reach any area where a fire may occur on the installation with at least two water jets from monitors or hose reels. Areas with deluge are excepted, but should have provisions for fire water either from hydrants or hose reels.

Electrical disconnection of equipment with voltage rating of 440V and higher in electrical equipment room shall be possible from outside the room, (e.g. from CCR) removing energy sources, in order to facilitate personnel entry for manual firefighting. The electrical disconnection may be realised together with disconnection of lower voltage supplies used for removing energy sources in connection with early detection.

21.4.7.2 Hydrants and hose reels

The design of Standpipe and Hose System shall be based on recognized international standards e.g.: NFPA 14.

In addition, the following shall apply:

— The maximum reaction force on the hose nozzle where only one person is supposed to operate the hose shall not be more than 250 N.

Hoses, nozzles, valve keys, etc. should be stored adjacent to hydrants. Couplings shall be standard throughout the installation. Nozzles shall be of robust construction, easy to operate and made of materials suitable for the intended duty.

Hydrants/hose reels shall be located in weather resistant cabinets. The cabinets shall be fitted with heating elements and should contain:

— 4 off 1½” fire hoses of an approved fire-resistant type, 15 m in length with instantaneous connection joints to hydrants and nozzles;
— two water spray nozzles with pistol grip, with easy water pattern adjusts from straight stream to wide fog. Capacity minimum 20 m^3/h with 2 hoses in series and a nozzle hooked up. Two sets of connecting key.

All hydrants shall have two outlets fitted with 1½” quick connections of a standard approved type throughout all areas.

Non-collapsible hose reels should have 25 m hose. In living quarters provided with capacity of minimum 8 m^3/h, and in all other areas provided with minimum capacity of 15 m^3/h.

21.4.8 Monitors

Activation of a fire monitor shall be from a location at sufficient distance protected from the fire.

It should be possible to operate remote controlled monitors both from central control room and from a local control panel at a sufficient distance from the fire. CCTV coverage for remote operation shall be considered.

Arrangement of monitors which can be remotely actuated, shall be selected to minimise risk of personnel injury. Local manual override controls shall be provided.

Monitors shall have sufficient freedom of travel in the horizontal and the vertical plane to be able to cover the specified area during specified wind conditions. It shall be possible to lock the monitor in any position. Automatic monitor valves shall fail in last position upon loss of signal from F&G logic and/or signal from remote control panel.

Monitor nozzles shall be of the constant flow type, i.e. the flow shall be the same at both fog and at jet spray setting. The spray angle shall be easily adjusted when in operation and return to maximum spray angle after use.

When monitors are used instead of deluge systems the requirements for deluge systems shall apply. Where there are dry pipe sections between the monitor and the monitor valve, the possibility for detrimental pressure peaks (water hammering) shall be considered.

Auto drain valve facilities shall be provided for each fire water monitor.

Areas with well intervention shall be covered by fire water monitors. At least 2 monitors shall be available to account for high wind. The release function shall be located along escape ways from the area protected from the fire.

21.4.9 Helideck firefighting system

The helicopter deck shall be equipped with adequate fire protection equipment and with sufficient drainage capacity to enable escape and firefighting in the event of helideck related fires. This shall be achieved by complying with the following sub-requirements:

- a DIFFS shall be the preferred means of active fire protection and shall comply with:
    - the water-foam mix shall be applied with a minimum spray height corresponding to the top of the applicable helicopter bodies in calm conditions. This to ensure a safety margin with respect to safe escape, including windy conditions;
    - the water density shall be minimum 10 (l/min)/m^2 for the helideck;
    - full water and foam supply shall be available within 20 s from time of activation;
    - the storage capacity of the foam concentrate holding tanks shall be sufficient for 10 min of full discharge of the DIFFS;
    - activation and deactivation shall be from both local and remote protected position.
- foam monitors (not required when DIFFS is installed) shall, when installed, comply with:
    - one monitor to be located at each of the three access ways;
    - the foam monitor firefighting system shall be capable of delivering foam on the helicopter deck maximum 20 s after activation at a rate of minimum 1 500 l/min per monitor at 0,7 MPa (7 barg) nozzle pressure;
    - foam monitors shall always start automatically with water spray in the fog position;
    - it shall be possible to start, stop and control monitors from both local and remote protected position;
    - the storage capacity of the foam concentrate holding tanks shall be sufficient for 10 min of full discharge;
    - risk assessment justifying the use of monitors as an alternative to DIFFS.
- the equipment shall have adequate frost protection, i.e. by heat tracing and/or drain;
- on NNMI the firefighting system on helideck, if installed, shall allow for remote operation and control;
- FW and spilled fuel shall be drained in a safe and controlled manner through a dedicated drain system with sufficient capacity. Special attention to location of drain gullies shall be made to helicopter decks on floating installations;
- three dual agent hose reels (combined water/foam and dry chemical hose reel) shall be provided at the stairways and have:
    - sufficient powder for discharge at a rate of 2 kg/s to 3 kg/s for minimum 100 s;
    - sufficient foam for minimum 10 min full discharge.

21.4.10 Extinguishing systems in enclosed compartments

21.4.10.1 General

Water mist system is the preferred extinguishing system for enclosed compartments such as:

- FW pump generator room;
- cement unit room;
- emergency generator room;
- turbine hoods;
- diesel engine rooms;
- trafo room for oil filled trafos.

21.4.10.2 Water mist system

The water mist systems shall provide a quick and reliable discharge of water mist at a sufficient density and at sufficient duration for adequate fire suppression and control. Generally, requirements for water mist systems are covered in ISO 13702. NFPA 750 should be used as guideline for design of water mist systems. Selection of type of water mist system (local and/or full flooding) shall be based on fire scenario, and described in safety strategy.

Water mist systems shall also comply with the following requirements:

- easily accessible manual release facilities shall be provided at each entrance to the protected areas;
- the ventilation (fans and/or dampers) shall be closed and the equipment shut down before release of water mist systems;
- the water mist cabinet shall be located outside of the protected room;
- the water mist skid including compressed gas bottles shall be certified for the actual maximum operating pressure;
- compatible materials shall be used throughout the system, e.g. nozzle/distribution piping.

The water mist system shall have an external connection to have the possibility to use fire water after the fresh water tank and the nitrogen tank are emptied.

Water quantities and release duration should typically be determined taking into consideration the size of the area and the degree of congestion, the fuel type and the nature of the fires which may be experienced, equipment types within area (e.g. the effect on electrical and other sensitive equipment within the area of water-mist application), protection inside equipment such as turbine enclosures, etc. Release duration and design should be in accordance with contractor's recommendations, and/or typically range from 5 up to 30 minutes as indicated in NFPA 750 depending on application.

21.4.10.3 Gaseous agents

The gaseous firefighting system shall provide a quick and reliable discharge of gaseous agents for fire mitigation at sufficient concentration and at sufficient duration for adequate fire suppression and control, in addition retaining an atmosphere non-harmful to humans. Generally requirements for gaseous firefighting systems are covered by ISO 13702.

Gaseous firefighting systems shall also comply with the following requirements:

- protection by use of CO_2 or other noxious and poisonous gases shall not be used;
- in order to enable personnel to evacuate before gas discharge, appropriate means for warning of gas release prior to release shall be provided, i.e. clearly visual and audible alarms;
- all rooms protected by gaseous agents shall be furnished with clear audible and visual means for system status annunciation on the outside at the room entries;
- the room where the gaseous agent is released shall be sufficiently tight to maintain the prescribed concentration for the pre-determined time period of minimum 10 min;
- the ventilation (fans and/or dampers) shall be closed and the area isolated before release of gaseous systems;
- the compressed gas bottles shall be certified for the actual maximum operating pressure;
- the gas bottles shall be located outside of the protected room;
- where appropriate, the system shall be monitored to enable the detection of faults which may affect the operational efficiency of the system;
- easily accessible manual release facilities shall be provided at the entrances to the area;
- isolation of power to electrical equipment to be considered.

21.5 Survivability requirements

System and components incorporated shall resist design accidental loads to which they may be exposed.

Special consideration should be given to protection of non-metallic materials and soldered joints.

The FW ring main shall be routed outside areas where it could be exposed to damage, and be protected against external forces, such as environment, falling loads, fire and explosion.

The fire water and centralised foam pumps, drivers (including electrical supply from dedicated generators and other sources) and controllers shall be located in the accommodation or utility area.

Fire pump arrangements shall be independent of each other. Several fire water pump systems may however be located in the same room as long as the remaining capacity is sufficient to cover the largest fire area when any fire water pump room is lost due to an accidental event.

The FW and centralized foam pump systems shall be connected to the ring main at different locations to avoid loss of FW supply.

Cables for fire water and centralized foam pumps shall be fire resistant in accordance with IEC 60331. The need for additional protection and cable routing should be evaluated.

Solutions with centralized deluge skids (multi deluge valve skids) shall be located in the accommodation or utility area well protected from hydrocarbon related accidental events. Supply lines from the deluge valve to the fire area they protect shall be routed such that exposure to accidental loads are minimized. The dry supply lines including pipe supports shall be provided with sufficient passive fire protection to ensure that they can fulfil their role. The supply lines shall also withstand the design explosion loads in relevant fire areas. Penetrations through fire partitions should be avoided.

Control valves for sprinkler and deluge systems shall be located outside the area they protect and they shall be protected against design fire- and explosion loads.

If more than one deluge valve is required to cover a fire area, separation of the supply lines and interlacing of deluge nozzles (fork shaped pattern) to improve robustness should be considered.

Damage in one area shall not cause loss of fire water supply to other areas.

22 Escape and Evacuation

22.1 Role

22.1.1 Escape routes and exits

In the case of a hazardous incident, the purpose of escape route is to:

- ensure that personnel may leave the area(s) in question by at least one safe route;
- enable personnel to safely reach the assigned mustering area from any position on the installation they are likely to occupy (and hence the designated embarkation area);
- enable rescue/medical teams to safely bring injured personnel to areas where medical treatment can be given.

22.1.2 Mustering areas

The purpose of mustering areas is to:

- provide safe refuge on the installation as long as required for a controlled evacuation to be carried out;
- ensure easy, fast and safe entering of the evacuation systems in question.

22.1.3 Evacuation systems

The purpose of the evacuation system(s) is to ensure safe means of evacuating the maximum POB.

22.2 Interfaces

The escape routes and evacuation system interfaces the following safety systems and barriers:

- Layout (Clause 6);
- Structural integrity (Clause 7);
- Human – machine interface (HMI) for CCR systems (Clause 16);
- Natural ventilation and heating, ventilation and air condition (HVAC) (Clause 17);
- Public address (PA), alarm and emergency communication (Clause 18);
- Emergency power and lighting (Clause 19);
- Passive fire protection (PFP) (Clause 20).

22.3 Required utilities

The escape routes and evacuation system performance is dependent upon emergency power for lighting upon loss of main electrical power supply.

22.4 Functional requirements

22.4.1 Escape routes and exits

Escape routes shall be provided enabling all personnel to safely leave the affected area(s) in case of a hazardous incident.

Escape routes shall by default be part of the daily used transport- and passageways.

All doors shall be constructed so that one person can easily open them from either side. They shall open in the direction of escape without blocking the outside route, and be self-closing. This requirement should consider the effect of wind (1 year condition), list (typically 17° for floating installations) and snow/ice conditions.

Escape from electrical rooms and from non-hazardous rooms with access to hazardous areas requires special consideration. Ref IEC 61892-6 para 9.4, and subclause 17.4.4.

If analysis shows that a door can be used from both directions during escape/evacuation, e.g. due to two separate incidents, a sliding door should be used.

Required width of escape routes shall allow easy transport of injured personnel on a stretcher. The dimensions shall minimum be 1 m in width (0,9 m for doors) and 2,3 m in height (2050 mm for doors). It shall be demonstrated in all cases that equipment used for transportation of injured personnel can be turned at corners and in the stair cases.

Escape routes intended for use by more than 50 persons shall be 1,5 m (1,2 m for doors) in width. Floor slope in escape shall not exceed 10 %. Single steps in escape routes shall be avoided.

Lifts shall not be considered as a part of escape routes. However, it shall be possible to escape from the lift and the hoist way with the lift at any elevation. Lift shall automatically go to next floor level and stop upon fire alarm and gas alarm. Escape from legs/shafts/columns of an installation shall be considered separately, and if use of lift is necessary to ensure adequate and effective escape, the lift system shall satisfy special requirements, e.g. concerning transport of injured personnel on stretchers, protection, ventilation, and power supply.

22.4.1.1 Outside buildings

Escape elsewhere than in the LQs and offices should preferably be provided on the outside along the periphery of the installation, and be designed to be passable by position rather than by special protection. Centrally located escape routes may be required. There shall be at least two exits to escape routes from permanently or intermittently manned areas leading in different escape directions and situated as far apart from each other as possible.

For intermittently and permanently manned areas, there shall be at least two access ways to escape routes. This applies to outdoor areas outside quarters and offices, leading in different escape directions.

Escape routes on decks shall be provided with a non-skid, oil resistant coating in yellow. On deck grating, two parallel 100 mm wide yellow lines shall be painted indicating the width of the escape route.

Escape routes leading to a higher or lower level should be provided by stairways. The number of these stairways shall be assessed based on the platform size, configuration of areas and equipment layout. Ladders can be used in areas where the work is of such a nature that only a few persons (maximum three) are in the area on short time basis.

Escape routes shall be arranged from the drill floor to adjacent modules and also down the substructure. Protection of these escape routes from radiation heat should be considered. It shall be possible to escape from a drilling area without running through a wellhead area.

For derricks, an escape arrangement leading away from the derrick to a safe area should be considered in addition to the main access routes.

22.4.1.2 Inside buildings

There shall be at least two exits for areas where more than 15 persons may assemble such as offices and rooms in LQs exceeding 20 m^2. In addition, at least one of the two routes leading in different directions from each level in the LQ shall be an internal stairway linking all levels. Internal room arrangement shall be considered for possible blocking of exits following an accident, e.g. due to heel angles on floating installations.

Corridors in permanently or intermittently manned areas shall not exceed 5 meters, unless provided with at least two exits, one at each end.

22.4.1.3 Signs and markings

A sufficient number of safety signs and markings shall be provided to convey necessary information to guide personnel in emergency situations and give clear information regarding directions/locations of various functions, areas and exits.

Safety signs and markings shall conform with NORSOK C-002 and shall be consistent throughout the installation, and the colour code used shall be specific and not used for other purposes. A descriptive text, in Norwegian and in English, shall be included if the symbols are not easily understood. Text shall however be kept to a minimum.

Escape routes inside offices and living quarters shall be provided with directional guidance showing correct escape direction in accordance with ISO 16069 Safety Way Guidance System (SWGS). Other enclosed and regularly manned utility and process areas should be considered separately.

Safety plot plans shall be strategically located / posted on the premises with high degree of accessibility and shall include:

— locations of safety, rescue and firefighting equipment;
— emergency exits and escape routes;
— evacuation instructions and legends.

22.4.2 Evacuation systems

22.4.2.1 General principles

Requirements relating to safe evacuation shall be met by using a combination of means of evacuation.

The preferred methods of evacuation for installations that are not bridge connected to a neighbouring installation are in prioritised order:

1) Helicopter (if possible in an accidental scenario)
2) Free-fall lifeboats
3) Escape chute with life rafts

For installations connected by bridge to other installations and/or floating accommodation installations that are safe in the design accidental event, the bridge should be the primary means of evacuation.

Number, size and location of evacuation means shall be established based on manning, risk analyses (e.g. risk exposure of muster area and escape routes towards this area) and safety strategy.

There shall be sufficient emergency lighting of the sea surface to ensure safe launching of evacuation means in darkness, ref. subclause 19.4.5.

22.4.2.2 Lifeboats

The minimum number of free-fall lifeboats in the main evacuation area available during a design accidental event shall correspond to the maximum number of personnel (100 %) on board plus one additional boat to compensate for unavailability (technical failure when required). This may also allow a staged evacuation, e.g. minimum crew to leave last. The maximum number of personnel on board shall include day visitors and shuttle personnel in transit (waiting for helicopter in sky lobby), but excluding crew change when helicopter is on deck. One lifeboat can be taken out of service for lifeboat maintenance provided that risk reducing measures are implemented, such as activity restrictions for work on hydrocarbon equipment. For floating installations, it shall be possible to launch lifeboats with capacity for all persons on board at the least favourable angle of heel specified in the stability calculations combined with weather condition with one year return period.

Free fall lifeboats shall comply with DNVGL-ST-E406: Design of Free Fall Lifeboats.

All free-fall lifeboats shall be launched as part of commissioning using design drop height, angle and weight. Equivalent test methods may be accepted as long as the relevant functionality is demonstrated.

The distance between lifeboats and escape chute should be optimised to ensure that a dropped boat will not hit a lowered escape chute and boarding platform during relevant weather conditions. The distance between lifeboats and platform structure shall be large enough to ensure a safe drop of the lifeboats, ref. DNVGL-ST-E406.

For NNMI, simpler evacuation means may be acceptable and shall be evaluated and described in the safety strategy.

The lifeboats:

- should have emergency power for power supply to lifeboats. The disconnection point should be in the vicinity of the lifeboat and disconnection shall be automatic without sparks when dropping or lowering the lifeboat;
- disconnection and launching mechanism should be considered to be winterised to prevent ice from interfering with the launching;
- winch for recovery of lifeboat from sea should be fed by main power;
- access ways should be provided with anti-skid coating;
- shall be equipped with:
  - lifeboat navigation assistance system (LNA), i.e. a navigational assistance tool (gyro heading display);
  - redundant communication system (radio);
  - fixed radar transponder/Class B AIS transponder with GPS and external antenna;
  - an engine that can be run at high speed (rpm) and load when stowed in the davit to prevent soot and coke build-up;
  - water spray protection system which can be tested when the lifeboat is stowed in the davit;
  - easy access for inspection and lifting of heavier components (e.g. air bottles) during periodical maintenance.

22.4.2.3 Escape chutes:

In the vicinity of the muster area at least one escape chute with minimum capacity of the largest lifeboat shall be included. The life rafts and boarding rafts shall be lowered together with the chute and the boarding raft shall automatically inflate. Escape chute and rafts shall be type approved and tested according to SOLAS and national maritime regulatory requirements. Stricter requirements may be necessary to fulfil survivability requirements. With respect to life raft capacity, a personnel weight of 100kg including survival suit shall be used (similar as for lifeboats DNVGL-ST-E406).

The following apply for escape chutes:

- they shall be readily available and easy to operate with clear operating instructions located on the wall inside the container;
- the winch for recovery should be fed by main power;
- removal of life rafts for re-certification shall be possible without affecting the suspension system including lifting wire;
- portable AIS-SART and VHF radios to be located at each escape chute station.

22.4.3 Survival suits

Survival suits for 75 % of maximum POB should be available at the main mustering area. If alternative lifeboat or escape chute stations are provided, survival suits should be available in accordance with the evacuation means capacity/study. Survival suits shall be based on Norwegian Oil and Gas Association GL094 “Kravspesifikasjoner for redningsdrakt til bruk på norsk kontinentalsokkel”, with the exception of the requirement of turning unconscious personnel.

22.4.4 Muster area

The muster area(s) shall be located outdoors by a primary or secondary embarkation area (preferably both), or in a protected area with easy access to the embarkation area(s). The muster area(s), and the route(s) from the muster area(s) to the embarkation area(s) in question, shall be arranged and protected in order to ensure the safety of all personnel during the period required for the evacuation process to be completed in an organised and efficient way.

The size of the muster area shall minimum correspond to N*0,4 m^2, where N denotes maximum POB. Consideration should be made to periods with higher manning such as maintenance shutdowns where additional lifeboat is utilized. The size of mustering area for alternative lifeboat and escape chute stations shall be 0,4 m^2 per person.

22.5 Survivability requirements

22.5.1 Survivability of escape routes

Escape routes outside the area for the initial event shall minimum be designed and protected so that at least one route of escape is available for the required period of time (reach mustering area) during a design accidental event, including possible search and rescue operations if defined in safety strategy. Personnel shall be able to use the escape routes without being exposed to excessive toxic fumes, smoke nor unacceptable heat loads.

Escape routes should be designed to remain passable by location rather than by protection. Where this is not possible, external escape routes shall be physically separated from open hazardous areas by blast-proof and fire-proof walls, or alternative routes shall be provided which are unlikely to be affected by the same incident.

Steel should be used in escape routes that may be exposed to hydrocarbon fires including handrails and stairs.

Composite grating shall not be used in escape routes if they can be exposed to hydrocarbon fires. Access platforms may be in composite material provided compliance with subclause 15.4.6.

22.5.2 Survivability of evacuation means and muster area

Muster area and evacuation means shall minimum be designed and protected for the period of time required to ensure safe muster, search and rescue operations if defined in safety strategy, embarkation and abandonment of the installation during a design accidental event. Consideration should be made to include smoke protected entrance from muster area to the lifeboats.

23 Rescue and safety equipment

23.1 Role

To provide personnel with suitable and sufficient protective equipment to effect rescue of personnel, enable them to reach escape/evacuation points and, if necessary, to maximise the chance of a successful recovery from the sea.

23.2 Interfaces

The rescue and safety equipment have no interfaces with other safety systems and barriers.

23.3 Required utilities

The rescue and safety equipment performance is not dependent on any specific utility. Launching and retrieval of MOB boat may depend on the platform cranes.

23.4 Functional requirements

23.4.1 Man over board (MOB) boat

The facility or standby vessel shall have a MOB boat available at all times. During periods with higher risk e.g. when working over sea or helicopter traffic relying on MOB boat recovery, two independent MOB boats shall be available. The MOB boat can be located on the facility, on the standby vessel or with one boat on each of these as specified in the Safety Strategy. An alternative to two MOB boats is to have a single fast rescue craft with full redundancy in all propulsion and launching facilities.

The MOB boat and launching arrangement, including loose equipment, shall as a minimum be in accordance with the IMO LSA Code (SOLAS) and NMA regulation no 90. It should be possible to launch and recover the MOB boat in 6 m significant wave height, reference NORSOK R-002 Lifting Equipment.

For MOB boat located at the facility, deck cranes or davits may be used as the launching arrangement. For detailed requirements see NORSOK R-002 Lifting Equipment.

If a crane is used for launching, the following requirements shall apply:

- The crane and the MOB boat shall be designed for the application.
- The MOB boat shall be visible from the crane cabin during handling.
- The MOB boat shall have a fixed lifting frame with one-point suspension for handling by cranes.

The availability of the MOB system(s) shall ensure compliance with defined time requirements for recovery of personnel from sea, ref. GL064 «Anbefalte retningslinjer for etablering av områdeberedskap».

Man-overboard boat crew shall have dedicated personal equipment such as suits etc. readily available for rapid mobilization. In addition to the suit shall clothing adapted to the climatic conditions be available. Equipment kept in the man-overboard boat shall be properly stored.

One watertight cabinet for storage of gear for the MOB boat crew should be installed in the vicinity of the MOB boat. The content of the cabinet should include:

- 4 swimsuits of wet suit type;
- 6 survival suits (to be compatible with possible use of helmets);
- 1 thermal protection blanket;
- 1 VHF radio with suitable charger;
- 3 life jackets;
- 30 m lifeline;
- a pair of flippers;
- a diving knife;
- a diving mask with breathing tube;
- a dive torch;
- a boat hook (telescope);
- a sea anchor;
- a tow rope with hook;
- suitable equipment to ensure proper pickup of personnel from the sea, e.g. rescue frame, scramble net;
- survival bag or warm blanket;
- first aid kit;

- pyrotechnic equipment such as signal pistol, smoke signals and flares;
- a pair of night vision goggles (for installations with moon pool work).

Other necessary equipment recommended installed in boat:

- VHF radio;
- compass;
- search light (s);
- radar reflector.

23.4.2 Safety showers and eyebaths

Areas where chemical or hot fluid spillage may occur exposing personnel shall be identified. The following list is considered to represent typical areas and is not to be interpreted as a complete list replacing the need for chemical health risk assessment:

Areas with safety showers and eye baths are:

- methanol pump and injection area;
- chemical injection pump and injection area;
- tote tank area.

Areas with eye baths are:

- workshops;
- cement room, shale shaker room, sack storage room;
- drill floor;
- mud pit area;
- battery room, paint store, and mud lab.

Adequate fresh water quality shall be used for safety showers and eyebaths.

23.4.3 Safety station cabinets

An adequate number of safety station cabinets shall be provided. They should contain

- four vacuum wrapped blankets;
- one scoop type stretcher;
- one basket type stretcher;
- one first aid kit;

or as otherwise required in the EER analysis. The cabinets shall be painted green (RAL 6002).

23.4.4 First aid kits

An adequate number of first aid kits shall be provided at suitable locations, e.g. galley, workshops, drill floor and other areas where cut injuries are likely to occur.

23.4.5 Lifebuoys

Lifebuoys shall be located at regular intervals along the periphery of the lower levels of the installation, according to MODU Code 10.13. Lifebouys with smoke signals shall be limited in numbers and placed in non-hazardous areas.

23.4.6 Firemen's equipment

Firemen's equipment should be stored in sets at no less than two locations separated from each other, so that access to all equipment will not be blocked in the event of a fire in one area. The number of sets of firemen's equipment required and the contents of each set shall be assessed.

Installations should have dedicated equipment for refilling breathing apparatus.

Breathing air bottles shall be of composite material type.

23.4.7 Smoke hoods/breathing masks

Breathing masks and/or smoke hoods shall be installed as follows:

— one smoke hood per bed in LQ cabins;
— breathing masks and/or smoke hoods for escape from / through indoor and outdoor areas exposed to toxic fumes or smoke shall be considered and strategically located, e.g. crane cabin;

The equipment shall be in accordance with EN 403 or similar.

23.5 Survivability requirements

There are no special survivability requirements beyond what is included in functional requirements above.

24 Marine systems and position keeping

24.1 Role

The safety critical marine systems are important to the overall safety of a floating installation. The roles of the various systems are as follows:

— the ballast system shall provide easy and reliable facilities for ballast water distribution in order to maintain control of the floating offshore installation during routine operations and emergency situations, in terms of stability, heel, trim and draft and ensuring that hull stresses do not exceed the design strength criteria;
— the bilge system shall provide easy and reliable facilities for pumping from and draining of watertight compartments;
— the weight and stability monitoring systems shall ensure that weights do not exceed the structural capacity and that weight distribution is such that stability curves are not exceeded;
— the weather- and watertight closing means such as doors and hatches shall maintain the watertight divisions during all operating conditions;
— the position keeping system shall enable the floating installation to maintain position and heading within given operational limits.

24.2 Interfaces

The marine systems interfaces with the following other systems:

— Emergency shut down (ESD) (Clause 11);
— Ignition source control (ISC) (Clause 15);
— Human – machine interface (HMI) for CCR systems (Clause 16);

- Public address (PA), alarm and emergency communication (Clause 18);
- Emergency power and lighting (Clause 19).

24.3 Required utilities

The marine systems performance is dependent on:

- emergency power supply to keep ballasting systems operational and maintain position keeping should main electrical power supply fails;
- cargo handling system including LCS;
- telecommunications for positioning.

24.4 Functional requirements

24.4.1 Ballast and bilge system

The ballast system shall ensure that hull structural loads are maintained within the design strength limits. The bilge system shall be an effective means for draining watertight compartments.

The ballast and bilge system shall comply with the requirements in

- NMA Regulations No. 67 concerning ballast systems on mobile offshore units, and
- NMA Regulations No.123 for mobile offshore units with production plants and equipment.

Ballast system should be arranged with cross connections ensuring that ballast water can be cross fed from one side of the vessel to the other as a contingency measure. The ballast pumps shall have capacity to maintain the operational draft during loading/offloading operations.

All ballast tanks shall be provided with two independent level measuring systems based on different measuring principles, one of the two remotely. For ballast tanks which are not always accessible for checking of tank level, two independent remote systems shall be arranged.

Ballast system valves shall be designed fail-to-close. The ballast valves position shall be indicated in marine CCR. Hand pumps for operation of ballast tank valves and solenoid valves shall be available in case of failure in the ballast control system.

For ship shaped structures where ballast pumps are located in the cargo pump room, all ignition sources shall be located in a separate safe area. Electrical motors shall not be located in the cargo pump room itself. In addition, temperature sensitive devices are to be fitted to bulkhead shaft glands, bearings and pump casings.

For column-stabilized units, the ballast sea water shall not be routed in or out directly from sea but via a point above the waterline in damaged condition. For ship shaped structures direct routing to sea may be accepted provided that acceptable stability in damaged condition can be demonstrated.

The ballast system shall be arranged so as to prevent any single failure in the system or any operator failure from causing ballast water to be inadvertently transferred from one tank to another or causing the unintentional flooding or emptying of ballast tanks.

The ballast system shall be provided with power from the emergency switchboard.

The bilge system shall be an effective means for draining watertight compartments.

The ballast control system shall incorporate an emergency stop device on the ballast control console, which can isolate or disconnect the power supply to the remote-control system and to the pumps. The ballast system shall then automatically change to safe position, i.e. with valves closed and pumps stopped.

24.4.2 Water- and weathertight Integrity

Void spaces which are regarded as buoyancy volumes shall be provided with means for checking water tightness, e.g., leak detection.

Watertight structural members such as box-beams shall be provided with means for effective drainage and sounding, e.g. water detector or level indication.

Watertight closing means shall be arranged for all openings and penetrations through watertight bulkheads and decks in order to maintain the unit's watertight divisions.

Watertight closing appliances shall be provided in all openings in hull and superstructure ensuring watertight integrity as indicated by the freeboard plan.

Watertight closing appliances shall be capable of being opened and closed locally from both sides of the door mechanically or hydraulically and by means of a hand pump.

The control system for watertight closing appliances shall provide the necessary alarms and visual indication in the control room with respect to open and closed status of the closing appliance.

Watertight doors shall be designed so that personnel cannot be injured by the door, (crushing), during normal operation. The doors shall not close automatically during normal operation.

Weathertight closing means shall be kept closed. Instructions to this effect shall be posted on the closing means.

For further details on watertight doors and personnel protection, ref. NORSOK C-002, subclause 7.24.

24.4.3 Weight and stability control

Weights shall be monitored and controlled to ensure compliance with structural design criteria and stability curves.

Permanent changes in weight and weight distribution, e.g. modifications shall be assessed against the platform structural design capacity and stability curves.

All permanent changes in weight and distribution of weight shall be recorded in a systematic manner, e.g. historic weight register.

Temporary changes in weight shall be in accordance with the allowable loading limits specified.

Consideration should be made to weight or stability changes due to release of fire water.

A weight control procedure shall be available, and shall clearly identify the procedure to be followed and the roles and responsibilities of the key personnel involved, when recording permanent and temporary weight changes on the platform.

An updated stability analysis model shall be available. This means a hydrostatic model, with typical loading condition.

The lightweight condition and centre of gravity for the installation in the various operating conditions shall be followed up, e.g. monitoring of limits for vertical centre of gravity (VCG) by means of the loading computer system (LCS).

Audible alarms shall be initiated upon filling/emptying of ballast or cargo tanks outside limits approved in the LCS.

24.4.4 Position keeping system

24.4.4.1 General

The position mooring system shall maintain the unit on location and if applicable enable relocation of the unit. Heading control shall be kept within defined design limits. The system should comply with NMA Regulations No. 998 concerning positioning and anchoring systems on mobile offshore units.

In addition, the need for quick re-positioning of the installation in case of specific emergency situations shall be evaluated. Important factors are number and types of risers, riser pressures, SSIVs and mooring arrangement.

There shall at all times be an updated mooring analysis which reflects all applicable operating scenarios (ultimate limit state (ULS), accidental limit state (ALS) and fatigue limit state (FLS)) and shall be verified in accordance with latest regulatory requirements, e.g. safety factors.

The positioning mooring system shall be capable of providing sufficient capacity to satisfy the positioning holding required in the mooring analysis.

Due to poor fatigue qualities, connection elements such as kenter shackles, pear links, C-links, D-shackles with locking pin through bow, pins and swivels shall not be used in permanent mooring systems.

A system for continuous measuring of anchor line tension, which monitors anchor line tension and compares with high and low values shall be provided. The system shall be calibrated regularly and it shall be ensured that line tension does not exceed limits determined in the mooring analysis.

A line length measuring system shall be available which indicates line lengths in use. The system shall be calibrated regularly. Additionally, a log shall be available indicating calibration of the line length measuring system, when calibration was last carried out and how the winches have been run.

In cases with thruster-assisted mooring the power system shall have sufficient redundancy so that power can be immediately provided following any single failure in any sub-system or component.

The power management system shall have adequate response time to power demand changes in both normal operation and fault situations.

Upon loss of a generator the power management system shall ensure sufficient power on remaining generators avoiding overloading.

All computer systems shall be backed up by UPS/battery supplies with at least 30 minutes battery capacity.

The thruster system shall have sufficient redundancy such that thrust can be provided following any single failure in any sub-system or component.

A failure in the thruster control system shall not make the thruster rotate or give increased thrust (especially on variable pitch propellers, variable speed propellers does normally not have the same problem).

For position keeping systems, the safety factors shall be met in the survival condition for the following failure modes:

— loss of holding power of any-one single thruster;
— loss of thrust of any one single thruster;
— single failure in thruster control or power system leading to stop of one or several thrusters.

For position keeping systems, the unit shall comply with one of the following:

— the unit is designed for black out of the thruster system,
— the system is to include redundant components or systems so that the single failure will not cause critical loss of position or exceedance of anchor line tension, or
— the safety factors for intact condition (consequence Class 3) are met in spite of one single failure.

24.4.4.2 Position Reference System

For installations with thruster-assisted mooring the positioning reference systems shall supply the positioning mooring system with adequate information whenever the vessel is moored at the location.

There shall be a sufficient number of position reference systems (typically one acoustic and one differential GPS-system).

If more than one position reference system is required, they shall be based on at least two different principles.

Monitoring of position reference systems shall be provided to indicate failures or degraded operation.

Manual control levers for the thrusters shall be provided in the position mooring control station.

If a vessel is operating in the vicinity of other structures, direct view to the vessel surroundings shall be provided from the positioning mooring control room.

24.5 Survivability requirements

System and components incorporated in systems shall resist design accidental loads to which they may be exposed for the required period of time.

As far as possible avoid leak sources within the compartments, consider implementing possibilities for stopping FW pumps from CCR, consider introduction of automatic stop of seawater on high water level detection within the compartments.

Location of vents from tanks and spaces within the hull shall take into account l maximum inclination angles in damaged conditions.

25 Avoidance of Vessel Collisions

25.1 Role

The Vessel Collision Avoidance System shall reduce the risk of vessel collisions.

25.2 Interfaces

The vessel collision barrier has interfaces with the following safety systems and barriers:

— Structural integrity (Clause 7);
— Emergency shut down (ESD) (Clause 11);
— Human – machine interface (HMI) for CCR systems (Clause 16);
— Public address (PA), alarm and emergency communication (Clause 18);
— Emergency power and lighting (Clause 19);
— Escape and evacuation (Clause 22).

25.3 Required utilities

Emergency power supply to keep the collision avoidance systems operational should main power supply fail.

25.4 Functional requirements

25.4.1 System for detection of vessel or drifting object on collision course.

Traffic display for radar and AIS signals shall be available. The AIS coverage around the installation shall be sufficient to detect AIS signals from vessels at a minimum of 20 nautical miles.

The radar coverage around the installation shall be sufficient to detect an approaching vessel sufficiently early to carry out the necessary emergency response actions, typically 50-70 minutes before collision between the vessel and the offshore unit. Collision course is defined as a course of a vessel that infringes the Safety Zone of the unit.

The unit responsible for surveillance shall be defined. The surveillance of the sector around the installation may be performed by a central surveillance unit, a local surveillance unit (a unit or vessel responsible for more than one installation), a dedicated standby vessel or the installation itself.

If radars are installed on the installation, it shall able to register the object's course and speed, including plotting facilities.

Radar signals shall be transmitted to the unit responsible for surveillance.

The radar shall be provided with a proximity alarm to warn of an approaching vessel with Time to Closest Point of Approach (TCPA).

25.4.2 Communication system

The communication system shall provide sufficient means for communication between the installation, the remote surveillance centre, and the vessel on collision course.

The installation shall be equipped with VHF and GMDSS, ref. subclause 18.4.4.

If a dedicated standby vessel is used, it shall be equipped with necessary equipment to get attention from vessel on collision course, e.g.:

— signal lamps with luminous intensity of minimum 1000 candelas;
— megaphone with sound intensity of 80 Dba.

If there is no dedicated standby vessel, the installation shall be equipped with the same equipment normally on the standby vessel. It should be noted that a standby vessel may play an important role in avoiding vessel collision, and therefore this role shall be considered when assessing the need for a dedicated standby vessel.

A MOB boat dedicated for collision avoidance operations shall have approved maritime VHF.

25.4.3 Systems for consequence reduction and evacuation

The following measures shall be defined in accordance with the safety strategy:

- evacuation:
    - means to ensure safe abandonment for the people on board the installation to the sea for the maximum POB, following a decision to abandon the installation in danger of vessel collision.
- ESD and EDP of the production system;
- secure wells in case of ongoing well operations;
- the possibility to move or rotate a floating unit out of way of the vessel or object on collision course;
- the need for field specific requirements to standby vessel such as:
    - emergency towing and
    - firefighting capacity.

Emergency preparedness strategies for situations with vessel on collision course shall be established, Figure 6.

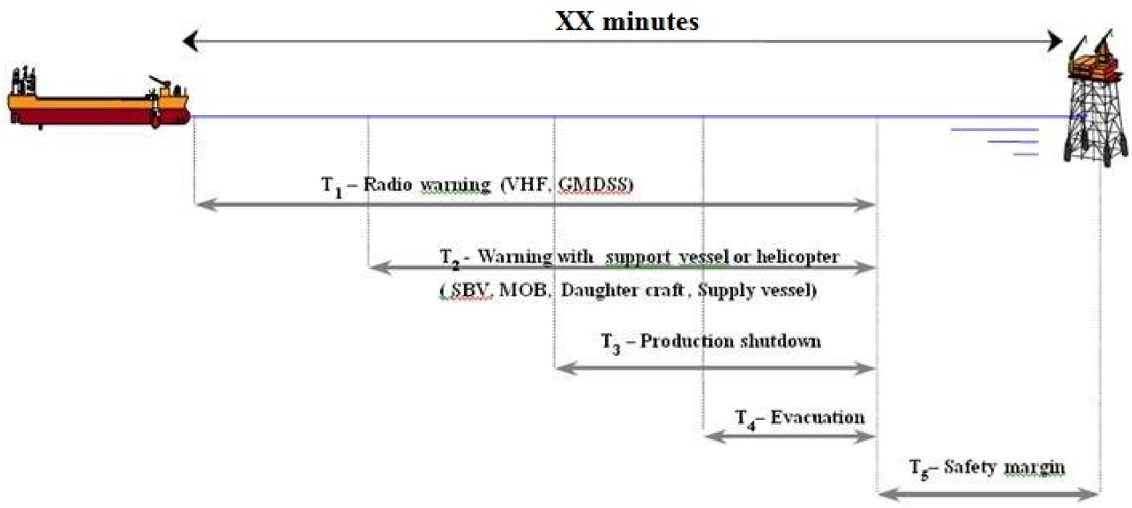

Figure 6 — Time phases for vessel on collision course

The following time phases should be estimated for the specific unit:

- T1 = Establish contact with the vessel on collision course by radio (VHF, GMDSS (Global Maritime Distress and Safety System));
- T2 = Other means of audible or visual warning by encountering support vessel (e.g. standby vessel, other vessels, MOB boat) or helicopter;
- T3 = Start ESD and EDP of the production system;
- T4 = Start evacuation and move away from the unit in a safe direction;
- T5 = Safety margin.

All activities shall be carried out within XX minutes.

25.5 Survivability requirements

There are no special survivability requirements. For sub-structure load capacity, see clause 7.

26 Well integrity

26.1 Role

The below subchapters for Well integrity give some principle safety requirements and guidance. Reference is made to NORSOK D-001 and NORSOK D-010 for further details.

Well integrity implies that uncontrolled flow from the well to the surroundings is prevented at all times.

26.2 Interfaces

The well barriers interface the following safety systems:

- Emergency shut down (ESD) (Clause 11);
- Gas detection (Clause 13);
- Fire detection (Clause 14);
- Human – machine interface (HMI) for CCR or other control stations (Clause 16);
- Public address (PA), alarm and emergency communication (Clause 18);
- Passive fire protection (PFP) (Clause 20);
- Active Fire Protection (Clause 21).

26.3 Required utilities

The well barrier performance is dependent on the availability of

- uninterruptible power supply (UPS) and emergency power to activate or maintain well barriers upon loss of main electrical power during well operations;
- hydraulic supply including back-up hydraulic accumulators for closure well valves;
- instrument air supply for critical equipment for securing wells.

26.4 Functional requirements

Well integrity shall be ensured by at least two independent and tested well barriers.

In all well activities, the well barriers shall provide means for shutting in the well both during normal operations and in a well control situation to avoid a blowout situation.

All barrier elements shall be designed to function when exposed to maximum well pressure, flow, temperature, erosive or corrosive substances like CO_2, H_2S and sand production during well life, normal operations and well control situations, e.g. to function exposed to high flow rates.

All wells shall have a system for continuous monitoring of tubing pressure and temperature and of A-annulus pressure. In gas lift wells there shall be continuous monitoring of the B-annulus.

When selecting gas lift solutions, the risks related to annulus gas release shall be part of the decision process, ref. subclause 5.6.3.3.

Automatic or manual activation of ESD-shutdown levels can affect both of main- and emergency power. The consequences of loss of main power during drilling and well intervention activities shall be evaluated to ensure that critical functions (emergency system consumers) are maintained during the emergency event. Typical drilling emergency systems consumers are: BOP control unit, instrument air supply, diesel transfer pump, drilling emergency circulation, drill pipe emergency hoisting, wireline grease pumps, etc. Reference is made to NORSOK D-001.

Function and equipment required to secure the well to avoid economical losses due to loss of main power, should have essential power supply.

Reference is made to subclauses 5.9, clause 11 and clause 15 for additional well integrity related requirements.

26.5 Survivability requirements

Well barrier elements shall resist the design accidental loads for the required period of time, e.g. BOP/safety head, control panels, hoses and connections, shall be protected against external loads like fire and explosion, dropped objects and other mechanical impact. Well barriers shall also be able to handle well kill scenario loads.

Well kill equipment shall be suitable for operation in a hazardous area zone 2 including protection such as “flame arrester”, overspeed control and “spark arrester”, ref. subclauses 15.4.1 and 15.4.4.

It shall be possible to shut down BOP/safety head (secondary barrier) from at least two different and well separated locations on the platform other than on the BOP/safety head control unit to ensure one is available during an accidental event (including influence of wind). In addition, for well intervention, the panels for manual control of the master valve and DHSV for the well in question, shall be located such that one is available during an accidental event typically along escape way to mustering point.

Dry XMTs and wellheads shall as a minimum have fire resistance in accordance with NORSOK D-010 references and subclause 5.6.3.3.

Annex A
(normative)

Jack-up Drilling Rig / Fixed Installation Constellations

A.1 Risk- and fire analysis

Concepts combining a jack-up drilling rig and a fixed installation require special consideration and are discussed in Proactima / PSA report "PS-1071613-RE-01 Prosjektrapport Brannbelastning ved boring over innretning i «cantilevermodus" [4] for guidance.

The following aspects shall be addressed:

— The major accidental risk for the fixed installation and the jack-up rig operating in cantilever mode should be assessed considering the platforms as one entity.
— Layout and arrangement of the fixed installation should be developed with consideration of the effect of the jack-up rig on risks.
— Rig owners generic QRA does normally not address operation over a fixed installation, hence additional and site and installation specific risk assessments is required to ensure that the jack-up rig can withstand the design accidental loads.
— Typical scenarios that need to be addressed in the QRA(s) are:
  - o blowout and well leaks at drill floor exposing derrick;
  - o blowout and well leaks in wellhead area on fixed installation exposing cantilever;
  - o ignited well-/process leaks exposing jack-up legs and hull;
  - o unignited gas leaks from the fixed installation exposing ventilation intakes and potential ignition sources on the jack-up rig;
  - o blowout and well leaks due to well intervention.
— Ensure that relevant drilling competencies are involved in identifying possible leak locations and associated operations during HAZID, e.g:
  - o number and location of leak points between wellhead and BOP;
  - o fire integrity of high pressure drilling riser;
  - o consequence of cantilever collapsing on drilling riser / BOP / wellhead.
— The effect on ventilation conditions on the fixed installation due to obstruction from the jack-up hull should be taken into account.
— CFD and structural response analyses should be the basis for evaluations of consequences of derrick and cantilever collapse.
— Effect of openings in the weather deck / hatch deck should be evaluated with respect to leaks in adjacent areas, i.e. gas and liquid leaks and blowouts.
— Access ways between the jack-up and the fixed installation are exposed to fire- and explosion loads. If access is required for escape, specific impairment analysis is required. This assessment should be a part of the site specific QRA.
— In addition to fire- and explosion hazards, ship collisions may require consideration since the installations may have different structural capacity.
— Relative movements of the two platforms should be considered when exposed to environmental and accidental loads, e.g. earthquake and collision loads, to ensure integrity of the well / drilling riser.
— The need for quick ignition source control on jack-up due to large gas leaks on the fixed installation.
— Jack-up diesel engines may have a large potential for igniting large gas clouds. Flame arrestors should be considered ref. subclause 15.4.1.
— Falling objects and material handling between installations.
— Location of atmospheric vents (on both installations).
— Radiation from flares.
— Helicopter approach including helideck effects such as turbulence.

A.2 Safety strategy and performance requirements

A.2.1 Introduction

A Safety Strategy needs to be developed for the simultaneous production and drilling (SIMOPS) phase ensuring that additional aspects relate to interface aspects. This is particularly relevant for the following systems:

- interaction between ESD systems;
- interaction between F&G systems;
- public address (PA), alarm and emergency communication;
- active fire protection;
- evacuation & escape.

The following clauses provide interface requirements related to clauses 11, 13, 1414, 15, 21 and 22.

A.2.2 ESD (Clause 11)

ESD levels as defined in NORSOK S-001 section 11.4.3 shall form the basis for the ESD interface philosophy. ESD levels defined for both fixed installations and MODUs may vary from the ESD levels specified in NORSOK S-001, but should be converted to corresponding ESD levels defined in NORSOK S-001 to be comparable.

The signals to be transferred between the fixed installation and the jack-up rig shall be identified and documented, e.g. in area safety charts for the fixed installation.

ESD signals for the ESD levels NORSOK APS, ESD1 and ESD2 shall be transferred from the host platform to the MODU and vice versa.

ESD levels at MODUs are typically initiated manually. Situations of hazard and accidents at the fixed installation shall not automatically initiate ESD at the MODU. Wells and activities at the drilling rig needs to be secured before initiating ESD at the drilling rig.

The highest ESD levels (corresponding to S-001 APS and ESD1) at MODU should cause automatic activation of minimum lowest ESD level at fixed installation.

ESD activation shall initiate general alarm on both installations.

A.2.3 Gas detection (Clause 13)

Gas detection signals, including toxic gas detection if relevant, shall be transferred between fixed host installation and MODU. The signals should distinguish between “low gas alarm” and “high/confirmed gas alarm”.

Low gas alarm on either installation shall give local alarm in CCR / other relevant strategic locations and ignition source isolation in accordance with clause 15. Confirmed (“high”) detection should follow the principles in Table 3 in subclause 14.4.5.

A.2.4 Fire detection (Clause 14)

Fire detection signals shall be transferred between fixed host installation and MODU. The signals should distinguish between alarm and confirmed fire detection.

Fire alarm on either installation shall give local alarm in CCR / other relevant strategic locations. Confirmed fire detection shall initiate general alarm on the other installation. Confirmed fire detection in the drilling area shall initiate ESD2 on the fixed installation.

A.2.5 Ignition source control (ISC) (Clause 15)

When connecting MODU to fixed host installation, it should be evaluated if the constellation influences existing area classification at host platform and MODU. A specific area safety chart describing area classification for the co-localization of installations shall be prepared.

Consideration should be made to ventilation and combustion engine air intakes with respect to gas exposure.

Low gas alarm on either installation shall give local alarm in CCR / other relevant strategic locations and ignition source isolation in accordance with Clause 15.

A.2.6 Public address (PA), alarm and emergency communication (Clause 18)

Control of personnel on board is required to ensure personnel control in an emergency situation including ensuring life boat capacity at both installations. The system may be manual or automatic personnel registration systems.

A.2.7 Active fire protection (Clause 21)

The jack-up rig should have sufficient fire water capacity, e.g. by use of fire water monitors, to cover the cantilever structure for fires from the fixed installation. Fire water may also be supplied from the fixed installation if available.

A.2.8 Escape and evacuation (Clause 22)

If not required for escape, the access way between the installations should use the requirements in clause 22 apart for the survivability requirements.

The following lifeboat aspects should be assessed for the jack-up rig:

— lifeboats height above sea level;
— lifeboats interaction with structures;
— inherent properties of davit launching lifeboat systems to ensure swift and safe lowering and release.

The evaluation of davit launched lifeboat systems should cover all phases;

— lifeboat lowering;
— lifeboat landing;
— release of wire falls;
— sail away phase.

Annex B
(informative)

Fire Protection datasheet

The below datasheet is an example, and can be downloaded here (www.standard.no/norsok-s001).

FIRE & GAS CAUSE & EFFECT / AREA SAFE CHART

Platform: **Fire area:**	Doc. no.:		Made by:	
	Rev. no.:		Checked by:	
Area description:	Date:		Approved by:	

Area classification
- Zone 1
- Zone 2
- Non hazardous by location
- Non hazardous by ventilation

Hazards
- Crude oil
- Condensate liquid
- Lighter HC gas
- Heavier HC gas
- Toxic gas H_2S, CO_2
- Chemicals
- Methanol
- Glycol
- Fuel oil/diesel
- Lubricants
- Electrical
- Other combustibles
- Radioactive
- Explosives
- Hydrogen gas

Fire- and gas detection
- HC gas in area
- HC gas in main HVAC intake
- HC gas in comb. air intake
- Smoke in area
- Smoke in main HVAC inlet
- Early smoke
- Toxic gas in area
- Flame in area
- Heat in area
- Manual call point
- Manual release water
- Manual electrical isolation

Protection **Rate**
- Area deluge
- Equipment deluge
- Watermist
- Port. extinguisher
- Monitor
- Hydrant
- Hosereel
- Dual agent hosereel
- Sprinkler
- Aqueous film foaming foam

Ventilation
- Natural
- Overpressure
- Underpressure
- Mechanical - local intake
- Mechanical with air supplied from area

Ignition source in area
- Group 1
- Group 2
- Group 3

Personnel occupancy
- Permanent
- Intermittently
- Normally unmanned
- No occupancy

Node

Rating walls, floor and ceiling

	N	S	E	W	Floor	Ceiling
None						
Wind shield						
Heat shield						
Steel walls						
Fire partitions						
Expl. panels						
Suspended						
False						

In area	
On floor	
On platform	
On field center	
On all platforms	

ID	Input signals	Tag ref.	Notes	Output signals: Ventilation and dampers	Active fire fighting	Isolation of ignition sources	Shutdowns	Alarms
			Tag ref.					
	Gas detection							
	Flame detection							
	Activations							
	Status alarms							

Id ref.	A	B	C	D	E	F	G
Tag nos							

NOTES:

Annex C
(informative)

Safety Equipment Data Sheets

C.1 General

This annex lists typical data sheets for safety equipment and replaces NORSOK S-011 rev. 2 Aug. 1999. These equipment data sheets may be used when enquiring, trading and purchasing such equipment.

The datasheets can be downloaded in native format here (www.standard.no/norsok-s001).

SDS-101 Firewater Monitors Data Sheet

SDS-102 Firewater Hose Reels w/nozzle Data Sheet

SDS-103 Evacuation Chute Data Sheet

SDS-104 Firewater Hydrant Data Sheet

SDS-105 Firefighting Cabinet Data Sheet

SDS-106 MOB Equipment Station Data Sheet

SDS-108 Survival Suits Cabinet Data Sheet

SDS-109 Fireman's Equipment Cabinet Data Sheet

SDS-110 Firewater Valve Skid Data Sheet

SDS-111 Portable Extinguisher Data Sheet

SDS-112 Eye Bath Data Sheet

SDS-113 Breathing Air Recharge Unit Data Sheet

SDS-116 Safety Station Cabinet Data Sheet

SDS-117 Safety Shower/Eye Bath (outdoor) Data Sheet

SDS-118 Lifeboat and Davit Data Sheet

C.2 SDS-101 Firewater Monitors Data Sheet

NORSOK S-001 Rev.5: 2018	FIREWATER MONITORS DATA SHEET	Made by	
		Checked by	
		Date	
		Data Sheet	SDS-101

Package no.	Doc. no.	Rev.	Page 1 of 2

Tag no.		Location/module	
Unit		No. req'd	
Service		Inquiry no.	
Size & type		Quote no.	
Supplier		P.O. no.	
Manufacturer		Job no.	
Model		Serial no.	

SECONDARY MANUFACTURER DATA

Part	Manufacturer	Type	Model	Serial No
Nozzle				
AFFF Prop.				

1 FLUID DATA			
2 AFFF:		:	
3 Temperature	°C	:	
4 Viscosity at T & P	cP	:	
5 Density at T & P	kg/m³	:	
6 Specific gravity 15.6/15.6	°C	:	
7		:	
8			
9 PERFORMANCE REQUIREMENTS			
10 Firewater:			
11Available inlet pressure (design con	barg	:	
12 Min inlet pressure	barg	:	
13 Max inlet presure	barg	:	
14 Design flow per outlet	m³/h	:	
15 Inlet flange size		:	
16		:	
17		:	
18 AFFF:		:	
19 Design pressure	barg	:	
20 Design flow	m³/h	:	
21 Differential pressure req.		:	
22 Inlet flange		:	
23		:	
24		:	

25 NOTES:

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NORSOK S-001 Rev.5: 2018	FIREWATER MONITORS DATA SHEET	Made by	
		Checked by	
		Date	
		Data sheet	SDS-101

Package no.	Doc. no.	Rev.	Page 2 of 2

42	**PERFORMANCE REQUIREMENTS** (CONT.)		
43	**Monitor:**		
44	Throw at min inlet pressure	m	:
45	Rotation in degrees		:
46	Vertical movement		:
47	Lockable in any direction		:
48	Remote release		:
49	Self oscillating with adjustable setting degrees:		
50	Colour		: Red (RAL 3002)
51			:
52	**Nozzle:**		:
53	Type		:
54	Connection		:
55	Spray angle		:
56			:
57			:
58	**AFFF proportioner:**		
59	Proportion	%	:
60	Proportioning tolerance		:
61	Differential pressure req.		:
62			:
63			:
64	**WEIGHT AND DIMENSIONS**		
65	Monitor		:
66	Nozzle		:
67	AFFF proportioner		:
68			:
69			:
70	**MATERIALS**		
71	Monitor		:
72	Nozzle		:
73	AFFF proportioner		:
74	Paint coatings		:
75			:
76	**NOTES:**		
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C.3 SDS-102 Firewater Hose Reels w/nozzle Data Sheet

NORSOK S-001 Rev. 5: 2018	FIREWATER HOSEREELS W/NOZZLE DATA SHEET	Made by	
		Checked by	
		Date	
		Data Sheet	SDS-102

Package no.	Doc. no.	Rev.	Page 1 of 1

Tag no.		Location/module	
Unit		No. req'd	
Service		Inquiry no.	
Size & type		Quote no.	
Supplier		P.O. no.	
Manufacturer		Job no.	
Model		Serial no.	

1 SERVICE CONDITIONS			
2 Ambient temperature min/max	°C	:	
3 Relative humidity	%	:	
4 Environment		:	
5 Indoor/outdoor		:	
6 PERFORMANCE REQUIREMENTS			
7 Available inlet pressure (design conditions)	barg	:	
8 Design temperature F.W	°C	:	
9 Design pressure	barg	:	
10 Min. Inlet pressure	barg	:	
11 Max. inlet pressure	barg	:	
12 Design flow per outlet	m³/h	:	
13 Inlet flange size		:	
14 Hose length	m	:	
15 Throw length at min. inlet press.	m	:	
16 Throw length at available inlet pressure	m		
17 Nozzle inlet pressure	barg	:	
18 Spray angle	°	:	
19 Cabinet		:	Δ 2018
20 Winterization heater		:	
21 Heater type		:	
22 Heater rating		:	
23 Heater maximum temperature	°C	:	
24 Hinge details		:	
25 Protection degree	IP	:	
26		:	
27 WEIGHT AND DIMENSIONS			
28 Hose reel weight	kg	:	
29 Hose reel dimension (WxHxL)	m	:	
30 Hose diameter	m	:	
31 Support frame dim's (WxHxL)	m	:	
32 Cabinet dimensions (WxHxL)	m	:	
33		:	
34 MATERIALS			
35 Hose		:	
36 Nozzle		:	
37 Cabinet		:	
38 Support frame		:	
39 Isolation valve		:	
40			
41 LIFTING			
42 No. of lifting lugs support frame		:	
43		:	
44 NOTES:			
45			
46			
47			

C.4 SDS-103 Evacuation Chute Data Sheet

NORSOK S-001 Rev. 5, 2018	EVACUATION CHUTE DATA SHEET	Made by	
		Checked by	
		Date	
		Data Sheet	SDS-103

Package no.	Doc. no.	Rev.	Page 1 of 1

Tag no.		Location/module	
Unit		No. req'd	
Service		Inquiry no.	
Size & type		Quote no.	
Supplier		P.O. no.	
Manufacturer		Job no.	
Model		Serial no.	

1 **SERVICE CONDITIONS**			
2 Electrical area hazard	: Zone 1	Gas/temp class	: IIA/T3
3 Location open/exposed	:		
4 **PERFORMANCE REQUIREMENTS**			
5 Special project requirements	:		
6 Design standard - chute	:		
7 Design standard - collection raft	: SOLAS 1983/NMD Approved		
8 Design standard - container	:		
9 Chute dimensions Length x Dia	:		
10 Container dimensions LxWxH	:		
11 Lowering height m	:		
12 No. of persons/capacity collection raft	: 25		
13 Weight (package) kg	:		
14 Electrical power supply	:		
15	:		
16	:		
17 **MATERIALS**			
18 Chute	:		
19 Collection raft	:		
20 Container	:		
21 Painting	:		Δ-2018
22	:		
23	:		
24 **NOTES:**			
25			
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C.5 SDS-104 Firewater Hydrant Data Sheet

NORSOK S-001 Rev. 5: 2018	FIREWATER HYDRANT DATA SHEET	Made by	
		Checked by	
		Date	
		Data Sheet	SDS-104

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Tag no.		Location/module	
Unit		No. req'd	
Service		Inquiry no.	
Size & type		Quote no.	
Supplier		P.O. no.	
Manufacturer		Job no.	
Model		Serial no.	

SECONDARY MANUFACTURER DATA

Part	Manufacturer	Type	Model	Serial no
Hydrant valve				
Hose				
Hose coupling				
Nozzle				
AFFF proportioner				
N2 press. system				

1 SERVICE CONDITIONS		
2 Zone		: Zone 1 Gas/temp. class :IIA/T3
3 Explosion protection		:
4		:
5		:
6 FLUID DATA		
7 **AFFF:**		
8 Temperature	°C	:
9 Viscosity at T & P	cP	:
10 Density at T & P	kg/m³	:
11 Specific gravity 15.6/15.6	°C	:
12 Available inlet pressure (design conditions)	barg	:
13		:
14		:
15 PERFORMANCE REQUIREMENTS		
16 Firewater:		
17 Available inlet pressure (design conditions)	barg	:
18 Min inlet pressure	barg	:
19 Max inlet presure	barg	:
20 Design flow per outlet	m³/h	:
21 Inlet flange size		:
22		:
23		:
24		:
25 Hose (Common for FW/AFFF):		
26 Hose length	m	:
27 Number off		:
28 Throw length at min. inlet press.	m	:
29 Hose size	mm	:
30 Nozzle inlet pressure	barg	:
31 Hydrant/hose/nozzle		:
32		:
33		:
34		:
35 AFFF:		
36 Design pressure	barg	:
37 Design flow	m³/h	:
38 Inlet flange		:
39		:

NORSOK S-001 Rev. 5: 2018	FIREWATER HYDRANT DATA SHEET	Made by	
		Checked by	
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40 **PERFORMANCE REQUIREMENTS** (CONT)		
41 **Hydrant valve:**		
42 Turning direction for closing	:	
43 Operating direction marked	:	
44 Colour	:	Δ-2018
45 **Nozzle:**		
46 Spray angle	:	
47	:	
48 **AFFF proportioner:**		
49 Differential pressure req.		
50 Proportion	% :	
51 Proportioning tolerance	:	
52	:	
53 **Nitrogen pressurisation system**		
54 Number of cylinders	:	
55	:	
56 **Cabinet:**		
57 Type	:	
58 Winterization heater fitted	:	
59 Heater type	:	
60 Heater rating	:	
61 Heater max. temperature	°C	
62 Door lock details	:	
63 Hinge details	:	
64 Hose cradle material	:	
65 Hose cradle pivots	:	
66 Protection degree	IP :	
67 Colour	:	Δ-2018
68 **WEIGHT AND DIMENSIONS**		
69 Hydrant valve	:	
70 Hose	:	
71 Hose coupling	:	
72 Nozzle	:	
73 Manifold	:	
74 AFFF proportioner	:	
75 Cabinet (LxWxH)	:	
76	:	
77 **MATERIALS**		
78 Hydrant valve	:	
79 Hose	:	
80 Hose coupling	:	
81 Nozzle	:	
82 Manifold	:	
83 AFFF proportioner	:	
84 Cabinet	:	
85	:	
86 **NOTES:**		
87		
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89		
90		
91		

C.6 SDS-105 Firefighting Cabinet Data Sheet

NORSOK S-001 Rev. 5: 2018	FIRE FIGHTING CABINET DATA SHEET	Made by	
		Checked by	
		Date	
		Data Sheet	SDS-105

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Tag no.		Location/module	
Unit		No. req'd	
Service		Inquiry no.	
Size & type		Quote no.	
Supplier		P.O. no.	
Manufacturer		Job no.	
Model		Serial no.	

1 DESIGN REQUIREMENTS			
2 Cabinet:			
3 Type and model		:	
4 Material		:	
5 Length	mm	:	
6 Width	mm	:	
7 Height	mm	:	
8 Weight	(empty) kg	:	
9 Weight	(including equipment) kg	:	
10 Door size	mm	:	
11 Door opening angle min.	°	:	
12 Door opens to		:	
13 Marking		:	
14 Painting		:	Δ-2018
15 Degree of protection		:	IP 55
16 Explosion blast pressure		:	
17 Electric Heater		:	
18 Lighting		:	
QUANTITY			
19 Contents of Cabinet:			
20 5 kg CO2 Portable extinguisher		:	
21 10 kg CO_2 Mobile extinguisher		:	
22 12 kg Dry powder extinguisher		:	
23 25 kg Dry powder mobile extinguisher		:	
24 50 kg Dry powder mobile extinguisher		:	
25 Portable monitor		:	
26 Breathing aparatus (complete)		:	
27 Spare air cylinder		:	
28 Torch		:	
29		:	
30		:	
31 NOTES:			
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C.7 SDS-106 MOB Equipment Station Data Sheet

NORSOK S-001 Rev. 5: 2018	MOB - EQUIPMENT STATION DATA SHEET	Made by	
		Checked by	
		Date	
		Data Sheet	SDS-106

Package no.	Doc. no.	Rev.	Page 1 of 1

Tag no.		Location/module	
Unit		No. req'd	
Service		Inquiry no.	
Size & type		Quote no.	
Supplier		P.O. no.	
Manufacturer		Job no.	
Model		Serial no.	

QUANTITY		
1 Contents		
2 Rescue suits medium	: 2	
3 Rescue suits large	: 2	
4 Rescue suits extra large	: 2	
5 Wet gloves	: 6	
6 Lifejackets	: 6	
7 Rescue stretcher blanket	: 1	
8 Bags each containing	: 2	
9 - 1 Off lifeline w/snap hook		
10 - 1 Pair fins		
11 - 1 Off diving knife		
12 - 1 Off mask and snorkel		
13 - 1 Off strobe light		
14 - 1 Off waterproof torch		
15 - 1 Off weight belt 6 kg		
16 Marking	: MOB BÅT UTSTYR / MOB BOAT EQUIPMENT	
17 Painting	:	Δ-2018
18	:	
19	:	
20 NOTES:		
21		
22		
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C.8 SDS-108 Survival Suits Cabinet Data Sheet

NORSOK S-001 Rev. 5: 2018	SURVIVAL SUITS CABINET DATA SHEET	Made by	
		Checked by	
		Date	
		Data Sheet	SDS-108

Package no.	Doc. no.	Rev.	Page 1 of 1

Tag no.		Location/module	
Unit		No. req'd	
Service		Inquiry no.	
Size & type		Quote no.	
Supplier		P.O. no.	
Manufacturer		Job no.	
Model		Serial no.	

1 CABINET			
2 No off survival suits in each cabinet		: (Insert actual number)	
3 Type and model		:	
4 Material		: GRP Fire retardent	
5 Length	mm	:	
6 Width	mm	:	
7 Height	mm	:	
8 Weight (empty)	kg	:	
9 Weight (including equipment)	kg	:	
10 Door size	mm	:	
11 Door opening angle min.	°	: 270	
12 Door opens to		: Both sides	
13 Marking		: Redningsdrakter / Life suits (Insert actual number)	
14 Painting		:	Δ-2018
15 Degree of protection		: IP 55	
16 Explosion blast pressure		:	
17 Electric heater		:	
18 Lighting			
19 SURVIVAL SUITS			
20 Approving authority		: NMD	
21 Type and model		:	
22 Size		: One size	
23 Marking according to NMD regulations		:	
24 Fitted with light		:No	
25 Attachments		:	
26		:	
27		:	
28 NOTES:			
29			
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C.9 SDS-109 Fireman's Equipment Cabinet Data Sheet

NORSOK S-001 Rev. 5: 2018	FIREMANS EQUIPMENT CABINET DATA SHEET	**Made by**	
		Checked by	
		Date	
		Data sheet	**SDS-109**

Package no.	**Doc. no.**	**Rev.**	**Page 1 of 4**

Tag no.		Location/module	
Unit		No. req'd	
Service		Inquiry no.	
Size & type		Quote no.	
Supplier		P.o. no.	
Manufacturer		Job no.	
Model		Serial no.	

1 DESIGN REQUIREMENTS			
2 **Cabinet:**			
3 Type and model		:	
4 Material		:	
5 Length	mm	:	
6 Width	mm	:	
7 Height	mm	:	
8 Weight (Empty)	kg	:	
9 Weight (Including equipment)	kg	:	
10 Door size	mm	:	
11 Door opening angle min.	°	: 270	
12 Door opens to		: Both sides	
13 Marking according to		:	
14 Painting according to		:	Δ-2018
15 Electric heater		: YES	
16 Lighting		: YES	
17 Degree of protection		: IP 55	
18 Explosion blast pressure		:	
19 Marking		: BRANNMANNS UTSTYR / FIREMANS EQUIPMENT	
20		:	
21		:	
22		:	
23		:	
24		:	
25 CONTENTS OF CABINET			
26			
27 **Firemans suit with hood:**			
28 No in cabinet		: 4	
29 Type, model and size		:	
30 Material		:	
31 Weight	kg	:	
32Approved by		:	
33		:	
34 **Firemans helmet with visor:**			
35 No in cabinet		: 4	
36 Type and model		:	
37 Material		:	
38 Weight	kg	:	
39 Approved by		:	
40			
41 **Firemans boots:**			
42 No in cabinet		: 4	
43 Type and model		:	
44 Material		:	
45 Weight	kg	:	
46 Approved by		:	
47			

NORSOK S-001 Rev. 5: 2018	FIREMANS EQUIPMENT CABINET DATA SHEET	Made by	
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48 CONTENTS OF CABINET (CONT)		
49		
50 Gloves aluminized:		
51 No in cabinet		: 4
52 Type and model		:
53 Material		:
54 Approved by		:
55		
56 Gloves electricians:		
57 No in cabinet		: 4
58 Type and model		:
59 Material		:
60 Approved by		:
61		
62 Rescue belt:		
63 No in cabinet		: 4
64 Type and model		:
65 Material		:
66 Weight	kg	:
67 Approved by		:
68		
69 Breathing apparatus:		
70 No in cabinet		: 4
71 Type and model		:
72 Material		:
73 Complete set weight	kg	:
74 Mask type and model		:
75 Set stored dimensions	mm	:
76 Number of cylinders per set		:
77 Nominal work duration		:
78 Operating temperature	°C	:
79 Approved by		:
80		
81 Air cylinders for breathing apparatus:		
82 No in cabinet		: 12
83 Type and model		:
84 Material		:
85 Weight	kg	:
86 Dimensions (DxH)	mm	:
87 Water capacity	ltr	:
88 Air capacity	ltr	:
89 Working pressure	barg	:
90 Test presure	barg	:
91 Approved by		:
92		
93 Radio sets:		
94 No in cabinet		: 4
95 Type and model		:
96 Material		:
97 Weight	kg	:
98 Electrical area hazard		:
99 Zone		:
100 Gas/temp class		:
101 Approved by		:
102		:

NORSOK S-001 Rev. 5: 2018	FIREMANS EQUIPMENT CABINET DATA SHEET	Made by	
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103 CONTENTS OF CABINET (CONT.)		
104		
105 Radio sets (cont.)		
106 Output power		:
107 Frequencies		:
108 Sensitivity		:
109 Modulation		:
110 Battery capacity		:
111		
112 Charger for radio sets:		
113 No in cabinet		: 1
114 Type and model		:
115 Dimensions (LxWxH)	mm	:
116 Material		:
117 Weight	kg	
118 Area classification		
119 Supply		:
120 Recharging time	hr	:
121		
122 Torches:		
123 No in cabinet		: 6
124 Type and model		:
125 Material		:
126 Weight	kg	:
127 Dimensions (LxWxH)	mm	:
128 Electrical area hazard		:
129 Zone		:
130 Gas/temp class		:
131 Operation time	hr	:
132 Recommended time between		:
133 Recharging (when not used)		:
134		
135 Batteries for torches:		
136 Type and model		:
137 Battery charger supply		:
138		
139 Boiler suit with hood:		
140 No in cabinet		: 4
141 Type and model		:
142 Material		:
143 Weight	kg	:
144 Approved by		:
145		
146 Rescue mask:		
147 No in cabinet		: 2
148 Type and model		:
149 Material		:
150 Weight	kg	:
151 Approved by		:
152		
153 Body Line:		
154 No in cabinet		: 4
155 Type and model		:
156 Material		:
157		:

NORSOK S-001 Rev. 5: 2018	FIREMANS EQUIPMENT CABINET DATA SHEET	Made by	
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CONTENTS OF CABINET	(CONT.)
158 **Body line (cont.)**	
159 Weight	kg :
160 Approved by	:
161	:
162	
163 **Force Tool:**	
164 No in cabinet	: 2
165 Type and model	:
166 Material	:
167 Weight	kg :
168	:
169	
170 **Stroke bar:**	
171 No in cabinet	: 2
172 Type and model	:
173 Material	:
174 Weight	kg :
175	:
176	
177 **Bolt cutter:**	
178 No in cabinet	: 2
179 Type and model	:
180 Material	:
181 Weight	kg :
182	:
183	
184 **NOTES:**	
185	
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C.10 SDS-110 Firewater Valve Skid Data Sheet

NORSOK S-001 Rev. 5: 2018	FIREWATER VALVE SKID DATA SHEET	**Made by**	
		Checked by	
		Date	
		Data Sheet	**SDS-110**

Package no.	**Doc. no.**	**Rev.**	**Page 1 of 2**

Tag no.		Location/Module	
Unit		No. req'd	
Service		Inquiry no.	
Size & type		Quote no.	
Supplier		P.O. no.	
Manufacturer		Job no.	
Model		Serial no.	

1 **SERVICE CONDITIONS**			
2 Module/area protected	:		
3 Explosion blast pressure	:		
4 Electrical area hazard	: Zone 1	Gas/temp class	: II A/T3
5 Equipment designed according to	:		
6	:		
7	:		
8 **PERFORMANCE REQUIREMENTS**			
9 Design standard	:		
10 Special project requirements	:		
11 Design flowrate water	m³/hr :		
12 Design flowrate foam	m³/hr :		
13 Design downstream operating press.	barg :		
14 Max. pressure downstream	barg :		
15 Design upstream operating press. water	barg :		
16 Design upstream max. pressure water	barg :		
17 Design upstream operating press. foam	barg :		
18 Design upstream max. pressure foam	barg :		
19 Electric heater	:		
20 Lighting	:		
21 Foam mixing ratio	:		
22 Required differential pressure foam prop.	bar :		
23 Proportional tolerance foam prop	:		
24 Colour	:		Δ-2018
25	:		
26 **WEIGHT**			
27 Weight dry	kg :		
28 Weight ope	kg :		
29 Lifting lugs	:		
30	:		
31	:		
32 **MATERIALS**			
33 Deluge valve	:		
34 Enclosure	:		
35 Foam proportioning	:		
36	:		
37	:		
38 **NOTES:**			
39			
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NORSOK S-001 Rev. 5: 2018	FIREWATER VALVE SKID DATA SHEET	Made by	
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DIMENSIONS

A		H		
B		I		
C		J		
D		K		
E		L		
F		M		
G		N		

NOZZLES

MARK	No.	DN	PN	TYPE	SERVICE

NOTES:

C.11 SDS-111 Portable Extinguisher Data Sheet

NORSOK S-001 Rev. 5: 2018	PORTABLE EXTINGUISHER DATA SHEET	Made by	
		Checked by	
		Date	
		Data Sheet	SDS-111

Package no.	Doc. no.	Rev.	Page 1 of 2

Tag no.		Location/module	
Unit		No. req'd	
Service		Inquiry no.	
Size & type		Quote no.	
Supplier		P.O. no.	
Manufacturer		Job no.	
Model		Serial no.	

1 DESIGN REQUIREMENTS		
2 **Extinguisher:**		
3 Charge capacity	kg :	
4 Fire rating/class	:	
5	:	
6	:	
7 **Extinguishing agent:**		
8 Type	:	
9 Manufacturer	:	
10 Trade name	:	
11 Approvals	:	
12	:	
13	:	
14 WEIGHT AND DIMENSIONS		
15 Dimensions (DxH)	mm :	
16 Total weight	kg :	
17	:	
18	:	
19 NOTES:		
20		
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NORSOK S-001 Rev. 5: 2018	PORTABLE EXTINGUISHER DATA SHEET	Made by	
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TAG Number	AREA	DESCRIPTION	COMMENTS

C.12 SDS-112 Eye Bath Data Sheet

NORSOK S-001 Rev. 5: 2018	EYE BATH DATA SHEET	Made by	
		Checked by	
		Date	
		Data Sheet	SDS-112

Package no.	Doc. no.	Rev.	Page 1 of 1

Tag no.		Location/module	
Unit		No. req'd	
Service		Inquiry no.	
Size & type		Quote no.	
Supplier		P.O. no.	
Manufacturer		Job no.	
Model		Serial no.	

1 DESIGN REQUIREMENTS			
2 No off		:	
3 Type		:	
4 Weight	kg	:	MDS :
5 Material		:	
6 Stay open valve		:	
7 Method of valve opening		:	
8 Max. working pressure	barg	:	
9 Min. working pressure	barg	:	
10 Test pressure	barg	:	
11 Flow rate	m^3/h	:	
12 Water temperature	°C	:	
13 Inlet connection diameter	mm	:	
14 Inlet connection type		:	
15 Dimensions overall	mm	:	
16		:	
17		:	
18		:	
19		:	
20 NOTES:			
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C.13 SDS-113 Breathing Air Recharge Unit Data Sheet

NORSOK S-001 Rev.5: 2018	BREATHING AIR RECHARGE UNIT DATA SHEET	Made by	
		Checked by	
		Date	
		Data Sheet	SDS-113

Package no.	Doc. no.	Rev.	Page 1 of 1

Tag no.		Location/module	
Unit		No. req'd	
Service		Inquiry no.	
Size & type		Quote no.	
Supplier		P.O. no.	
Manufacturer		Job no.	
Model		Serial no.	

1 DESIGN REQUIREMENTS			
2 Nominal capacity	m^3/hr	: 19.2	
3 Working pressure	barg	: 300	
4 Filling pressure	barg	:	
5 Power supply	V	: 660	
6 Power rating		:	
7 Frequency	Hz	:	
8		:	
9		:	
10		:	
11 CONSTRUCTION			
12 Classification:		:	
13 Length	mm	:	
14 Width	mm	:	
15 Height	mm	:	
16 Weight	kg	:	
17 Material		:	
18 Surface protecton (panel)		:	
19 Surface protection (rack)		:	
20 Colour		:	Δ-2018
21 Approvals		: Manufacturers Standard	
22		:	
23		:	
24		:	
25 Air testing kit:			
26 Manufacturer		:	
27 Model		:	
28 Utility consumption		:	
29 Approvals		:	
30		:	
31		:	
32		:	
33 NOTES:			
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C.14 SDS-116 Safety Station Cabinet Data Sheet

NORSOK S-001 Rev. 5: 2018	SAFETY STATION CABINET DATA SHEET	Made by	
		Checked by	
		Date	
		Data Sheet	SDS-116

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Tag no.		Location/module	
Unit		No. req'd	
Service		Inquiry no.	
Size & type		Quote no.	
Supplier		P.O. no.	
Manufacturer		Job no.	
Model		Serial no.	

1 DESIGN REQUIREMENTS			
2 Cabinet:			
3 Type and model		:	
4 Material		:	
5 Length	mm	:	
6 Width	mm	:	
7 Height	mm	:	
8 Weight (empty)	kg	:	
9 Weight (including equipment)	kg	:	
10 Door size	mm	:	
11 Door opening angle	deg.	:	
12 Door opens to		:	
13 Marking		:	
14 Painting		:	Δ-2018
15 Electric heater		:	
16 Lighting		:	
17 Degree of protection		:	
18 Explosion blast pressure		:	
19		:	
20		:	
QUANTITY			
21 Contents of Cabinet:			
22 12 kg dry powder extinguisher		:	
23 Breathing apparatus (complete)		:	
24 Spare air cylinder		:	
25 Torch		:	
26 First aid kit		:	
27 Basket type stretcher		:	
28 Scoop type stretcher		:	
29 Wool blankets		:	
30 50 kg dry powder mobile extinguisher		:	
31 10 kg wheeled CO^2 extinguisher		:	
32 Crash equipment set		:	
33		:	
34		:	
35 NOTES:			
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C.15 SDS-117 Safety Shower/Eye Bath (outdoor) Data Sheet

NORSOK S-001 Rev. 5: 2018	SAFETY SHOWER/EYE BATH DATA SHEET	Made by	
		Checked by	
		Date	
		Data Sheet	SDS-117

Package no.	Doc. no.	Rev.	Page 1 of 1

Tag no.		Location/module	
Unit		No. req'd	
Service		Inquiry no.	
Size & type		Quote no.	
Supplier		P.O. no.	
Manufacturer		Job no.	
Model		Serial no.	

1 DESIGN REQUIREMENTS			
2 No off		:	
3 Type		:	
4 Weight	kg	:	
5 Material		:	MDS :
6 Stay open valve		:	
7 Method of valve opening		:	
8 Max. working pressure	barg	:	
9 Min. working pressure	barg	:	
10 Test pressure	barg	:	
11 Flow rate	m^3/h	:	
12 Water temperature	ºC	:	
13 Heater type		:	
14 Heater voltage	Volt	:	
15 Heater rating	Watt	:	
16 Heater duty continuous rated		:	
17 Inlet conection diameter	mm	:	
18 Inlet conection type		:	
19 Dimensions overall	mm	:	
20		:	
21		:	
22		:	
23		:	
24 NOTES:			
25			
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C.16 SDS-118 Lifeboat and Davit Data Sheet

NORSOK S-001 Rev. 5: 2018	LIFEBOAT AND DAVIT DATA SHEET	Made by	
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1 Tag no.		Location/module	
2 Unit		No. req'd	
3 Service		Inquiry no.	
4 Size & type		Quote no.	
5 Supplier		P.O. no.	
6 Manufacturer		Job no.	
7 Model		Serial no.	

8 SERVICE CONDITIONS AND DESIGN REQUIREMENTS			
9 Ambient temperature [°C]			
10 Hazardous Area Classification		Gas group:	Temp Class:
11 Design standard	DNVGL-ST-E406		
12 Approving Authority			
13 Launching height (Max./Min) [m]			
14			Δ 2018
15			Δ 2018
16			Δ 2018
17			Δ 2018
18			Δ 2018
19			
20 GENERAL DATA LIFEBOAT			
21 Type & Model			
22 Manufacturer			
23 No.off			
24 Overall dimensions LxWxH [mm]			
25 Max. no off persons			
26 Dry weight of empty boat [kg]			
27 Max Speed calm weather [knots]			
28 Persons needed to launch			
29 Static Bollard pull			Δ 2018
57 Deluge test facility in davit / skid (Y/N)			Δ 2018
30 ENGINE			
31 Supplier/Type			
32 Rated power [kW]			
33 Fuel Tank capacity [l]			
34 Gear box			
35 Fuel consumption at max. speed [l/m]			
36			Δ 2018
37 Propulsion system			Δ 2018
38 Engine brake system (for engine test)			
39 VENTILATION (CLOSED DOWN CONDITION)			
40 Method			
41 No. of cylinders			
42 Size [l]			
43 Pressure [barg]			
44 Capacity per cylinder (Free air) [m3]			
45			
46 HELMSMANS POSITION			
47 Steering method			
48 Back-up Steering method			
49 Boat Release control			
50 Engine Start control			
51 Connection for VHF Radio			
52 Navigational Assistance System (NAS)			Δ 2018
53 Automatic Identification System (AIS)			Δ 2018
54			
55			
56			

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59 INSTRUMENTATION			
	Indicator	**Warning Light**	**Audible Alarm**
60 Diesel Engine			
61 Tachometer			
62 Cooling Water temperature			
63 Cooling Water level			
64 Running Hour counter			
65 Lubricating Oil pressure			
66 Lubricating Oil temperature			
67 Compressed Air pressure			
68 Fuel Oil level			
69 Battery charge			
70 Compass			
71 Water Spray Pump pressure			
72			

73 ELECTRICAL EQUIPMENT			
74 Electrical supply			
75 Battery type	No off.:	Capacity:	Voltage:
76 Dynamo type			
77 Starter type	No off:		Voltage:
78 Searchlight type	No.off:	Watts:	Voltage:
79 Navigation Lights type			
80 Interior Lights type			
81 Connection for Engine 81 Heater			
82 Connection for Battery Charger			
83 Light Switches			
84			
85			
86			
87			
88			

180 MATERIAL SPECIFICATION	
181 Lifeboat	
182 Hull	
183 Internals	
184 Seats	
185 Propeller Shaft	
186 Propeller	
187 Propeller Shaft Bearings	
188 Rudder	
189 Fuel Tank	
190 Exhaust Pipe	
191 Davit	
192 Frame	
193 Winch	
194 Frame	
195 Drum	
196 Shaft	
197 Shaft Bearing	
198 Auxiliaries	
199 Chain	
200 Shackles	
201 Sheaves	
202 Sheave Bearings	
203	
204	

205 NOTES:

206 Lifeboats of conventional type should as far as possible have bow thrust propellers in order to reduce the collision risk and improve operability in critcal

207 situations

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91 CASE 1 HYDRAULIC OPERATED DAVIT	
92 Operating pressure [barg]	
93 Reservoir capacity [l]	
94 Hydraulic Fluid type	
95 Hydraulic Fluid system capacity [l]	
96	
97 Pump	
98 Equipt. No.	
99	
100 Supplier/Type	
101 Output [kW]	
102	
103 Filters	
104 Supplier/Type	
105 Filtration ratio	
106	
107 Winch	
108 Equipt.No.	
109 Supplier/Type	
110 Hoisting capacity [kg]	
111 Hoisting height [m]	
112 Hoisting speed with max. load [m/s]	
113 Lowering speed [m/s]	
114 Drum details	
115	
116 Gearbox	
117 Supplier/Type	
118 Gear ratio	
119	
120 Electric Motor	
121 Equipt. No.	
122 Supplier/Type	
123 Motor supply	
124 Rated power [kW]	
125	
126 Hydraulic Motor	
127 Supplier/Type	
128	
129 CASE 2 ELECTRICAL OPERATED DAVIT	
130 Motor	
131 Equipt.No.	
132 Supplier/Type	
1 33 Motor supply	
134 Rated power [kW]	
135	
136 Gearbox	
137 Equipt.No.	
138 Supplier/Type	
139 Gear ratio	
140	
141 Winch	
142 Equipt.No.	
143 Supplier/Type	
144 Hoisting capacity [kg]	
145 Hoisting height [m]	
146 Hoisting speed with max. load [m/s]	
147 Lowering speed [m]	
148 Drum details	
149	
150 WIRE ROPE AND HOOKS	
151 Hooks	
152 Supplier/Type	
153 SWL [kg]	
154	
155 Wire Rope	
156 Diameter [mm]	
157 Core material	
157 Wire material	
159 Tensile strength [kg/mm2]	
160 Total breaking load [kN]	
161 Corrosion protection	
162 Wire length [m]	
163 No. of falls	

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