NORSOK STANDARD S-001

Edition 4, February 2008

Technical safety

Standards Norway
Strandveien 18, P.O. Box 242
N-1326 Lysaker
NORWAY

Telephone: + 47 67 83 86 00
Fax: + 47 67 83 86 01
Email: petroleum@standard.no
Website: www.standard.no/petroleum

Foreword		**6**
Introduction		**6**
1	**Scope**	**7**
2	**Normative and informative references**	**7**
2.1	Normative references	7
2.2	Informative references	8
3	**Terms, definitions and abbreviations**	**8**
3.1	Terms and definitions	8
3.2	Abbreviations	10
4	**Management of technical safety**	**11**
4.1	General	11
4.2	Risk reduction principles – inherent safety design	12
4.3	Safety performance standards	12
4.4	Qualification of technology	12
4.5	Experience transfer	13
4.6	Integrity – availability and reliability	13
4.7	Dimensioning accidental load (DAL)	13
4.8	Documentation	14
5	**Layout**	**14**
5.1	Role	14
5.2	Interfaces	14
5.3	Required utilities	15
5.4	Functional requirements	15
5.5	Survivability requirements	17
6	**Structural integrity**	**17**
6.1	Role	17
6.2	Interfaces	17
6.3	Required utilities	17
6.4	Functional requirements	17
6.5	Survivability requirements	17
7	**Containment**	**18**
7.1	Role	18
7.2	Interfaces	18
7.3	Required utilities	18
7.4	Functional requirements	18
7.5	Survivability requirements	18
8	**Open drain**	**18**
8.1	Role	18
8.2	Interfaces	18
8.3	Required utilities	18
8.4	Functional requirements	19
8.5	Survivability requirements	19
9	**Process safety**	**19**
9.1	Role	19
9.2	Interfaces	19
9.3	Required utilities	19
9.4	Functional requirements	19
9.5	Survivability requirements	20
10	**Emergency shut down (ESD)**	**20**
10.1	Role	20
10.2	Interfaces	20
10.3	Required utilities	21
10.4	Functional requirements	21
10.5	Survivability requirements	24

11 Blow down (BD) and flare/vent system 25
11.1 Role 25
11.2 Interfaces 25
11.3 Required utilities 25
11.4 Functional requirements 25
11.5 Survivability requirements 26

12 Gas detection 26
12.1 Role 26
12.2 Interfaces 27
12.3 Required utilities 27
12.4 Functional requirements 27
12.5 Survivability requirements 33

13 Fire detection 33
13.1 Role 33
13.2 Interfaces 33
13.3 Required utilities 33
13.4 Functional requirements 34
13.5 Survivability requirements 40

14 Ignition source control (ISC) 40
14.1 Role 40
14.2 Interfaces 41
14.3 Required utilities 41
14.4 Functional requirements 41
14.5 Survivability requirements 43

15 Human – machine interface (HMI) 44
15.1 Role 44
15.2 Interfaces 44
15.3 Functional requirements 44
15.4 Survivability requirements 45

16 Natural ventilation and heating, ventilation and air conditioning (HVAC) 45
16.1 Role 45
16.2 Interfaces 46
16.3 Required utilities 46
16.4 Functional requirements 46
16.5 Survivability requirements 47

17 Public address (PA), alarm and emergency communication 48
17.1 Role 48
17.2 Interfaces 48
17.3 Required utilities 48
17.4 Functional requirements 48
17.5 Survivability requirements 50

18 Emergency power and lighting 50
18.1 Role 50
18.2 Interfaces 50
18.3 Required utilities 50
18.4 Functional requirements 50
18.5 Survivability requirements 52

19 Passive fire protection (PFP) 52
19.1 Role 52
19.2 Interfaces 52
19.3 Required utilities 52
19.4 Functional requirements 52
19.5 Survivability requirements 54

20 Fire fighting systems 54
20.1 Role 54
20.2 Interfaces 54
20.3 Required utilities 55

20.4	Functional requirements	55
20.5	Survivability requirements	61
21	**Escape and evacuation**	**62**
21.1	Role	62
21.2	Interfaces	62
21.3	Required utilities	62
21.4	Functional requirements	62
21.5	Survivability requirements	64
22	**Rescue and safety equipment**	**65**
22.1	Role	65
22.2	Interfaces	65
22.3	Required utilities	65
22.4	Functional requirements	65
22.5	Survivability requirements	67
23	**Marine systems and position keeping**	**67**
23.1	Role	67
23.2	Interfaces	67
23.3	Required utilities	67
23.4	Functional requirements	67
23.5	Survivability requirements	68
24	**Ship collision barrier**	**68**
24.1	Role	68
24.2	Interfaces	68
24.3	Required utilities	68
24.4	Functional requirements	68
24.5	Survivability requirements	69
Annex A (Informative) Fire protection data sheet		**70**

Foreword

The NORSOK standards are developed by the Norwegian petroleum industry to ensure adequate safety, value adding and cost effectiveness for petroleum industry developments and operations. Furthermore, NORSOK standards are, as far as possible, intended to replace oil company specifications and serve as references in the authorities' regulations.

The NORSOK standards are normally based on recognised international standards, adding the provisions deemed necessary to fill the broad needs of the Norwegian petroleum industry. Where relevant, NORSOK standards will be used to provide the Norwegian industry input to the international standardisation process. Subject to development and publication of international standards, the relevant NORSOK standard will be withdrawn.

The NORSOK standards are developed according to the consensus principle generally applicable for most standards work and according to established procedures defined in NORSOK A-001.

The NORSOK standards are prepared and published with support by The Norwegian Oil Industry Association (OLF), The Federation of Norwegian Industry, Norwegian Shipowners' Association and The Petroleum Safety Authority Norway.

NORSOK standards are administered and published by Standards Norway.

Annex A is informative.

Introduction

This NORSOK standard is organised according to principles given in clause 4. 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 dimensioning accidental event.

1 Scope

This NORSOK standard describes the principles and requirements for the development of the safety design 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 for implementation of technologies and emergency preparedness to establish and maintain an adequate level of safety for personnel, environment and material assets.

2 Normative and informative 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.

2.1 Normative references

API RP 14C,	Recommended Practice for Analysis, Design, Installation, and Testing of Basic Surface Safety Systems for Offshore Production Platforms
API RP 521,	Guide for Pressure-Relieving and Depressurizing Systems
Directive 94/9/EC,	Concerning equipment and protective systems intended for use in potentially explosive atmospheres (ATEX "Product")
CENELEC CLC/TR 50427,	Assessment of inadvertent ignition of flammable atmospheres by radio-frequency radiation
EN 1838,	Lighting applications – Emergency lighting
EN 13463 – (all parts),	Non-electrical equipment intended for use in potentially explosive atmospheres
IMO Res.A.653,	Flame spread, surface materials and floorings
ISO 5660 – (all parts),	Reaction-to-fire tests – Heat release, smoke production and mass loss rate
ISO 10418,	Petroleum and natural gas industries – Offshore production installations – Basic surface process safety systems
ISO 13702,	Petroleum and natural gas industries – Control and mitigation of fires and explosions on offshore production installations – Requirements and guidelines
IEC/TR 60079-13,	Electrical apparatus for explosive gas atmospheres – Part 13: Construction and use of rooms or buildings protected by pressurization
IEC 60331– (all parts),	Tests for electric cables under fire conditions – Circuit integrity
IEC 60332– (all parts),	Tests on electric and optical fibre cables under fire conditions
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 61892-7,	Mobile and fixed offshore units – Electrical installations – Part 7: Hazardous areas
IP 15,	Area Classification code for installations handling flammable fluids
ISO 23251,	Petroleum, petrochemical and natural gas industries – Pressure-relieving and depressurizing systems
OLF Guideline No. 070,	Guidelines for the Application of IEC 61508 and IEC 61511 in the petroleum activities on the continental shelf
OLF Retningslinjer Nr. 075,	Anbefalte retningslinjer for vannbaserte brannbekjempelsessystemer
MODU Code,	Code for the construction and equipment of mobile offshore drilling units, 2003 Consolidated edition (2001 MODU Code)
NFPA 20,	Standard for the Installation of Stationary Fire Pumps for Fire Protection Spray Systems
NMD Regulation No.123,	Regulation for mobile offshore units with production plants and equipment
NMD Regulation No.492,	Regulation 11 April 2003 No.492 concerning lifesaving appliances and evacuation on mobile offshore units
NMD Regulation No.879,	Regulation concerning ballast systems on mobile offshore units
NORSOK C-001,	Living quarters area

NORSOK C-002,	Architectural components and equipment
NORSOK D-001,	Drilling facilities
NORSOK H-001,	HVAC (Heating, ventilation and air conditioning)
NORSOK L-001,	Piping and Valves
NORSOK L-002,	Piping design, layout and stress analysis
NORSOK M-501,	Surface preparation and protective coating
NORSOK N-001,	Structural design
NORSOK N-003,	Actions and action effects
NORSOK P-001,	Process Design
NORSOK P-100,	Process systems
NORSOK Z-013,	Risk and emergency preparedness analysis
SOLAS requirements	

2.2 Informative references

DNV-RP-A203, Qualification Procedures for New Technology

Guidelines for protection of pressurised systems exposed to fire, Report 27.101.166/R1 Scandpower Risk Management AS

ISO 17776, Petroleum and natural gas industries – Offshore production installations – Guidelines on tools and techniques for hazard identification and risk assessment

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 750, Standard on Water Mist Fire Protection Systems

NMD Regulations No.857, Regulation concerning anchoring/positioning systems on mobile offshore units

NORSOK L-005, Compact flanged connections

SINTEF NBL report A05103, Branntekniske krav til materialer i boligkvarter offshore

YA 711, Principles for alarm system design (Petroleum Safety Authority publication)

3 Terms, definitions and abbreviations

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

3.1 Terms and definitions

3.1.1
area classification
division of an installation into hazardous areas and non-hazardous areas and the sub-division of hazardous zones

3.1.2
can
verbal form used for statements of possibility and capability, whether material, physical or casual

3.1.3
dimensioning accidental load (DAL)
most severe accidental load that the function or system shall be able to withstand during a required period of time, in order to meet the defined risk acceptance criteria

3.1.4
emergency lighting
lighting which will ensure adequate light conditions on the installation in the event of failure of the main power supply

3.1.5
explosion load
time dependent pressure or drag forces generated by violent combustion of a flammable atmosphere

3.1.6
fire area
area separated from other areas either by physical barriers (fire/blast partition) or distance which will prevent dimensioning fire to spread

3.1.7
fire detection area
area, or areas, of similar environmental conditions and hazards, and with similar detection and protection arrangements defined for the purpose of grouping areas or rooms into similar F&G logic

3.1.8
fire load
heat load from a fire for a specified time period

3.1.9
firewater (FW) pump system
total system, which supplies water for fire fighting system, i.e. water inlets with filters, FW pumps, risers, power sources, power transmissions, fuel pipes/tanks and control systems

3.1.10
hazardous area
three-dimensional space in which a flammable atmosphere may be expected to be present at such frequencies as to require special precautions for the control of potential ignition sources

3.1.11
ignition source groups
non-essential equipment, Group 1, is equipment not affecting production availability or safety integrity

NOTE Non-essential equipment may include equipment such as non-Ex lighting, heat tracing, welding socket outlets, electrical outlets for hand tools, air operated tools and other hot work activities.

essential equipment, Group 2, is equipment that shall be kept alive to maintain production or drilling operations

NOTE Affected equipment may include main power generator, main electrical distribution panels, all electrical consumers not required during ESD1, diesel engines, heaters, boilers, ventilation systems unless defined as a safety critical item.

safety critical equipment, Group 3, is equipment that shall be in operation to ensure escape, evacuation and/or to prevent escalation

3.1.12
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

3.1.13
may
verbal form used to indicate a course of action permissible within the limits of this NORSOK standard

3.1.14
muster area
area where mustering shall take place in the event of general and/or evacuation alarm

3.1.15
non-hazardous area
area in which an explosive gas atmosphere is not expected to be present in quantities such as to require special precautions for the construction, installation and use of electrical apparatus and equipment in “normal operation”

NOTE 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 shut down are not considered to be part of normal operation, and may require special precautions of potential ignition sources.

3.1.16
normally not manned
work area or work place that is not permanently or intermittently manned

3.1.17
safety function
physical measures which reduce the probability of a situation of hazard and accident occurring, or which limit the consequences of an accident

3.1.18
shall
verbal form used to indicate requirements strictly to be followed in order to conform to this NORSOK standard and from which no deviation is permitted, unless accepted by all involved parties

3.1.19
should
verbal form used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred, but not necessarily required

3.1.20
temporary refuge
place provided where personnel can take refuge for a pre-determined period whilst investigations, emergency response and evacuation pre-planning are undertaken

3.2 Abbreviations

AC/h	air changes per hour
AFP	active fire protection
API	American Petroleum Institute
APS	abandon platform shut down
ATEX	EU Directive covering “Equipment Intended for Use in Potentially Explosive Atmosphere”
BD	blow down
BOP	blow out preventer
C&E	cause and effect
CAP	critical action panel
CCR	central control room
CENELEC	European Committee for Electrotechnical Standardization
DAL	dimensioning accidental load
DHSV	down hole safety valve
DIFFS	deck integrated fire fighting system
EERS	evacuation, escape and rescue strategy
EN	European Standard
ESD	emergency shut down
F&G	fire and gas
FES	fire and explosion strategy
FPDS	fire protection data sheet
FPSO	floating production, storage and offloading
FW	firewater
GA	general alarm
HC	hydro carbon
HMI	human-machine interface
HVAC	heating, ventilation and air conditioning
IEC	International Electrotechnical Commission
IMO	International Maritime Organisation
IP	Institute of Petroleum
ISC	ignition source control
ISO	International Organization for Standardization
IR	infrared
LAHH	level alarm high high (trip level)
LEL	lower explosion limit
LELm	lower explosion limit meters

LER	local equipment room
LIR	local instrument room
LQ	living quarter
MOB	man over board
MODU	mobile offshore drilling unit
NA	not applicable
NFPA	National Fire Protection Association
NMD	Norwegian Maritime Directorate
NNMI	normally not manned installations
OLF	Oljeindustriens Landsforening
PA	public address
PFP	passive fire protection
PSD	process shut down
PSV	pressure safety valve
RAL	Deutches Institut für Gutesicherung und Kennzeichnung
SAS	safety and automation system
SINTEF NBL	Norwegian Fire Research Laboratory
SOLAS	International Convention for the Safety of Life at Sea
SSIV	subsea isolation valve
UHF	ultra high frequency
VDU	visual display unit
VHF	very high frequency
UPS	uninterruptible power supply

4 Management of technical safety

4.1 General

Technical safety management in project development and design processes comprises activities to identify risks, develop safety strategies and performance requirements for safety systems and barriers. Technical safety management shall also facilitate the design process to ensure that studies, analysis and reviews are performed in due time and properly documented with due consideration of the needs for timely input to design and procurement processes.

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 considered to be affected by the modification.

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.

The individual project or installation shall perform specific hazard identification and risk evaluation process, and supplement the requirements as necessary to manage the actual risk picture.

A flow diagram describing some of the main activities related to technical safety design is shown in Figure 1.

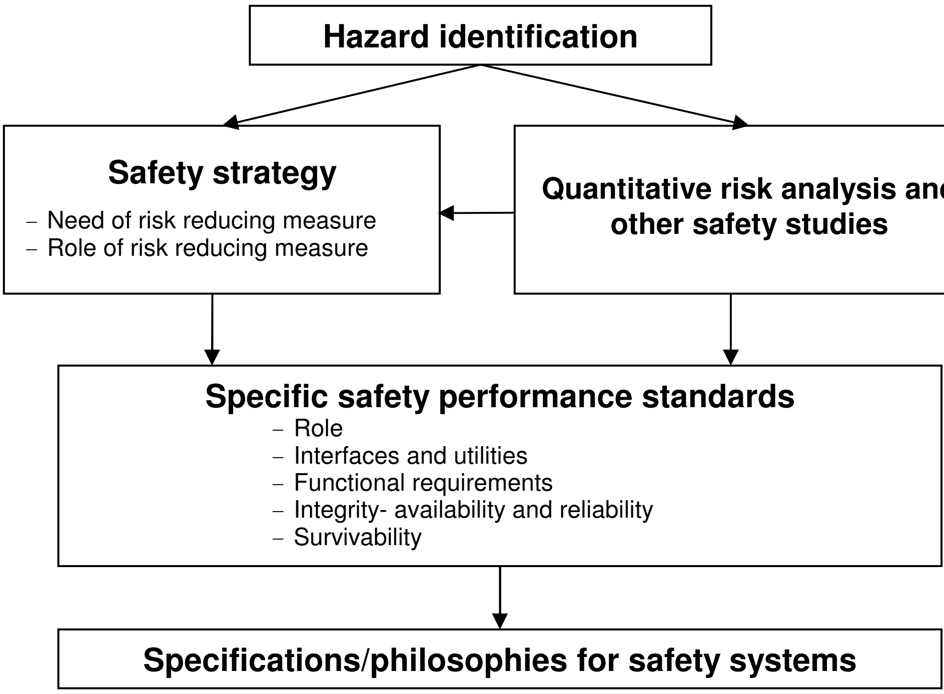

Figure 1 - Technical safety design

4.2 Risk reduction principles – inherent safety design

In concept optimisation and design development, priority shall always be given to use of preventive measures/exposure barriers and inherently safer design principles. The objectives with risk reduction principles and inherent safety design are to

- reduce potential hazards,
- reduce probability of unwanted events,
- reduce inventory and damage potential,
- strive for simplicity and reliability,
- prevent escalation, e.g. by safety barriers.

4.3 Safety performance standards

Safety performance standard shall be the verifiable standard to which safety system elements are to perform. The objective of the specific safety performance standards is to add any supplemental safety requirements other than those specified by authority requirements and standards.

The performance standards shall be based on the safety strategy document(s) and these should be read in conjunction with each other.

The specific safety performance standards shall ensure that barriers, safety systems or safety functions

- are suitable and fully effective for the type hazards identified,
- have sufficient capacity for the duration of the hazard or the required time to provide evacuation of the installation,
- have sufficient availability to match the frequency of the initiating event,
- have adequate response time to fulfil its role,
- are suitable for all operating conditions.

4.4 Qualification of technology

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

4.5 Experience transfer

To ensure transfer of technical safety experience from relevant installations in operation, an experience transfer activity prior to start of detail engineering should be carried out. 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.

4.6 Integrity – availability and reliability

The minimum requirements to availability and reliability for safety functions/systems shall be determined based on IEC 61508 or IEC 61511 or other specific safety analysis/risk assessments as relevant for the safety function in question.

All relevant safety function/systems shall be subject to testing at regular intervals. Test intervals should be determined based on relevant standards, criticality analysis and experience. For instrumented safety systems, see OLF Guideline No. 070.

The design of safety functions/systems shall, where practical, allow for required testing to be carried out without interrupting production or operations.

The applicable safety system or affected parts of it shall go to a predefined safe state in the event of detectable malfunction.

If not fail-safe, the same level of safety shall be achieved by redundancy, diagnostics and alarm to control room. Single faults/errors should not prohibit actions on demand.

4.7 Dimensioning accidental load (DAL)

DALs shall be established based on quantitative risk analysis and the comparison of estimated risk with risk acceptance and/or design criteria. Dimensioning loads shall be revised upon modifications, e.g. layout, equipment density and natural ventilation conditions.

Dimensioning load shall not cause loss of safety functions or escalation (locally). The following principles shall apply:

- dimensioning explosion loads shall be established using a recognised method (e.g. NORSOK Z-013) and a representative geometric explosion model. The loads shall be defined for relevant local horizontal and vertical area dividers (pressure and impulse from explosion) and equipment (pressure/drag forces);
- explosion loads shall also be defined for areas external to the initial explosion location (typical LQ, utility modules etc.);
- fire loads, (e.g. heat loads). Unless specific fire analysis is performed, Table 1 applies;
- ship collisions (e.g. impact loads to be absorbed by installation structure), see NORSOK Z-013 and NORSOK N-001;
- falling loads and dropped objects (e.g. impact loads to be absorbed by installation structure), see NORSOK Z-013.

Table 1 - Heat flux values

	Jet fire		**Pool fire**
	For leak rates $m > 2$ kg/s kW/m^2	**For leak rates $0,1$ kg/s $< m < 2$ kg/s** kW/m^2	kW/m^2
Local peak heat load	350	250	150
Global average heat load	100	0	100

The effect of area deluge is not accounted for in Table 1. The effect of deluge may be taken into account for process piping/equipment (not for main structural elements and fire partitions) provided proper documentation is available on the effect of deluge as well as on the reliability of the FW supply system.

The global average heat load represents the average heat load that expose a significant part of the process segment or structure. The global average heat load provides the major part of the heat input to the process segment and, hence, affects the pressure in the segment.

The local peak heat load exposes a small (local) area of the process segment or of the structure to the peak heat flux. The local peak heat load, with the highest heat flux, determines the rupture temperature of different equipment and piping within the process segment. The local peak heat load has marginal influence on the pressure profile within the process segment.

An alternative approach to assessing the heat fluxes and the size of the fire is to base this on a probabilistic approach in combination with relevant acceptance criteria.

4.8 Documentation

The following technical safety documents should be developed during development of a new installation:

- hazard identification report, see ISO 17776;
- safety strategies and safety performance standards;
- specifications and philosophies for safety systems as required;
- FW report;
- dimensioning accidental load specification;
- safety analyses and evaluations, e.g.:
  - vulnerability analyses for safety systems;
  - sectionalisation of the process plant including categorization and location of safety critical valves;
  - reliability and availability;
  - fire load analyses;
  - explosion analyses;
  - dispersion analyses.
- FPDS/area safety charts/F&G C&E;
- safety arrangements drawings and diagrams as follows:
  - passive fire and blast protection;
  - area classification;
  - F&G detection layout;
  - escape routes, muster areas, evacuation means;
  - safety equipment plot plans;
  - fire fighting plot plans and process and instrument diagrams;
  - ESD C&E diagram (PSD C&E may be developed);
  - ESD hierarchy.

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

5 Layout

5.1 Role

The layout 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 hydrocarbon,
- 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.

5.2 Interfaces

Layout has interfaces with all of the safety systems-/functions.

5.3 Required utilities

Layout is not dependent on any specific utility.

5.4 Functional requirements

5.4.1 Main design principles

The installation 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.

Temporary refuge, accommodation, evacuation means, escape routes and rescue facilities shall be located where they are least affected from fires and explosions.

Safety systems shall be located or protected to ensure operation during relevant emergency condition. Examples of relevant safety systems are FW pump units, emergency generator(s), UPS, ESD/PSD/F&G nodes, ballast system and position keeping system. As far as practical such systems shall be located in accommodation or utility area. CCR shall be located as safe as possible, normally in the accommodation area.

Doors from non-hazardous rooms facing directly towards hazardous areas should be avoided.

Non-hazardous rooms with doors or openings less than 3 m away from hazardous area should be avoided.

5.4.2 Riser flow line area

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

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.

Topsides riser ESD valves should be located as low down the riser as practicable, so as to minimize the likelihood of damage below the ESD valves causing release of pipeline/riser inventories, see 10.5.

5.4.3 Process area

Fire and explosion evaluations shall be made 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.

5.4.4 Wellhead area

The wellheads should be located above the main support frame in order to reduce exposure of the main support frame from a wellhead fire.

The design of wellhead area shall be evaluated with respect to need for assistance from external fire fighting vessel.

5.4.5 Piping

Routing of piping containing hydrocarbon to or through the utility area shall be avoided except for fuel lines to utility systems. On FPSO crude lines to aft offloading systems are accepted provided they are located at the platform periphery and contain no leak sources.

Routing of hydrocarbon piping is not allowed in the LQ areas.

Routing of piping containing any liquid or hydrocarbon gas is not allowed through electrical room, instrument room and control room.

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

5.4.6 Lifting and lay down

Crane coverage and lay down areas shall be arranged to promote safe crane operations with free visibility from crane cabin to 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.

Storage of equipment shall be assessed regarding possible negative effects on technical barriers (e.g. F&G detection, FW system, natural ventilation), explosion risk and explosion relief (panels).

5.4.7 Storage and handling of explosives

Explosives shall be stored and handled such that the risk of fire or explosion is minimised.

All explosives shall be separated from other goods. Storage locations shall be clearly marked and located in areas without ignition sources. Incompatible explosives shall be separately stored.

The storage location for explosives shall allow for emergency dumping to sea.

5.4.8 Floating installations

5.4.8.1 General

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;
- vital control functions (e.g. maritime control/bridge, process control and special emergency preparedness functions) should 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;
- equipment that can represent an ignition source 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;
- location and type of crude oil pumps shall be based on a hazard evaluation for operation and maintenance of the pumps. Submerged pumps should be preferred. Crude oil transfer lines shall not be located in double bottom.

5.4.8.2 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 over pressure 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.

5.4.9 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, 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 erection of 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.

5.5 Survivability requirements

Consideration shall be given to the protection of well and BOP equipment, such as control panels and hydraulic systems and their related signal paths.

6 Structural integrity

6.1 Role

Load bearing structure shall withstand all load conditions under normal operation and also ensure structural integrity during dimensioning accidental events.

6.2 Interfaces

Structural integrity has interfaces with the following safety systems/functions:

- passive fire protection;
- fire fighting systems;
- escape and evacuation;
- marine systems and position keeping;
- ship collision barrier.

6.3 Required utilities

Structural integrity is not dependent on any specific utility.

6.4 Functional requirements

Load bearing structures shall be designed so that single component failure cannot lead to loss of structural integrity.

6.5 Survivability requirements

The design shall ensure sufficient structural integrity during DALs. This applies to main structure as well as other structures such as derricks and flare towers which may lead to escalation in case of collapse. The main load carrying capacity shall be maintained until the facility has been evacuated.

The DALs shall be combined with other functional and environmental loads according to NORSOK N-003.

7 Containment

7.1 Role

The containment function shall prevent release of hydrocarbons, chemicals and/or toxic gases.

7.2 Interfaces

The containment function has interfaces with the following safety systems/functions:

- passive fire protection;
- fire fighting systems.

7.3 Required utilities

The containment function is not dependent on any specific utility.

7.4 Functional requirements

7.4.1 Piping

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

7.4.2 Flanges and connections

The number of flanged connections in systems containing hydrocarbon fluids shall be kept to a minimum. Generally flanges shall be selected to reduce leakage probability.

Flanges on the pipeline side of the riser ESD valves shall not be used unless subsea isolation valve is installed and the shut in volume is sufficiently small. The flanges shall normally be of compact type, see NORSOK L-005. There shall not be instrument connections on the pipeline side of the riser ESD valve.

Relief/BD headers shall normally be designed without flanges.

Flanges in hydrocarbon piping to, or through, the utility area shall be avoided. One flanged connection is allowed on the fuel line to each combustion engine, turbines and fired units in the utility area.

Mechanical connections shall be designed to withstand vibrations, according to NORSOK L-001.

In modification projects a flanging philosophy shall be established prior to modifications taking into account the risk of ordinary flanges, compact flanges and welded solutions.

7.5 Survivability requirements

The equipment and piping components related to the containment function shall resist the DALs to which they may be exposed for the required period of time. Particular attention should be made to flanges exposed to fire.

8 Open drain

8.1 Role

Control of spills is fulfilled through the open drain system. The purpose of the open drain system is to provide measures for containment and proper disposal of liquids including handling of FW, e.g. through fire seals.

8.2 Interfaces

Open drain has interfaces with the fire fighting systems.

8.3 Required utilities

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

8.4 Functional requirements

8.4.1 Minimize fire/escalation risk arising from spills

The design of the open drain shall limit the spread of a spill and route the spill away to avoid escalation. The drainage systems shall be designed in accordance with NORSOK P-100 and ISO 13702.

Open drain systems on floating installations shall be designed to operate satisfactorily for all sea states in which the hydrocarbon inventory is present in the process system.

On floating installations with turret, decks above moon pool where liquid spills may occur shall have an adequate drain routed to a collection tank.

8.4.2 Separation of drain systems

Hazardous and non-hazardous open drains shall be physically separated to prevent back flow of hydrocarbons from a hazardous to a non-hazardous area. The design shall be in accordance with NORSOK P-100.

The hazardous drain collection tank shall be purged.

8.5 Survivability requirements

There are no specific survivability requirements.

9 Process safety

9.1 Role

Systems and equipment, typically PSD, PSV and local instrumented safety functions, shall control abnormal operating conditions to prevent possible hydrocarbon release. This includes typically

- stop hydrocarbon flow,
- shut down process and utility equipment,
- pressure relief.

9.2 Interfaces

The process safety system has interfaces with the following safety systems/functions:

- ESD;
- BD and flare/vent system.

9.3 Required utilities

Process safety system performance is dependent on:

- UPS;
- hydraulic power;
- instrument air.

9.4 Functional requirements

9.4.1 Process safety principles

Process and auxiliary systems shall be designed such that no single failure during operations can lead to unacceptable hazardous situations. Two independent levels of protection shall be provided. The design shall be in accordance with ISO 10418 (alternatively API RP 14C may be applied).

The PSD system shall be independent from the process control system.

9.4.2 Process shut down (PSD) valves

Shut down 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 shut down valve shall be minimised.

9.4.3 Pressure safety valves (PSVs)

The PSV configuration on the pressure vessel shall be evaluated. Common mode failure shall be included in the evaluation. To ensure sufficient reliability "N-1 out of N configuration" (for N>=4) should be avoided.

9.4.4 Alarms, automatic actions

Alarms shall be initiated as quickly as possible upon abnormal process developments and when equipment protection exceeds the limit setting. The alarm shall warn personnel in CCR and initiate required automatic actions.

9.4.5 Response time

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

9.4.6 Logic solver

Logic solver compliance with the intended use and safety integrity requirements shall be demonstrated, i.e.:

- logic solver (firmware) compliance with IEC 61508 shall be documented, i.e. certified/type approved by an independent body;
  NOTE This is also valid for system software revisions.
- use of non-certified equipment may be accepted subject to particular safety assessment and "proven in use" characteristics;
- the logic solver shall, by hardware and software means, permit adequate testing of the functions within specified limitations regarding degradation of safety and impact on production regularity. This shall also include trip signals between SAS units;
- logic solver software shall be protected against illegal access from external sources, i.e. external data communication interface security of common SAS network and units.

9.4.7 Instrument based systems for secondary pressure protection

In the event instrument based systems need to be installed for secondary pressure protection and rupture of the vessel may expose personnel, the solutions shall be designed such that the frequency of rupture due to over pressure is less than 10^{-5} per year and segment. Evaluations and implementation shall be performed in accordance with IEC 61508.

For guidance with respect to application of instrument based systems for secondary pressure protection, reference is made to NORSOK P-001.

9.5 Survivability requirements

The logic solver and essential utilities shall be located in a protected area that withstands the DALs.

10 Emergency shut down (ESD)

10.1 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.

10.2 Interfaces

ESD system has interfaces with the following safety systems/functions:

- process safety;
- BD and flare/vent system;
- gas detection;
- fire detection;
- ISC;

- PA, alarm and emergency communication.

In addition, ESD initiations will activate (direct or indirect) other safety systems/functions such as HVAC, emergency power and lighting, PA, subsea control, drilling and well intervention and marine systems.

10.3 Required utilities

ESD system performance is dependent on

- UPS,
- hydraulic power,
- instrument air.

10.4 Functional requirements

10.4.1 Manual release buttons

Manual activation buttons shall be located at strategic positions where accessibility and manning in a hazard situation is taken into account, such as:

- CCR (APS/ESD1/ESD2);
- helideck (APS);
- muster areas/lifeboat stations (APS);
- bridge connections (ESD2);
- drilling areas (driller shut down and ESD2);
- exits from process and wellhead areas (ESD2).

Manual activation buttons shall be protected against inadvertent activation, e.g. with protective covers. Each activation station 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 (e.g. UPS) upon APS shall be executed via a timer independent of the logic solver, normally 30 min. It shall be possible to initiate immediate shut down from CCR during timer countdown.

10.4.2 Emergency shut down (ESD) final elements

ESD valves shall isolate and sectionalise the installations process plant in a fast and reliable manner to reduce the total amount of released hydrocarbons in the event of a leakage.

A shut down valve shall be categorised as an ESD valve if the consequence of valve failure is that a possible fire will exceed the dimensioning fire load for the area in question. In addition the following shut down valves shall be categorised as ESD valves:

- valves located in, or are the nearest shut down valve to, a hydrocarbon riser;
- valves located on the liquid outlet of large liquid vessels, such as separators and coalescers, see 9.4.2 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 stream isolation valves (DHSV, master valve, wing valve);
- BD valves, see 11.4.1.

An ESD valve may be used as a PSD valve, but combined ESD and PSD valves shall have physically separate ESD/PSD activation signals and solenoids.

ESD valves shall be equipped with both remote and local position indication.

ESD valves shall have either spring return or local accumulators to ensure fail-safe function. Spring return type of valves shall be used when required size is available. Local accumulators shall have capacity for at least three operations (close-open-close) and be placed as close as possible to the valve.

ESD valves shall have defined criteria for leakage rates based on safety criticality. There shall be facilities for testing of internal leakage rate.

ESD valves, except BD valves, shall only have local reset function. For NNMI reset of the ESD valves should be made at the valve itself, but shall also be possible from the remote CCR when the NNMI is unmanned.

Isolation valves in equalizing lines across ESD valves shall be secured in closed position during normal production. Such valves shall fulfil the specifications applicable for the ESD valve itself including acceptance criteria with respect to internal leakage.

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

10.4.3 Emergency shut down (ESD) actions

ESD system shall activate all actions in accordance with the FES. Consideration shall be given to interrelations between interconnected fields and 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 2. A superior ESD level shall initiate lower levels including PSD. A signal on a certain level should never initiate shutdowns or actions on higher levels. The following automatic actions shall be executed:

- shut down of wells (installation and subsea) and import/export pipelines including stop of export from upstream installations;
- shut down and sectioning of the hydrocarbon process facilities;
- initiation of BD;
- ignition source isolation;
- shut down of main power generation;
- start/stop of emergency power generator;
- shut down of drilling, intervention and work-over equipment not required for well control.

It shall be possible to close DHSV and master valves during well intervention from a position outside the wellhead area, and locally from wellhead/drilling area.

Loss of ESD signals between an NNMI and remote control centre shall shut down the NNMI. A possible time delay in shut down due to a link failure should not exceed 10 min.

ESD of the remote control centre or plant should result in operational shut down of the NNMI.

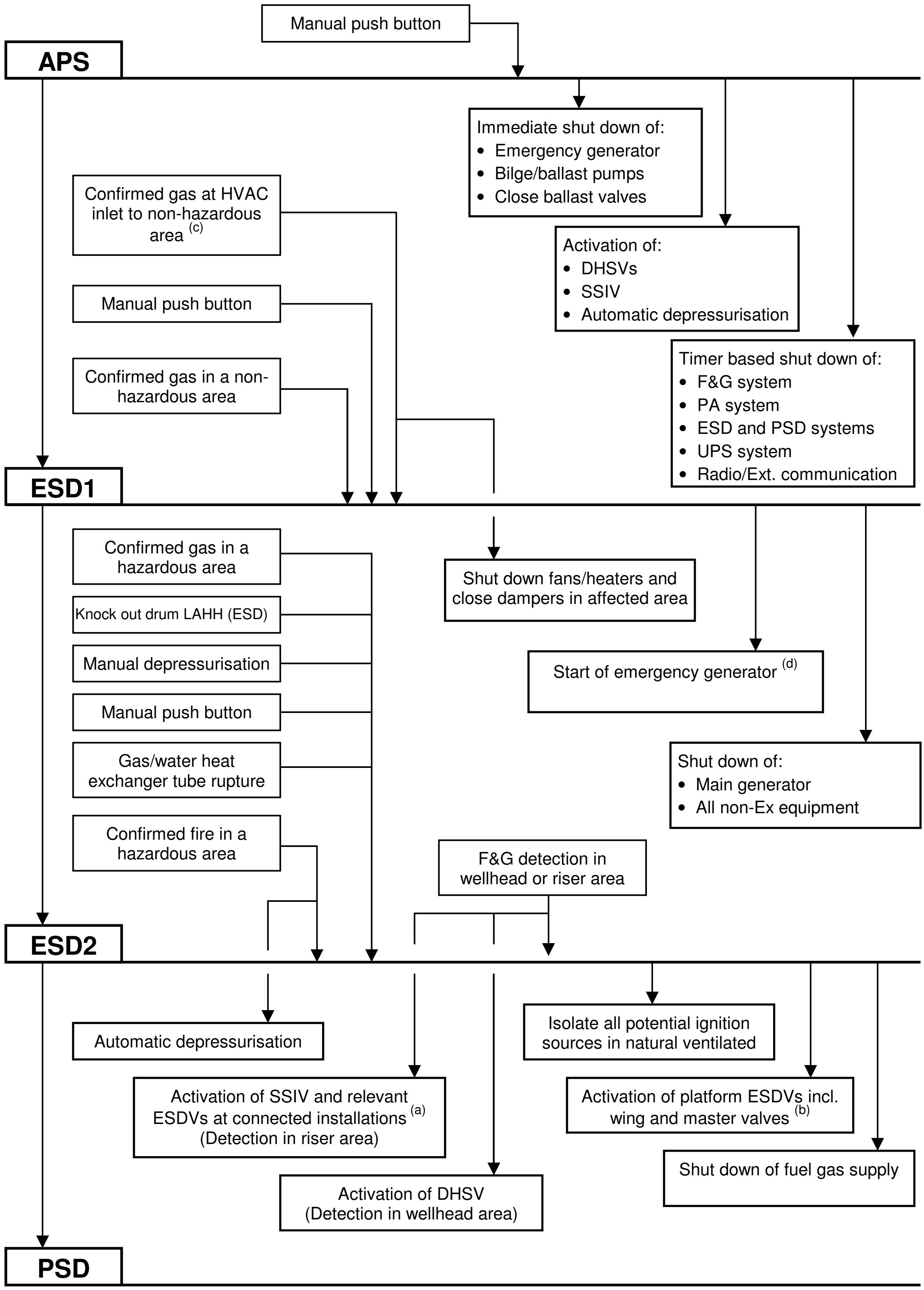

Figure 2 - Emergency shut down (ESD) principle hierarchy

(a) Can be sub-sea well template, wellhead platform, compressor platform, onshore plant.
(b) Local shut down of flow from subsea templates and upstream platforms by ESD or PSD.
(c) Alternative to ESD1 can be ESD2 and selective electrical isolation depending on location, see Table 2.
(d) Alternatively inhibit start of emergency generator may be considered due to ISC.

10.4.4 Emergency shut down (ESD) alarm annunciation

Alarms shall be given as quickly as possible to warn personnel upon ESD level initiation.

APS muster alarm shall only be manually initiated.

Manual initiation of ESD1 or ESD2 level shall initiate general alarm on affected platform. In addition the F&G system shall initiate automatic general alarm as described in clause 12 and clause 13.

An ESD shall be announced at strategic location outside CCR, such as through visual display of alarms in drillers cabin, work over control station and crane cabin.

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.

10.4.5 Emergency shut down (ESD) response time

Response time of all equipment and components included in the ESD function shall be defined. Travel time of ESD valves in service should normally not exceed 2 s/in (valve size).

Applied time delays associated with an ESD action to achieve safe state shall be clearly identified in relevant documentation, e.g. C&E diagrams.

10.4.6 Logic solver

Reference is made to 9.4.6.

10.4.7 Emergency shut down (ESD) independence

The ESD system shall operate as an independent system.

ESD functions shall be functionally and physically segregated from other systems/functions but the ESD logic solver can be an integrated node in the overall SAS, i.e.:

- ESD units (logic solver) shall not be used for other than ESD functions;
- if applied for ESD, sensor accessories (e.g. process tapping, impulse lines, air supply branch-off and power fuses) shall be separate from other functions such as process control devices and process shut down devices.

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 OLF Guideline No. 070.

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

10.5 Survivability requirements

The ESD system shall not be dependent on local instrument rooms with location less safe than the CCR, including satellites, retrofits and extensions.

Equipment that is critical for the effectuation of system actions shall be protected against mechanical damage and accidental loads until shut down sequence is complete. This include ESD valves, accumulators, electrical cables, pneumatic and hydraulic tubing. ESD valves shall remain in safe position during dimensioning event.

Riser ESD valves shall be located such that exposure to accidental loads is minimized. Riser ESD valves should be located in open naturally ventilated area and such that liquid accumulation below the valve is not possible.
ESD valves shall be certified in accordance with recognized standard regarding fire resistance, and shall preferably have metal-to-metal seats.

11 Blow down (BD) and flare/vent system

11.1 Role

The purpose of the BD (depressurisation) and flare/vent system is during an accidental event or emergency situation to

- in the event of a fire to reduce the pressure in process segments to reduced the risk of rupture and escalation,
- reduce the leak rate and leak duration and thereby ignition probability,
- in some cases avoid leakage at process upsets, e.g. in case of loss of compressor seal oil/seal gas,
- route gases from atmospheric vent lines to safe location.

11.2 Interfaces

The BD and flare/vent system have interfaces with the following safety systems/functions (directly or indirectly):

- process safety;
- ESD;
- gas detection;
- fire detection;
- passive fire protection.

Automatic BD functions are normally realized though other systems such as the ESD system.

11.3 Required utilities

BD system performance is not dependent on

- UPS,
- hydraulic power,
- instrument air.

11.4 Functional requirements

11.4.1 Blow down (BD) (depressurisation)

BD, as fast as possible, shall be the primary mean of protection. The BD time should be reduced as much as possible to limit the need for passive fire protection. Passive fire protection is only to be considered as a supplement to BD.

BD times shall be in accordance to specified requirements for protection of pressurised systems exposed to fire. Evaluations regarding material capacity versus BD should be performed as specified in “Guidelines for protection of pressurised systems exposed to fire”, Report 27.101.166/R1 Scandpower Risk Management AS or similar methods

Failure of process shut down valve shall not result in overpressure of the flare system. Failure of sequence in connection with sequential BD shall not lead to rupture of flare system. However, exceeding the radiation levels may be acceptable. The increased risk with sequential BD shall be evaluated. Reference is also given to API RP 521/ISO 23251.

BD valves shall be treated as ESD valves and equipped with both remote and local position indication. Remote reset of BD valves is acceptable.

All pressure vessels and piping segments, which during shut down 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 than 1 000 kg. Location of segment (enclosed or open area), risk of segment being exposed to a fire, consequence of rupture, etc. should be considered.

Location of isolation-, check- and control valves shall be evaluated with respect to shut in volumes between the valves during an ESD.

11.4.2 Activation of blow down (BD)

Activation of BD shall be automatically initiated upon confirmed fire detection in hazardous area. Sufficient time for sectionalisation valves to close shall be allowed before opening of BD valves

Full platform depressurisation shall be possible from CCR (operator station and CAP). Use of the dedicated push buttons shall also initiate ESD2.

For confirmed gas detection automatic depressurisation should be evaluated also as a mean to avoid use of passive fire protection.

Manual release buttons shall be protected against inadvertent activation, e.g. with protective covers.

11.4.3 Flare, vent and knock out drum

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 following shall apply for flare:

- permissible radiation levels for personnel exposure shall be in accordance with API RP 521/ISO 23251;
- the flare system including pipe supports shall be analysed for vibrations;
- BD valves shall be located at high points;
- provision of a separate low temperature flare header to avoid mixing of low temperature gas with hot, wet gas and/or liquid containing free water, shall be evaluated.

Cold vent

Cold venting shall not create ignitable gas concentrations anywhere on the installation. The possibility of an unintended ignition shall be taken into account in the design and dimensioning of the cold vent.

The following shall apply for cold vent:

- gas concentrations from a cold vent (or extinguished flare) shall not exceed 20 % LEL in any area on the installation where ignition of the release is possible. No more than 30 % in helicopter flight path. Scenarios that can give gas heavier than air shall be specially evaluated;
- unintentional ignition of a cold vent shall not give unacceptable heat loads. Radiation levels shall be calculated by an approved method.

Knock out drum

Knock out drums shall be dimensioned

- for containment of liquid carryover for the predefined period,
- without arrangement on gas outlet that may restrict flow, if failing.

11.5 Survivability requirements

The BD and relief system/function and components incorporated shall resist the DALs to which they may be exposed for the required period of time.

The equipment which is critical for the effectuation of the function actions shall be located/protected against design accidental loads such as explosion and fire where applicable, e.g.:

- valves and control circuit;
- piping and pipe support;
- flare structure;
- flare knock-out drum.

12 Gas detection

12.1 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.

12.2 Interfaces

Gas detection system has interfaces with the following safety systems/functions:

- ESD;
- BD system;
- ISC;
- ventilation;
- PA and alarms system;
- fire fighting systems (FW).

12.3 Required utilities

Gas detection system performance is dependent on

- UPS,
- that instrument air supply can be required if aspiration systems are applied.

12.4 Functional requirements

12.4.1 Gas detection 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.

12.4.2 Leak detection

Flammable gas detection shall be provided in all areas where flammable gas leakages could occur. In these areas the smallest gas cloud that has the potential to cause unacceptable damage shall be specified as the minimum cloud size for confirmed gas detection.

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 in naturally ventilated areas. Detection of smaller leaks in mechanical ventilated areas shall be subject to special considerations.

Detectors shall be provided based on an assessment of gas leakage scenarios within each area considering potential leakage sources and rate, dispersion, density, equipment arrangement and environmental conditions such as ventilation, and the probability of detection of small leakages within the area.

Dispersion simulations may be performed for optimisation of the number and location of detectors.

The basis and assumptions used for detector selection and location for each area shall be documented.

Open path detectors are preferred where the layout enables good coverage by such detectors.

Considerations related to detection principle shall be made to environmental effects (e.g. snow, fog, sun, rain/wind, relative motion, detector beam blocking) and necessary protection arranged when detectors are located. Open path detectors should be used in combination with point detectors when environmental condition may make the open path detectors unavailable.

Catalytic detectors shall not be used unless proper detection performance by other types is not achieved.

12.4.3 Gas detection location

The following principles shall be applied with respect to location of detectors:

- natural flow “corridors” (e.g. walkways along flow direction) should be covered;
- detectors should be positioned in different levels in an area or module.

Hydrocarbons detectors shall as a minimum be installed in

- zone 1 and zone 2 areas,
- ventilation outlet from hazardous areas (except paint containers),
- enclosed areas if gas can enter/be trapped,

- air inlets:
  - HVAC inlets,
  - combustion air inlet,
  - turbine hoods and cooling air inlet,
  - air compressors air inlet.

Gas detection in rooms containing non-Ex equipment in ignition source Group 3 shall be considered based on location of the room.

Air inlets or ducts shall be monitored by an adequate number of gas detectors. Factors such as the size of the air inlet, airflow patterns and voting philosophy should be evaluated when deciding number of detectors.

Toxic gas detectors shall be provided in all areas where potentially toxic gas concentrations may be present or be formed.

Oil mist detectors (optical obscuration) should be installed in machinery spaces and turbine hood extract channels, indicating the release of high-pressure flammable liquids such as fuel or lubrication oil that may lead to aggressive and damaging fires.

Gas detectors shall be located such that they can be accessed without scaffolding.

12.4.4 Gas detection characteristics and calibration

Gas detector characteristic and calibration (or pre-set sensitivity) shall ensure that the present gas concentration (point detectors), gas amount (open path detectors) or leakage rate (acoustic detectors) is not underestimated.

Gas detectors shall be individually identifiable with a self test function.

12.4.5 Gas detection actions and voting

The gas detection system shall activate all actions in accordance with the FES.

Main principles for action initiated upon gas detection are as follows:

- ESD system is automatically activated upon gas detection;
- ISC is automatically initiated upon gas detection through actions of the ESD system or can be executed directly by the F&G system;
- activation of FW pump start-up and deluge, if required;
- ventilation is automatically shut down upon gas detection in HVAC inlet;
- activation of PA/alarms system to alert personnel.

See Table 2 for further details.

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

- 2ooN detector to reach specified alarm limit when $N \geq 3$;
  - confirmed gas using 2ooN voting should use low alarm limits if two alarm limits is used in voting logic.
  - an overridden or faulty gas detector shall, when used in 2oo3 voting arrangement, be treated logically as if in alarm imposing reconfiguration to 1oo2 voting.
- voting shall as a minimum include all detectors within a defined area (any type of detectors), but voting may be applied between detectors in different areas (intelligent voting);
- 1ooN detectors to reach specified high alarm limit when $N \geq 2$.

Table 2 - Gas detection main principles

Area/room	Detector location	Gas detection (NOTE 1)	Alarm type (NOTE 2)	Automatic shut down	HVAC action	Comments
Wellhead area (Naturally ventilated)	Area	Alarm	CCR	ISC Group 1 equipment[(A)/(B)]	NA	(A) Reference is made to clause 14. (B) Start FW pump(s) if specified in FES or used for explosion mitigation (C) BD if specified in FES. (D) Release deluge if specified in FES or used for explosion mitigation.
		Confirmed	CCR + GA	ESD2 + DHSV + BD[(C)/(D)]	NA	
Manifold area	Area	Alarm	CCR	ISC Group 1 equipment [(A)/(B)]	NA	(A) Reference is made to clause 14. (B) Start FW pump(s) if specified in FES or used for explosion mitigation. (C) BD if specified in FES. (D) Release deluge if specified in FES or used for explosion mitigation.
		Confirmed	CCR + GA	ESD2 + BD[(C)/(D)]	NA	
HC process area (Naturally ventilated)	Area	Alarm	CCR	ISC Group 1 equipment [(A)/(B)]	NA	(A) Reference is made to clause 14. (B) Start FW pump(s) if specified in FES or used for explosion mitigation. (C) BD if specified in FES. (D) Release deluge if specified in FES or used for explosion mitigation.
		Confirmed	CCR + GA	ESD2 + BD[(C)/(D)]	NA	
HC process area (Mech. ventilated)	Area Inlet Extract	Alarm	CCR	ISC Group 1 equipment [(A)/(B)]	Continue ventilation [(D)]	(A) Reference is made to clause 14. (B) Start FW pump if specified in FES. Consider ESD2 upon loss of mechanical ventilation. (C) BD if specified in FES. (D) If gas is detected in inlet; close damper and fans.
		Confirmed	CCR + GA	ESD2 + BD[(C)]	Continue ventilation[(D)]	
Utility areas (Non-hazardous naturally ventilated)	NA	NA[(A)]	NA	NA	NA	(A) Areas not normally covered. Gas detection may be implemented for ISC purposes.
Utility areas (Hazardous mech. ventilated) e.g. turbine hall	Area[(A)] Extract[(A)]	Alarm	CCR	ISC Group 1 equipment [(B)]	Continue/increase ventilation	(A) Need for detection to be evaluated based on leakage medium. (B) Reference is made to clause 14. (C) ESD2 + selective isolation of affected area (e.g. Zone 2 approved equipment) can be evaluated.
		Confirmed	CCR + GA	Unit shut down El. isolation of all equip. in room	Continue/increase ventilation	
	Inlet	Alarm	CCR	ISC Group 1 equipment [(B)]	Close damper and fans	
		Confirmed	CCR + GA	ESD1[(C)]	Close damper and fans	

Area/room	Detector location	Gas detection (NOTE 1)	Alarm type (NOTE 2)	Automatic shut down	HVAC interface	Comments
Non-hazardous mech. Ventilated areas/rooms including LER, LIR, turbine hall, utility rooms etc.	Inlet	Alarm	CCR	ISC Group 1 equipment(A)	Close damper and fans	(A) Reference is made to clause 14. (B) ESD2 + selective isolation of affected area (e.g. Group 1 and 2) can be evaluated. (C) Shall include electrical isolation of equipment in room. Safety critical equipment shall be subject to special consideration.
		Confirmed	CCR + GA	ESD1(B)/(C)	Close damper and fans	
Rooms non-hazardous by ventilation e.g. LER	Inlet	Alarm	CCR	ISC Group 1 equipment (A)	Close damper and fans	(A) Reference is made to clause 14. (B) ESD2 + selective isolation of affected area (e.g. Group 1 and 2) can be evaluated. (C) Shall include electrical isolation of equipment in room. Ignition sources in Group 3 shall be subject to special consideration. For further details see 14.4.7.
		Confirmed	CCR + GA	ESD1(B)/(C)	Close damper and fans	
Drill floor	Area	Alarm	CCR(A)	ISC Group 1 equipment (B)		(A) And drillers cabin and office. (B) Reference is made to clause 14. (C) Manual drillers shut down to be considered.
		Confirmed	CCR(A) + GA	ESD2(C)		
Drillers cabin	Inlet	Alarm	CCR	ISC Group 1 equipment (A)	Close damper and fans	(A) Reference is made to clause 14. (B) E.g. Zone 2 approved equipment.
		Confirmed	CCR + GA	ESD2 + selective isolation of affected area(B)	Close damper and fans	
Drilling and mud service areas (Hazardous mechanical ventilation)	Area Extract	Alarm	CCR(A)	ISC Group 1 equipment (B)	Continue ventilation	(A) And drillers cabin and office. (B) Reference is made to clause 14.
		Confirmed	CCR(A) + GA	Manual action	Continue ventilation	
	Inlet	Alarm	CCR(A)	ISC Group 1 equipment (B)	Close damper and fans	(A) And drillers cabin and office. (B) Reference is made to clause 14. (C) E.g. Zone 2 approved equipment.
		Confirmed	CCR(A) + GA	ESD2 + selective isolation of affected area(C)	Close damper and fans	
Drilling and mud service areas (Non-hazardous mechanical ventilation)	Inlet	Alarm	CCR(A)	ISC Group 1 equipment (B)	Close damper and fans	(A) And drillers cabin and office. (B) Reference is made to clause 14. (C) E.g. Zone 2 approved equipment.
		Confirmed	CCR(A) + GA	ESD2 + selective isolation of affected area(C)	Close damper and fans	

Area/room	Detector location	Gas detection (NOTE 1)	Alarm type (NOTE 2)	Automatic shut down	HVAC interface	Comments
Shale shaker room	Area Extract	Alarm	CCR(A)	None	Continue ventilation	(A) And drillers cabin and office. (B) Local shut down of drilling equipment in ISC Group 1 can be evaluated. (C) E.g. Zone 2 approved equipment.
		Confirmed	CCR(A) +GA	ISC Group 1 equipment (B)/(C)	Continue ventilation	
	Inlet	Alarm	CCR(A)	ISC Group 1 equipment (C)	Close damper and fans	
		Confirmed	CCR(A) + GA	ESD2 + selective isolation of affected area(C)	Close damper and fans	
Turbine hood and -combustion inlet	Inlet	Alarm	CCR	ISC Group 1 equipment (A)	None	(A) Reference is made to clause 14. (B) Trip turbine, close fuel valves including depressurisation of relevant fuel system. (C) ESD1 for turbines in utility area, ESD2 for turbines in process area.
		Confirmed	CCR + GA	Turbine shut down (B) ESD1/ESD2(C)	Close damper and fans	
Turbine hood	Area(A) Extract	Alarm	CCR	None	Continue ventilation	(A) Inlet detection takes precedence over area/extract detection. (B) Trip turbine, close fuel valves including depressurisation.
		Confirmed	CCR	Turbine shut down (B)	Continue ventilation	
Battery room	Extract(A)	Alarm	CCR	Trip boost charging	Continue ventilation	(A) If H_2 is present.
LQ, including CCR and LER	Inlet	Alarm	CCR	ISC Group 1 equipment (A)	Close damper and fans	(A) Reference is made to clause 14. (B) Shall include electrical isolation of equipment in room. Ignition sources in Group 3 shall be subject to special consideration. For further details, see 14.4.7.
		Confirmed	CCR + GA	ESD1(B)	Close damper and fans	
Crane (engine and cabin)	Inlet	Alarm	CCR + Crane cabin	Group 1 Ignition sources (A)/(B)	Close damper and fans	(A) When crane not in use potential ignition sources shall be isolated automatically upon gas detection anywhere on the installation. (B) Reference is made to clause 14. (C) ESD1 + crane shut down, or ESD2 + selective isolation of affected area (e.g. Group 1 and 2) can be evaluated. (D) Particular modes of crane operation, i.e. emergency use may enforce specific requirements.
		Confirmed	CCR + Crane cabin + GA	ESD1(C)/(D)	Close damper and fans	
Turret area						See HC process area, naturally or mechanically ventilated as appropriate.

NOTE 1 Number of detectors above alarm limit to initiate actions depend on voting principle. If two alarm levels are used “Alarm” shall be initiated upon single low detection.
NOTE 2 Alarms presented in CCR shall also be presented as a not area specific general gas alarm in other strategic location such as crane cabin and drillers cabin.

12.4.6 Gas detection levels

Alarms shall be given as quickly as possible to warn and guide personnel upon detection of gas.
Detection of gas, failure to execute actions upon demand and system defects shall be presented as alarms in CCR.

Each individual gas detector shall provide alarm upon gas exposure. The general alarm limits listed below shall be used. If only one alarm limit is used, the low alarm limits shall be used.

For hydrocarbon gas detection (including H_2 as relevant) the following general alarm limits shall be used:

- low alarm limit for point detectors is maximum 20 % LEL. For turbine enclosure the alarm limit shall be 10 % LEL;
- low alarm limit for IR open path detector is maximum 1 LELm;
- low alarm limit for IR open path detectors in air inlets is maximum: “detection distance x 20 % LEL” (not > 1 LELm);
- high alarm limit for point detectors is maximum 30 % LEL. For turbine enclosure the alarm limit shall be 15 % LEL;
- high alarm limit for IR open path detector is maximum 2 LELm;
- high alarm limit for IR open path detectors in air inlets is maximum: “detection distance x 30 % LEL” (not > 2 LELm).

Alarm limits for acoustic detectors shall be determined based upon background noise measurements.
Acoustic detectors should have adjustable sensitivity setting.

Separate outputs for annunciation of toxic gas alarm shall be provided, i.e. the effects of toxic gas are directly linked to concentration and for some gases exposure time. The following alarm limits for toxic gas shall be used:

- general alarm limits for H_2S gas detection;
  - low gas alarm is maximum 10×10^{-6};
  - high gas alarm is maximum 20×10^{-6}.
- general alarm limits for CO_2 gas detection;
  - low gas alarm is maximum $5\,000 \times 10^{-6}$;
  - high gas alarm is maximum $15\,000 \times 10^{-6}$.
- general alarm limits for CO gas detection;
  - low gas alarm is maximum 30×10^{-6};
  - high gas alarm is maximum 200×10^{-6}.

All alarm shall be presented in CCR. Gas alarms shall also be announced at other strategic locations, e.g.:

- drillers cabin and office;
- crane cabin.

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

12.4.7 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;
- acoustic detector response time including delays employed to improve false alarm immunity should not exceed 30 s;
- the time from detector alarm limit is reached until alarm is presented/tagged on operator station 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 16.4.7.

12.4.8 Gas detection logic solver

Reference is made to 9.4.6.

12.4.9 Fire and gas independence

The F&G detection system shall operate as an independent system.

F&G detection safety instrumented functions shall be functionally and physically segregated from other systems or functions but can be integrated as a node within the SAS, e.g.:

- F&G units (logic solver) shall not be used for other than F&G related safety functions;
- F&G field devices (arrangement of sensor and final element) shall be separate and independent from other devices, and used for the safety function only including activation of equipment such as fire dampers.

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 deluge, shall be normally energized.

12.5 Survivability requirements

The gas detection system shall not be dependent on local instrument rooms with location less safe than the CCR.

Equipment that is critical for the effectuation of system actions shall be protected against mechanical damage and accidental loads until all actions from the gas detection system have been activated.

13 Fire detection

13.1 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.

13.2 Interfaces

Fire detection system has interfaces with the following safety systems/functions:

- ESD;
- BD system;
- ventilation;
- PA and alarms system;
- ISC;
- fire fighting systems.

In addition, actions (direct or indirect) upon fire detection will be required for other systems, e.g. cranes, drilling and well intervention facilities.

13.3 Required utilities

Fire detection system performance is dependent on UPS.

13.4 Functional requirements

13.4.1 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.

Determination of fire detection coverage (sensor number and distribution) for each area shall be based on flame size, smoke characteristics and temperature (heat) rise. For a fire (jet and pool) in hazardous areas the following apply:

- a flame size of 0,5 m in diameter and length of 1 m shall be detected by at least one detector;
- a flame size of 1 m in diameter and length of 3 m shall be detected by at least two detectors.

Detectors shall be provided based on an assessment of fire scenarios within each area considering potential fire sources and characteristics, consequences, area and equipment arrangement and environmental conditions.

The basis and assumptions used for detector selection and location shall be documented for each area.

13.4.2 Fire detection location

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.

Early warning smoke detection systems, sensitive to small concentration of combustion products, should be considered in rooms containing live electrical equipment.

Location of smoke detectors shall be verified by smoke tests. One typical location should be at HVAC extract. Scenarios to be detected shall be defined in FES.

Fire detection layout shall be in accordance with the dimensioning FW scenario (capacity), i.e. detectors in one fire area shall not detect fires in adjacent fire areas.

13.4.3 Manual call points

Manual call points shall be provided at strategic locations, e.g.:

- exits from process areas and rooms;
- along escape routes;
- at fire stations.

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

Manual call points may be used for accidents or situations other than fire, where the attention of CCR is required in accordance with established operational procedures.

13.4.4 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.

Alarms from each fire detector shall be identifiable in the CCR. Fire detectors shall be self-monitoring.

Heat detectors 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;
- application of fixed, compensated or rate-of-rise type heat detectors;
- maximum coverage in naturally ventilated area approximate 24 m^2, maximum distance between sensors 7 m and maximum distance from wall 4,5 m;

- maximum coverage in mechanically ventilated area approximate 37 m^2, maximum distance between sensors 9 m, maximum distance from wall 4,5 m and minimum 0,5 m away from outside wall or dividing partition.

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

- optical detectors used for smouldering fires;
- ionic 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;
- 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.

13.4.5 Fire detection actions

The fire detection system shall activate all actions in accordance with the FES.

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

- ESD2 is automatically activated upon confirmed fire in hazardous areas;
- BD is automatically activated upon confirmed fire in hazardous areas;
- HVAC and fire damper is shut down upon confirmed fire, except for areas subject to smoke control;
- fire fighting equipment is activated upon confirmed fire;
- start of FW pumps (fire alarm including manual call point);
- activation of PA/alarms systems to alert personnel.

See Table 3 for further details.

Confirmed fire detection is defined as

- smoke (except areas such as accommodation):
  - 2ooN detectors to reach specified alarm limit when N ≥ 3
- flame (one of the listed principles):
  - 1ooN detectors to reach specified alarm limit when N ≥ 2,
  - 2ooN detectors to reach specified alarm limit when N ≥ 3.
- heat:
  - 1ooN detectors to reach specified alarm limit when N ≥ 2.

Voting shall include all fire detectors within a fire detection area (any type of detectors) and may be applied between detectors in different areas (intelligent voting), but within same fire area. Fire detectors that are overridden or are in fault shall be treated as if one is in alarm.

Table 3 – Fire detection principles

Area/room	Type of detection (NOTE 1)	Alarm type (NOTE 2)	Automatic shut down/BD	Automatic AFP	HVAC interface	Comments
Wellhead area (Naturally ventilated)	Flame 1ooN	CCR	None	Start FW pump	NA	In addition fusible bulbs may be considered as a supplement.
	Flame 2ooN	CCR + GA	ESD2 + BD + DHSV	Release deluge		
Manifold area	Flame 1ooN	CCR	None	Start FW pump	NA	In addition fusible bulbs may be considered as a supplement.
	Flame 2ooN	CCR + GA	ESD2 + BD	Release deluge		
HC process area (Naturally ventilated)	Flame 1ooN	CCR	None	Start FW pump	NA	
	Flame 2ooN	CCR + GA	ESD2 + BD	Release deluge		
HC process area (Mechanically ventilated)	Flame 1ooN	CCR	None	Start FW pump	No action	Consider time delayed ESD2 upon loss of mechanical ventilation. Damper and fans to be interlocked.
	Flame 2ooN	CCR + GA	ESD2 + BD	Release deluge	Close damper and fans	
Utility areas (Hazardous naturally ventilated)	Flame 1ooN	CCR	None	Start FW pump	NA	
	Flame 2ooN	CCR + GA	To be evaluated	Release deluge/sprinkler		
Utility areas (Non-hazardous naturally ventilated)	Flame 1ooN	CCR	None	Start FW pump	NA	For areas without flammable liquids other detection means, e.g. camera should be considered. (A) Automatic GA if significant flammable liquid volumes are present. (B) If installed.
	Flame 2ooN	CCR + GA(A)	To be evaluated	Release deluge/sprinkler(B)		
Utility areas (Hazardous mechanically ventilated)	Flame 1ooN	CCR	None	Start FW pump	No action	(A) AFP may be deluge, sprinkler, water mist or gaseous systems.
	Flame 2ooN	CCR + GA	To be evaluated	Release AFP(A)	Close damper and fans	
Utility areas (Non-hazardous mechanically ventilated)	Flame 1ooN	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) Automatic GA if significant flammable liquids are present. (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 2ooN	CCR + GA(A)	To be evaluated	Release AFP(B)	Close damper and fans(C)	
Drill floor	Flame 1ooN	CCR(A)	None	Start FW pump	NA	(A) And drillers cabin and office. (B) Manual drillers shut down to be considered. (C) If installed.
	Flame 2ooN	CCR(A) + GA	ESD2(B)	Release AFP(C)	NA	

Area/room	Type of detection (NOTE 1)	Alarm type (NOTE 2)	Automatic shut down/BD	Automatic AFP	HVAC interface	Comments
Drillers cabin	Smoke 1ooN	CCR	None		Maintain ventilation	Internal alarm in drilling areas to be considered.
Degasser room, shale shaker room, active mud tank room	Flame 1ooN	CCR	None	Start FW pump	No action	Internal alarm in drilling areas to be considered. (A) If installed.
	Flame 2ooN	CCR + GA	ESD2	Release deluge/sprinkler(A)	Close damper and fans	
Sack/bulk storage area	Heat 1ooN	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 1ooN	CCR	None		Maintain ventilation	Internal alarm in drilling areas to be considered.
Cementing unit room	Flame 1ooN	CCR	None	Start FW pump	No action	Internal alarm in drilling areas to be considered. (A) AFP may be sprinkler, water mist or gaseous systems.
	Flame 2ooN	CCR + GA	None	Release AFP(A)	Close damper and fans	
Central control room (CCR)	Early detection smoke	CCR	None	None	Maintain ventilation	Smoke detection in cabinets, roof level and voids (false ceiling/floor) to be evaluated.
Instrument room adjacent to CCR	Early detection smoke	CCR	None	None	Maintain ventilation	Smoke detection in cabinets, roof level and voids (false ceiling/floor) to be evaluated.
Central tele equipment room	Early detection smoke	CCR	None	None	Maintain ventilation	Smoke detection in cabinets, roof level and voids (false ceiling/floor) to be evaluated.
LER	Early detection smoke	CCR	None	None	Maintain ventilation	Smoke detection in cabinets, roof level and voids (false ceiling/floor) to be evaluated.
Turbine hall (Non-hazardous mechanically ventilated) (Applicable for other engine rooms)	Flame 1ooN(A)	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 2ooN	CCR + GA	Turbine SD(B)	Release AFP(C)	Close damper and fans	
Turbine hall (Hazardous mechanically ventilated)	Flame 1ooN	CCR	None	Start FW pump	No action	(A) AFP may be deluge, sprinkler or water mist.
	Flame 2ooN	CCR + GA	ESD2	Release AFP(A)	Close damper and fans	

Area/room	**Type of detection (NOTE 1)**	**Alarm type (NOTE 2)**	**Automatic shut down/BD**	**Automatic AFP**	**HVAC interface**	**Comments**
Turbine hood	Flame 1ooN(A)	CCR	None	None	No action	(A) Flame and/or heat. (B) AFP may be water mist or gaseous systems.
	Flame 2ooN	CCR	Unit shut down	Release AFP(B)	Close damper and fans	
	Heat 1ooN(A)	CCR	Unit shut down	Release AFP(B)	Close damper and fans	
Switch board and electrical room (including "dry" transformers)	Smoke 1ooN(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 2ooN	CCR	Electrical power switch off(B)	None	Maintain ventilation	
Transformer (oil filled) rooms	Smoke 1ooN(A)	CCR	None	Release AFP	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.
	Smoke 2ooN	CCR	Electrical power switch off		Maintain ventilation	
Battery room	Early detection smoke	CCR	None(A)	None	Maintain ventilation	(A) Shut down boost charging.
Firewater pump room and em. generator room with diesel engine	Flame 1ooN	CCR	None	None	No action	(A) Automatic shut down of emergency generator provided not required for critical drilling/well service activities.
	Flame 2ooN	CCR	None(A)	Release AFP	Close damper and fans	
Air compressor	Flame, smoke or heat(A)	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	CCR	None	Sprinkler	Maintain ventilation	
Instrument workshop	Smoke or heat	CCR	None	Sprinkler	Maintain ventilation	
Paint storage	Flame or heat	CCR	None	Sprinkler	Close damper and fans	
HVAC inlet LQ	Smoke 1ooN	CCR	None	None	None	
	Smoke 2ooN	CCR	None	None	Close damper and fans	
LQ (cabins, rooms, corridors)	Smoke 1ooN	CCR	None	None(B)	Maintain ventilation/active smoke control(C)	(A) Voting to be across fire cells, e.g. cabin and corridor. (B) Provided amount of flammable material is sufficiently low. (C) See NORSOK H-001.
	Smoke 2ooN(A)	CCR + GA	None	None(B)	Maintain ventilation/active smoke control(C)	

Area/room	Type of detection (NOTE 1)	Alarm type (NOTE 2)	Automatic shut down/BD	Automatic AFP	HVAC interface	Comments
LQ (common areas)	Smoke 1ooN	CCR	None	None(A)	Maintain ventilation/active smoke control(B)	(A) Provided amount of flammable material is sufficiently low. (B) See NORSOK H-001.
	Smoke 2ooN	CCR + GA	None	None(A)	Maintain ventilation/active smoke control(B)	
Vent extract from galley	Heat	CCR	None	Release AFP(A)	Manual shut down.	(A) AFP may be foam, water mist or gaseous systems. If manual, release station shall be accessible in the fire scenario.
General galley area	Heat	CCR	None	None	Maintain ventilation	
Crane engine room	Flame or heat	CCR + Crane cabin	None	Release AFP (A)	Close damper and fans	(A) Applies to diesel driven engines.
Hangar	Smoke or flame	CCR	None	To be considered		
Turret area	Flame 1ooN	CCR	None	Start FW pump	NA	(A) SSIV if installed. Including wing and master on subsea template upon confirmed fire.
	Flame 2ooN	CCR + GA	ESD2 +BD +SSIV(A)	Release deluge	NA	

NOTE 1 Number of detectors above alarm limit to initiate actions may depend of voting principle.
NOTE 2 Alarms presented in CCR shall also be presented as a not area specific general fire alarm in other strategic location such as crane cabin and drillers cabin.

13.4.6 Fire detection alarms

Alarms shall be given as quickly as possible to warn and guide personnel upon detection of fire.

Detection of fire, failure to execute actions upon demand and system defects shall be presented as alarms in CCR.

All fire alarms shall be presented in CCR. F&G alarms shall also be announced at other strategic locations, e.g.:

- drillers location;
- crane cabin.

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

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

- detection of fire or activation of manual call point,
- failure to execute action upon demand,
- function (sensor, logic solver, final element) defect or failure.

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

13.4.7 Response time

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

There shall be no predefined delays of actions initiated upon fire 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.

13.4.8 Logic solver

Reference is made to 9.4.6.

13.4.9 Independence

Reference is made to 12.4.9.

13.5 Survivability requirements

The fire detection system shall not be dependent on local instrument rooms with location less safe than the CCR.

Equipment that is critical for the effectuation of system actions shall be protected against mechanical damage and accidental loads until all actions initiated by the fire detection system have been performed.

The fire detection function for hazardous areas shall be operative after a dimensioning explosion to ensure alarm and that the necessary actions can be realised.

Equipment that is critical for the effectuation of system actions shall be protected against mechanical damage and accidental loads until all actions from the gas detection system have been activated.

Activation or damage to local pneumatic heat detection in hazardous areas shall not cause activation of deluge in adjacent areas, see 20.4.3.

14 Ignition source control (ISC)

14.1 Role

The ISC function shall minimize the likelihood of ignition of flammable liquids and gases following a loss of containment.

Electrical isolation is defined as disconnection of power feeder cable from distribution board, i.e. local disconnection only is not regarded as electrical isolation.

14.2 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/functions:

- ESD;
- gas detection;
- fire detection;
- ventilation;
- emergency power and lighting.

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

14.3 Required utilities

No particular utilities required for the ISC function. Reference is made to requirements for interfacing safety systems/functions.

14.4 Functional requirements

14.4.1 Area classification

Area classification shall be in accordance with IEC 61892-7 and IP 15.

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

14.4.2 Equipment in hazardous areas

All equipment, both electrical and non-electrical, installed and used in hazardous areas, shall comply with ATEX requirements (see Directive 94/9/EC) relevant of the hazardous area classification, i.e. Zone 0, Zone 1 or Zone 2.

Non-essential equipment, Group 1, shall be disconnected upon single low gas detection anywhere on the installation, and also on ESD.

All Ex-equipment in Group 2 shall be isolated from switchgear upon confirmed gas detection and/or ESD2.

14.4.3 Equipment in non-hazardous naturally ventilated area

Equipment installed in non-hazardous naturally ventilated areas shall as a minimum be suitable for operation in Zone 2, including equipment in HVAC supply system.

Non-essential equipment, Group 1, shall be disconnected upon single low gas detection anywhere on the installation and also on ESD2.

14.4.4 Safety critical equipment active after time delayed APS

The following safety critical equipment shall remain operative even after an time delayed APS isolation and shall as a minimum comply with hazardous area zone 1 requirements:

- emergency lighting with built in battery;
- SOLAS communication equipment;
- navigation aid.

Exceptions from this are the FW pump arrangement, including diesel engines, electric generators and motors, which shall be

- located within enclosed compartments in non-hazardous area,
- automatically tripped only by overspeed, if not in test mode.

14.4.5 Hot surfaces

The temperature of hot surfaces such as exhaust pipes and channels shall not exceed the relevant ignition temperatures of flammable mediums that can be present upon accidental leaks.

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.

14.4.6 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 ATEX requirements (see Directive 94/9/EC) and EN 13463.

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 will be required if non-conductive materials 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.

14.4.7 Electrical ignition source isolation in mechanically ventilated non-hazardous areas

Electrical ignition sources shall be disconnected in accordance with the assigned ignition source isolation groups.

Group 1 and Group 2

Upon confirmed gas detection in HVAC inlet to areas all equipment in Group 1 and Group 2 shall be disconnected.

Non-Ex protected equipment located inside rooms with doors/air locks bordering classified areas shall be subject to instantaneous automatic isolation by coincident loss of ventilation and single gas detection in adjacent area.

CCR shall have the possibility to perform a manual disconnection of ignition sources in rooms with openings (self-closing doors) towards classified areas.

Group 3

Group 3 equipment left live after initiation of time delayed APS isolation shall, as a minimum be suitable for operation in zone 2 areas.

The following exemptions are accepted for LQ and in the vicinity of CCR:

- 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 above equipment shall be shut down after predefined time delay (APS).

Equipment required to secure a well in an emergency situation shall be defined in the shut down philosophy. This equipment shall as a minimum be suitable for operation in hazardous area zone 2. Such equipment is typically:

- BOP system;

- temporary well service equipment (safety critical);
- well kill equipment (cement unit including emergency distribution system of cement/kill mud).

14.4.8 Non-electrical ignition source isolation

Non-electrical equipment shall generally comply with hazardous area zone requirements as for electrical equipment.

Diesel or gas fuelled equipment, including associated non-Ex equipment (e.g. prime movers and heaters), shall be stopped upon confirmed gas detection in ventilation air inlet to the enclosure or combustion inlet. Exemption is made for FW generators.

Confirmed gas detection in turbine enclosure/compartment and/or ventilation outlet shall automatically trip the gas turbine including non-Ex equipment in the enclosure. Ventilation in turbine enclosure shall continue.

Diesel engines shall be fitted with spark arrestors in exhaust pipes and have an overspeed protection system (close combustion air damper and fuel valve).

14.4.9 Cranes

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

- upon single gas alarm signal at any location on installation the crane operator shall immediately take the crane into a safe position, secure the load and initiate a manual shut down;
- upon confirmed gas detection in crane ventilation or combustion air inlet an automatic shut down of crane, without time delay, shall be initiated.

When the crane is not in use potential ignition sources in the crane shall be isolated automatically upon single low gas detection anywhere on the installation.

Cranes located in non-hazardous areas shall as a minimum have external equipment suitable for use in hazardous area zone 2. Crane boom movement may require zone 1 equipment.

14.4.10 Anchoring equipment

Anchor handling winches should be located in non-hazardous area.

Seawater spraying (deluge) or other relevant measures for spark suppression should be considered.

14.4.11 Temporary equipment

The platform shall be designed such that temporary equipment is shut down according to the relevant ignition source groups.

Gas detection shall give signal to F&G nodes on the installation and relevant actions shall be initiated.

Fire detection and other alarms shall be given to CCR. This may be given as a single common alarm. Relevant actions shall be initiated. This may be locally.

14.4.12 Ignition source control (ISC) independence and reliability

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

All ISC signals from F&G/ESD shall be hardwired to the respective breakers.

The ISC shall be realized with as few breakers as possible to ensure sufficient reliability. The breakers shall be fail-safe.

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

14.5 Survivability requirements

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

15 Human – machine interface (HMI)

15.1 Role

HMI in CCR shall provide system information presentation and means for operator interactions.

15.2 Interfaces

The HMI is an integral part of the following safety systems/functions:

- process safety;
- ESD;
- BD and flare/vent system;
- gas detection;
- fire detection;
- ISC;
- natural ventilation and HVAC;
- PA, alarm and emergency communication;
- emergency power and lighting;
- fire fighting systems;
- marine systems and position keeping.

15.3 Functional requirements

15.3.1 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.

YA-711 should be used as basis for design of alarm functions.

15.3.2 Human-machine interface (HMI) status and alarm

The HMI facilities shall present system information in CCR, i.e.:

- F&G overview (installation level);
- ESD overview;
- PSD overview;
- F&G system details (input/output details, geographical arrangement, etc.).

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 safety system status, including blocking, overrides and suppression and loop failures.

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

15.3.3 Human-machine interface (HMI) control functions

The HMI facilities shall include the following control functions:

- initiate ESD;
- main ESD level reset;
- initiate F&G;
- F&G reset;
- F&G and ESD common reset of blockings (i.e. per fire detection area for F&G reset);
- manual control of ignition sources, according to ISC groups;
- cargo and ballast operations on floating installations arranged for operation from CCR;
- manual control levers for the thrusters in the position mooring control station;

- hardwired emergency stop for each thruster;
- FW/foam pump start;
- fire fighting release.

15.3.4 General requirements for critical action panel (CAP)

The CAP shall be independent of the visual display unit and data networks, i.e. all control signals shall be connected to the relevant logic solvers.

In addition a function disconnecting power to the ESD logic solvers shall be included allowing activation upon failure of programmable logic.

15.3.5 Critical action panel (CAP) status and alarm

The CAP shall include the following status capabilities:

- start of FW/foam pumps called for;
- FW/foam pump running;
- FW/foam ring main pressure;
- fire fighting release activation status.

The CAP shall present the following alarms:

- FW/foam pumps unavailable warning;
- common fire alarm, e.g. per main area;
- common gas alarm, e.g. per main area.

15.3.6 Critical action panel (CAP) control functions

The CAP shall include the following control functions:

- selection of FW/foam pumps for standby/duty;
- manual start of FW/foam pumps;
- release of automatic fire fighting systems;
- activation of APS, ESD1 and ESD2 levels;
- activation of BD;
- ignition source isolation by relevant levels;
- electrical isolation for fire fighting in rooms containing electrical equipment with voltage above 230V to earth;
- ESD common reset of blockings;
- emergency stop of ballast pumps and valves;
- function disconnecting power to the ESD logic solvers.

15.4 Survivability requirements

There are no special survivability requirements.

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

16.1 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

- prevent ingress of smoke or gas,
- dilute gas leakages (mechanically ventilated areas with leak sources),
- provide smoke ventilation for internal fire conditions,
- ensure acceptable environment for personnel and equipment.

16.2 Interfaces

The HVAC system has interfaces with the following safety systems/functions:

- ESD;
- gas detection;
- fire detection;
- ISC.

16.3 Required utilities

HVAC system performance may depend on

- emergency power supply,
- instrument air.

16.4 Functional requirements

16.4.1 Natural ventilation in hazardous areas

Natural ventilation in hazardous areas shall be as good as possible and shall as a minimum provide an average ventilation rate of 12 AC/h for 95 % of the time. The ventilation rate shall be provided throughout the area to avoid stagnant zones.

Natural ventilation shall be documented by calculations and/or model testing. Potential stagnant zones shall be evaluated and precautions taken where considered necessary. Natural ventilation rates should be evaluated by commissioning for potential stagnant zones.

Location and sizes for ventilation louvers shall be optimised to give required minimum ventilation air change rates for dilution of gases but shall in addition comply with safety risk analysis (gas dispersion, explosion loads etc.) and maintain acceptable working environment/weather protection for personnel.

16.4.2 Mechanical ventilation in hazardous areas

A ventilation rate to ensure minimum 12 AC/h shall be provided. The ventilation rate shall be provided throughout the area to avoid stagnant zones.

Ventilation shall be maintained, and, if practical, increased, in the event of an internal gas leak.

Alarm shall be given in CCR upon loss of ventilation.

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

Ventilation shall be maintained, and if practical increased, in the event of an internal gas leak for such applications as turbine enclosures.

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.

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).

Uncertified equipment in area non-hazardous by ventilation (e.g. turbine enclosures) shall automatically be disconnected upon loss of ventilation.

Boost charging of batteries shall be tripped upon loss of ventilation, as well as upon H_2 detection.

16.4.4 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 60079-13 and IEC 61892-7.

Alarm shall be given in CCR upon low overpressure relative to surrounding classified areas. Alternatively alarm shall be given both upon low airflow and time delayed indication of open door.

16.4.5 Mechanical ventilation in areas safe by location

There shall be a positive airflow into mechanical ventilated areas safe by location.

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

16.4.6 Ventilation inlets and outlets

All air 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.

Air inlets shall be located, or measures taken, so that accumulation of ice and snow is avoided.

Simulation studies or wind tunnel tests should be used for location of main HVAC air inlets to ensure that HVAC systems serving quarters and emergency equipment rooms are minimally affected by smoke and escaped gases from incidents onboard.

The distance between air inlet and HVAC outlet from hazardous areas shall be such that gas from the outlet cannot enter the air inlets.

The distance between air inlets and HVAC outlet from non-hazardous areas (e.g. LQ) shall be such that smoke from the outlet cannot enter the air inlets during active smoke control.

All ventilation outlets from non-hazardous areas shall be into non-hazardous areas. The outlet air from hazardous spaces shall be routed through separate ducts to outdoor area which, in the absence of the considered exhaust, is of the same or lesser hazard than the ventilated space.

Special considerations with regards to ventilation inlets and outlets can be made for enclosures for noise or working environment purposes.

16.4.7 Dampers

Dampers shall provide quick, reliable and effective means to prevent escalation of a fire into other areas. Dampers shall prevent ingress/spreading of gas or smoke.

A fire damper and smoke ventilation philosophy shall be established for operation of dampers for both high and low risk areas, see NORSOK H-001.

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 dampers shall be closed and the heating element shut off. The surface temperature of heating elements shall not exceed the auto ignition temperature of any gas potentially present in the area.

Total response time for closing of HVAC inlet dampers in rooms where all ignition sources are shut down upon gas detection in the inlet shall not exceed 6 s. In rooms where ignition sources are kept alive 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. However, the total response time for closing of HVAC inlet dampers shall not exceed 6 s.

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

Damper position shall be monitored from the CCR.

Fire-dampers shall be closed automatically by signal from the F&G-system and by “fusible link”.

16.5 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.

HVAC system having a safety role shall have a suitable and reliable power supply, e.g. UPS, emergency power generators or dual fuelled generators.

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.

17 Public address (PA), alarm and emergency communication

17.1 Role

The PA, alarm and communication system shall warn and guide personnel as quickly as possible in the event of a hazardous or emergency situation.

17.2 Interfaces

PA, alarm and emergency communication have interface with the following safety system/functions:

- ESD;
- gas detection;
- fire detection;
- ISC;
- escape and evacuation;
- rescue and safety equipment.

17.3 Required utilities

The PA, alarm and emergency communication systems depend on emergency power systems (emergency generators and UPS).

17.4 Functional requirements

17.4.1 Public address (PA) system, loudspeakers, alarm horns/sirens, bells and alarm lights

Location, number, type and effect from alarm systems/equipment/signal shall be easily recognised in any area where distribution of the alarm is required.

Alarm voice communication shall be heard in a surrounding noise level up to and including 85 dBA.
In areas with noise levels of above 85 dBA the audible alarm shall be supplemented by light signals.

The PA and alarm system shall be divided into two independent systems (A system and B system).

An alarm system with announcer in the galley and a push button in each refrigerating room shall be installed. The main purpose of this system is to provide an alarm in case personnel is trapped within refrigerated areas. This system shall be fed by emergency power (UPS). The alarm shall also be routed to CCR and F&G mimic.

17.4.2 Alarm signals

The alarm signals shall be in accordance with Table 4.

Table 4 - Alarm signals

Alarm type	Signal	Indicates
Muster alarm	Continuous audible signal of variable frequency. Yellow flashing light or rotating visual lamp	Prepare to abandon installation. Manual initiation.
General alarm	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
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

Alarm type	Signal	Indicates
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

(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.

17.4.3 Platform 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, such that CCR easily may be contacted in an emergency situation.

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

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.

At least two different communication facilities shall be available at the muster stations. The main facilities shall be hand portable radios and telephones.

Required telecommunication units at the muster station where the APS switch is located are

- telephone (Eex),
- PA access unit (Eex).

Drillers intercom function shall provide two-way communication in drilling and workover areas between the driller and drilling personnel.

The crane operator shall be able to communicate with the CCR, ships and operators on deck. Maritime VHF, UHF radio, PA loudspeaker and telephone shall be located in the crane cabin.

17.4.4 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.

17.4.5 Telecommunication system in an emergency situation

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

The emergency communication systems shall be in accordance with requirements for ISC, i.e. only equipment subject to special considerations or Eex-certified communication equipment shall be in operation in situations where a flammable gas mixture can be present.

Radio frequency radiation from antennas shall be in compliance with the requirements in CENELEC CLC/TR 50427.

17.5 Survivability requirements

System and components shall resist DALs to which they may be exposed.

Field equipment (including antennas) shall be located such that they are protected against accidental loads as much as practical feasible. Cables shall be fire resistant.

PA, alarm and emergency communication systems shall be located and/or protected against DALs to ensure continuous operation. To achieve this the central equipment room and batteries shall be located in accordance with requirements in 5.4 regarding location of safety systems.

18 Emergency power and lighting

18.1 Role

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

- electrical power for specified consumers when main power generation is being shut down;
- emergency electrical power supply for a specific period of time for systems required being in operation during or after a major hazard incident.

The purpose of the emergency lighting system is to provide sufficient lighting for evacuation and escape in an emergency situation.

18.2 Interfaces

Emergency power interfaces the following safety systems/functions:

- ESD;
- emergency power consumers.

18.3 Required utilities

Emergency power and lighting system performance shall be independent of other utility systems.

18.4 Functional requirements

18.4.1 Uninterruptible power supply (UPS)

UPS for emergency equipment and systems required in an emergency situation shall be installed. UPS shall ensure continuous power supply to all emergency equipment and systems in all situations where main power and emergency power generator is not available.

UPS shall have a capacity to supply the required emergency power for a minimum period of 30 min, or longer if required by FES/EERS.

18.4.2 Emergency power supply

In addition to UPS, a reliable emergency power supply, independent of the installations main power supply, shall be available for minimum 18 h at full load.

Type of emergency power source shall be evaluated, e.g. emergency generator versus power via cable from another installation.

For NNMI the emergency power supply shall be provided with a capacity of minimum 4 h. Emergency power supply by batteries only is acceptable.

The emergency power shall be exclusively dedicated for supply of emergency power during emergency mode of operation.

Upon zero voltage on emergency switchboard emergency power supply shall be established within 45 s.

Start of the emergency generator shall be possible from CCR upon zero voltage on emergency switchboard.

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

For emergency generator(s) the following shall apply:

- it shall be possible to isolate the fuel supply to each diesel driven generator from outside of the generator room;
- the emergency generator system shall be self-contained;
- in addition to automatic starting provisions, manual starting and testing devices shall be provided;
- 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;
- prime mover for emergency generators can only be stopped automatically in the event of
  1. gas detection in ventilation air inlet,
  2. overspeeding,
  3. loss of lubricating oil pressure,
  4. Item 1 and 3 above do not apply to emergency generator(s) supplying FW pump(s).

Fuel for prime movers should not represent an explosion hazard under anticipated operating conditions.

Exhaust pipes from prime movers of emergency equipment should neither emit sparks nor have a surface temperature which exceeds the ignition temperature of the gas mixture which is produced or stored on the installation.

18.4.3 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.

Typically the following equipment and systems have a function during an emergency situation and shall have emergency power supply:

- SAS;
- active smoke control ventilation system(s);
- charging of UPS and lifeboat batteries;
- emergency lighting;
- auxiliary equipment (e.g. ventilation fans) required for run down of turbines and generators after a shut down;
- electrical deck cranes (power capacity required for operation of one crane);
- 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 fire fighting systems as required by FES;
- helicopter landing and warning lights;
- PA, alarm and emergency communication systems;
- navigation aids;
- bilge and ballast pump(s).

18.4.4 Emergency lighting

Emergency lighting shall be provided in all accommodation spaces, control rooms, work locations, along all escape routes, the helicopter deck, emergency stations, lifeboat stations and lifeboat drop zones.

Emergency lighting shall be provided with local self-contained batteries or central uninterruptible power supplies, both with a minimum capacity of 30 min or longer if required by FES/EERS.

Emergency lighting shall remain lit upon loss of main power.

Lighting levels shall be in accordance with EN 1838. Emergency stations shall have minimum 15 lux.

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

Emergency light fixtures shall be certified for use in hazardous areas zone 1.

18.5 Survivability requirements

System and components incorporated shall resist the DALs to which they may be exposed.

UPS and essential utilities, and emergency generator shall be located in accordance with 5.4.

If emergency light fixtures without internal batteries are used in an area alternate fixtures shall be supplied from two different UPS systems and two well separated cable routes.

19 Passive fire protection (PFP)

19.1 Role

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 dimensioning fire, and contribute in reducing the consequences in general.

Fire divisions shall ensure that a dimensioning fire and explosion does not escalate into surrounding areas.

19.2 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/functions:

- containment;
- ESD;
- BD system;
- emergency power;
- fire fighting systems;
- escape and evacuation;
- structural integrity.

19.3 Required utilities

Passive fire protection performance is not dependent on any specific utility.

19.4 Functional requirements

19.4.1 Fire divisions

Fire divisions shall as a minimum separate the main areas, unless it is proven that separation by distance is sufficient. Fire divisions shall be capable of resisting dimensioning fire, see ISO 13702, Table C.4.

Areas with important safety functions and areas with a high fire risk shall be separated from the surroundings by adequate fire divisions.

Fire divisions shall remain intact with regard to the thermal loads and their duration to which they are subjected in the event of a dimensioning fire.

Fire partitions exposed to hydrocarbon fires shall be rated according to H-class.

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 in place to withstand dimensioning explosion loads.

CCR, FW pump systems, emergency power supply with related distribution equipment and fuel tank shall be protected from the surroundings by minimum Class A-60 fire divisions. Cementing units and associated equipment required for emergency operation (kill function) shall be protected from fire events to which they can be exposed.

Generators (including prime mover), transformers, major distribution panels, rooms for ventilation equipment and equipment used for storage of flammable commodities or easily ignitable material shall be separated from the surroundings of at least Class A-0 fire divisions.

Penetrations (e.g. for ventilation ducts, piping, cables, beams as well as windows and doors in fire divisions), shall not reduce the strength or the fire integrity of such divisions.

Structural elements, beams and piping shall be fireproofed on either side of a fire division between hydrocarbon areas.

Doors in fire divisions shall be of a self-closing type.

The following special considerations apply for horizontal fire divisions:

- **Fire on the upper side:** Horizontal fire divisions shall be designed to withstand dimensioning fire load in the area. In order to reduce damage to PFP, H-0 requirement may be deviated from. Application of PFP on the underside of a horizontal division can make conditions worse due to prevention of heat radiation from the "backside".
- **Fire on the underside:** The use of PFP on horizontal divisions is normally limited to protect against fire on the underside.
  PFP on horizontal divisions shall not be implemented without assessing the total risk impact. If there is a need for maintaining the integrity of a load bearing system in horizontal structures as decks that can be exposed to fire from both sides, it may be sufficient to use PFP only on the girder system.

19.4.2 Load bearing structures

Load bearing structures/important elements shall have adequate fire resistance to maintain required integrity during a dimensioning fire.

No account shall be taken from possible cooling effect from fire fighting equipment.

Coat back (integrity protection) may be required on unprotected structural elements in order to maintain load bearing capacity during dimensional accidental loads. This may be necessary in order to avoid excessive and unacceptable heat conduction into fireproofed structural elements. In general the following shall apply:

- coat back is required for structural elements with a contact area equal or larger than 1 000 mm^2 per m^2 of fireproofed structural elements;
- coat back distance shall be 450 mm, unless documented otherwise.

Contact area also includes the part of the cross sectional area inside hollow sections. The coat back requirements may be deviated from if it can be documented that structural load bearing capacity is maintained for dimensional accidental loads.

19.4.3 Vessels and piping

Pressurized vessels, process equipment and piping shall have adequate fire resistance to prevent escalation of a dimensioning fire scenario. This includes pipe and vessel supports. "Guidelines for protection of pressurised systems exposed to fire", Report 27.101.166/R1 Scandpower Risk Management AS, may be used as guidance. Credit for possible cooling effect from fire fighting equipment shall be justified.

The flare system shall maintain its integrity during DALs for the required period of time.

On turrets, production or export/gas injection risers shall be protected against fires in the turret by passive means, such as conductors or coating. At riser termination end the riser connector and first ESD valve shall be protected by passive means.

19.4.4 Safety critical equipment

Equipment intended to function during a dimensioning fire shall have adequate fire protection.

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

- important cables,

- cable trays (including suspension) for important cables,
- suspension for important pipes (as fire fighting, flare/vent lines) and important ducting,
- ESD-valves and activation system,
- BD valves and activation system,
- flare-/vent lines,
- emergency power systems.

19.4.5 Non-combustible materials

Materials on the installation 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 and heat generation. Documentation shall be available to support the basis for the decision regarding selection of materials.

An assessment shall be made of the toxicity of gas emitted in the event of a fire.

19.4.6 Living quarter (LQ)

LQs shall be designed and protected to ensure that the emergency functions therein can be maintained during dimensioning accidental events.

Outer surfaces of LQs shall minimum be A-60. If the surfaces can be subject to heat flux exceeding 100 kW/m^2 in a dimensioning fire, minimum class H-60 shall be used for these surfaces.

Windows shall not be installed in H partitions or walls facing process area.

Choice of materials and interior design of the LQ shall be decided in relation to the 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. Floor, wall and roof finishes shall pass the fire test requirements in IMO Res. A.653 (flame spread). In addition, the materials shall comply with the requirements of ISO 5660 (smoke and ignition properties). These evaluations are particularly important for LQ without water sprinkler protection. Reference is also made to SINTEF NBL report A05103.

Fire integrity of bulkheads and decks shall comply with chapter 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.

19.5 Survivability requirements

The passive fire protection system shall resist the DALs to which they may be exposed.

Fire protection materials used in outdoor areas shall comply with NORSOK M-501.

20 Fire fighting systems

20.1 Role

The purpose of the fire fighting systems is to provide quick and reliable means for fighting fires and mitigate explosion effects.

20.2 Interfaces

The fire fighting systems has interfaces with the following other safety systems/functions:

- open drain;
- ESD;
- gas detection;
- fire detection;
- ISC;
- emergency power.

20.3 Required utilities

The performance of the fire fighting systems typically depends on the:

- diesel system (applicable for FW pump systems with diesel drivers);
- emergency power system;
- instrument air system;
- hydraulic system.

20.4 Functional requirements

20.4.1 General

Fixed fire fighting systems shall be installed in areas representing a major fire risk, and particularly cover equipment containing significant quantities of hydrocarbons.

20.4.2 Firewater (FW) supply system

The FW supply shall be sufficient to cover area with the largest FW demand plus the adjacent fire area with largest demand. The FW demand shall include supply to two hydrants.

The FW ring main shall be dimensioned for the demand of the largest fire area with one segment 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 segments closed.

The FW ring main shall be water filled and pressurised in the standby mode. The pressure source shall have the capacity of flow through frost protection bleed lines plus two hydrant hoses.

Firewater ring main sectioning valves shall be easily accessible, car sealed 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. 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 OLF Guideline No. 075.

For general piping requirements, see NORSOK P-001 and NORSOK L-002.

The water supply system and level control arrangement in water filled structures shall meet the required reliability.

20.4.3 Firewater pump arrangement

The FW pump system configuration shall at least be equal to 4 x 50 % of the largest fire area with respect to capacity and availability. Alternatively a 3 x 100 % pump system configuration is acceptable.

A procedure shall be prepared defining compensating measures to accommodate temporary reduced FW capacity. The compensating measures shall be defined as part of the design basis.

The FW pump system should include spare capacity for future expansions.

Firewater pump systems shall be self-contained. It shall be possible to start the FW system even if no other systems on the platform are operational.

The basis for prime mover and FW pump system design shall be NFPA 20.

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 segments 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 FW pump engine shall have a starting system with sufficient reliability to satisfy the integrity requirement for the FW system. 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.

Each FW pump engine shall have its own dedicated day tank sufficient for 18 h continuous full power operation.

The fuel supply line between the FW pump engine and diesel day tank shall be equipped with a valve capable of being closed from outside the FW pump engine 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 in air inlet to the FW pump engine room, the ventilation to the room shall be stopped and dampers automatically closed and the cooling air shall be taken from the engine room itself. Cooling of the FW pump engine room shall be by an air/FW-cooling unit powered directly from the FW 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 damper initiated by overspeed. Automatic stop of FW pump engine driven FW pumps shall only be permitted due to overspeeding. Failure of the overspeed securing device should not cause the FW pump engine to stop. Simple reset of the systems shall be possible.

It shall be evaluated if confirmed gas detection in the combustion air inlet shall inhibit FW pump start.

Consideration shall be made to extreme weather conditions 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.

20.4.4 Deluge system

NFPA 13, NFPA 15 and NFPA 16 should be used as guideline for design of deluge systems. The deluge system shall provide adequate coverage for the relevant fire and explosion scenarios, with respect to both volume and area coverage, horizontal and vertical surfaces.

A fire area may be covered by several deluge valves. All deluge valves covering a fire area shall be released when fire detected anywhere in the fire area. This applies also for manual release of any deluge valve covering the fire area.

The FW system shall be designed and calibrated such that deluge nozzles will receive water at design pressure not later than 30 s after a confirmed fire signal has been given.

The minimum required densities of FW shall be

- 10 (l/min)/m^2 for process areas and equipment surfaces,
- 20 (l/min)/m^2 wellhead (including riser balconies, manifolds located on FPSO turrets etc.).

For other areas the protection should be in accordance with ISO 13702.

Foam supply shall be provided for all areas where hydrocarbon or alcohol pool fires are likely to occur.

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 at release stations located along the escape routes outside the fire area itself.

Activation of deluge systems shall trigger alarm in CCR. Pressure transmitters shall be fitted downstream deluge, monitor and sprinkler valves to provide confirmed flow signal to CCR.

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 arrangement with interfaces shall be such that it can be function tested (at full capacity, if desirable) 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. Isolation valve shall also be included upstream of the deluge valve.

Deluge valves shall be provided with manual bypass including flow restriction (if necessary) to match flow through the valve. The bypass line shall be taken from another section of the ring main ensuring FW supply at all times, including maintenance situations.

Deluge valves shall fail in last position upon loss of signal from F&G logic.

For manned installations resetting of deluge, monitor and sprinkler control valves shall normally only be possible local to the valves.

Deluge nozzles for area coverage on fully open process and drilling areas should be of the high velocity types.

The number of low points shall be minimized. All low points in piping downstream deluge and monitor skids shall be equipped with 3 mm weep holes to prevent pockets of water to be entrained. Alternatively the low points shall be equipped with deluge nozzles or auto drain valves.

The need for strainers in deluge system shall be considered. Deluge nozzles shall be without individual strainer.

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 OLF Guideline No. 075.

20.4.5 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 delivered flow rate of water shall be

- 10 (l/min)/m^2 in utility areas, helicopter hangars,
- 6 (l/min)/m^2 in LQ.

For other areas the protection should be in accordance with ISO 13702.

It shall be possible to fully function test the sprinkler system by use of a suitably located test sprinkler and using fresh water. There shall 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.

There shall be a pressure sensor downstream of each sprinkler valve and a flow indicator upstream each area indicating in which area release is taking place. Indication in the CCR shall be provided.

Sprinkler valves shall be provided with full capacity manual by-pass.

Priming of wet pipe sprinkler systems with fresh water should be evaluated.

For fresh water filled wet pipe sprinkler systems, the transition from fresh water feed to normal FW shall be automatic and reliable.

Adequate venting facilities with valves shall be provided for wet pipe sprinklers.

For dry pipe sprinkler systems the sprinkler valve arrangement shall be fitted with an accelerator.

The sprinkler heads should be of the frangible bulb type, set to burst at 68 °C, in general areas. However, a higher temperature limit should be selected for areas where high ambient temperatures might be expected.

Carbon steel and galvanised steel shall not be used in the sprinkler system. For material selection, see OLF Guideline No. 075.

20.4.6 Foam system

The foam system shall provide a quick and reliable supply of foam concentrate with correct concentration.

Centralised foam systems shall have a total foam concentrate capacity 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.

To avoid foaming draining of the foam concentrate tanks shall not be made to the open deck drain.

A system shall be installed which is capable of providing sufficient foam system standby pressure.

The centralised foam concentrate pump system shall comprise of two pump systems and be powered from dedicated drivers or from the FW diesel drivers. If the pumps are connected to FW diesel generator, it shall also be possible to run the pumps from main power in order to run/test pump without starting the FW diesel generator.

Foam pumps shall be equipped with minimum flow control and pump testing facilities.

Foam pumps shall during normal operation be in standby mode and start on foam demand.

When in operation, the foam supply shall have an operation pressure of at least 0,2 MPa (2 bar) above the FW pressure to prevent reverse flow. The pressure in the foam ring main shall be presented in CCR.

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 shall generally be secured open, e.g. by car sealing.

For a centralised foam system the foam ring main shall be provided with easy accessible isolation valves.

20.4.7 Manual fire fighting

Manual fire fighting 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 fire fighting by manual intervention.

In order to protect people from electrical hazards, relevant equipment (such as switchboards) with voltage above 230 V shall be disconnected before performing manual fire fighting with water. Dedicated facilities shall be provided for this purpose.

Manual fire fighting equipment shall have adequate frost protection, e.g. by heat tracing and/or drain possibilities as applicable.

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 hoses.

The FW supply from the ring main to hose reels and FW hydrants shall be such that not more than 50 % of the FW to water hoses and hydrants for one area is affected if one segment of the FW ring main is unavailable.

Quick operating isolation valves shall be provided for each hydrant.

When monitors are used instead of deluge systems, the requirements for deluge systems such as water density and functionality shall apply.

Monitors shall have sufficient freedom of travel in the horizontal and the vertical plane. Normally they shall be adjustable through 360° in the horizontal plane and from + 60° to - 40° in the vertical plane.

It shall be possible to lock a monitor in any position.

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. All monitors, except monitors used instead of deluge, should return to maximum spray angle after use.

Automatic drain facilities shall be provided for each FW monitor.

Monitor valves shall fail in last position upon loss of signal from F&G logic.

20.4.8 Hydrants and hose reels

NFPA 14 should be used as guidance.

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.

<u>Hydrants</u>

Hydrants shall be located in weather resistant cabinets fitted with heating units where required. One cabinet shall be provided per hydrant.

The hydrant cabinet shall contain

- 4 off 1½ in bore hoses of an approved fire-resistant type, 15 m in length with instantaneous connection joints to hydrants and nozzles,
- 2 auto to fog nozzles with pistol grip. Capacity minimum 20 m^3/h with two hoses and a nozzle hooked up,
- 2 sets of connecting key.

All hydrants shall have two outlets fitted with 1½ in quick connections of a standard approved type throughout all areas (NOR No. 1).

Hose reels
Non-collapsible hose reels shall have

- within LQ 25 m of 1 in bore hose, capacity approximately 8 m^3/h,
- within all other areas 25 m of 1 ¼ in bore hose, capacity approximately 15 m^3/h.

20.4.9 Helideck fire fighting system

The helicopter deck shall be equipped with adequate fire protection equipment and with sufficient drainage capacity to enable escape and fire fighting 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.
- foam monitors (normally 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 fire fighting 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 monitors in preset oscillation or fixed position from both local and remote protected position;
  - 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 fire fighting system on helideck 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;
- two dual agent hose reels (combined water/foam and dry chemical hose reel) shall be provided 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.

20.4.10 Extinguishing systems in enclosed compartments

Water mist system is the preferred extinguishing system for enclosed compartments such as:

- FW pump generators room;
- cement unit room;
- emergency generator room;
- turbine hoods;
- diesel engine rooms;
- trafo room for oil filled trafos.

20.4.11 Water mist system

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 FES.

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 shall be stopped and dampers closed for the protected area before release of water mist systems;
- the water mist cabinet shall be located outside of the protected room;
- compatible materials shall be used throughout the system, e.g. nozzle/distribution piping.

Where possible, external connection to the water mist system from the FW system shall be considered.

20.4.12 Gaseous agents

Generally requirements for gaseous fire fighting systems are covered by ISO 13702.

Gaseous fire fighting systems shall also comply with the following requirements:

- gaseous agents not harmful to humans are preferred. If noxious and poisonous gaseous systems (e.g. CO_2) are used, it shall only be used for locked off rooms;
- 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 gas bottles shall be located outside of the protected room.

20.4.13 Fire fighting system – Commissioning

The system design shall allow for complete system flushing in commissioning.

The capacity and efficiency of the FW, deluge, foam and water mist systems shall be verified through realistic full scale testing during commissioning.

20.5 Survivability requirements

System and components incorporated shall resist DALs to which they may be exposed.

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 above performance requirements can be met by the following:

- the FW and centralized foam pumps, drivers (including electrical supply from dedicated generators and other sources) and controllers shall be located in non-hazardous areas;
- each FW pump system shall be mutually independent. Several FW 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 FW pump room is lost;
- all fire fighting equipment shall maintain its integrity during DALs. This includes cables for FW and centralized foam pumps. As a minimum cables shall be fire resistant in accordance with IEC 60331 and IEC 60332;
- damage in one area shall not cause loss of the entire FW function, e.g.:
  - the FW and centralized foam pump systems shall be connected to the ring main at different locations to avoid loss of FW supply;
  - isolation valves and cross connections on the fire main shall be included to enable isolation of parts of the FW ring main and to ensure supply to consumers from two different sections of the ring main. Remote operated isolation valves shall be considered in the FES;
  - control valves for sprinkler and deluge systems shall be located outside the area they protect and normally towards the safe side/area of the installation.

21 Escape and evacuation

21.1 Role

The purpose of the escape routes is to ensure that personnel may leave areas in case of a hazardous incident by at least one safe route and to enable personnel to reach the designated mustering area from any position on the installation.

The purpose of the evacuation system is to ensure means of safe abandonment of the installation for the maximum personnel on board, following a hazardous incident and a decision to abandon the installation.

21.2 Interfaces

The escape routes and evacuation system interfaces the following safety systems/functions:

- ventilation;
- PA, alarm and emergency communication;
- emergency power and lighting;
- passive fire protection;
- structural integrity

21.3 Required utilities

The escape routes and evacuation system performance is dependent upon emergency power and lighting to ensure lighting for escape and evacuation if main electrical power supply fails.

21.4 Functional requirements

21.4.1 Escape routes

Escape routes, leading to the muster area, shall be provided to enable all personnel to leave an area in case of a hazardous incident.

Escape routes shall be part of the daily used transport- and passageways. Escape routes should preferably be provided on the outside along the periphery of the installation.

Escape routes shall be well marked, including signs. Marking shall show the preferred direction of escape.

There shall be at least two exits to escape routes from permanently or intermittently manned area outside quarters and offices, leading in different escape directions.

The escape route network shall lead to safe areas and facilities as follows:

- LQ;
- muster area/temporary refuge;
- lifeboats and life rafts-stations;
- boat landings (NNMI);
- helicopter deck;
- flotel or other installations linked by bridge/walk way.

Required width of escape routes shall emphasize easy transport of injured personnel on stretcher.

The dimension of escape routes shall be minimum 1 m width (0,9 m for doors) and 2,3 m in height (2 050 mm for doors). Escape routes intended for use by more than 50 persons shall be extended to 1,5 m (1,2 m for doors) in width.

Escape routes on decks shall be provided with a non-skid, oil resistant coating in yellow (RAL 1023). On deck grating, two parallel 100 mm wide yellow lines shall be painted indicating the width of the escape route.

Escape routes inside the LQ shall be provided with low level florescent arrows, and/or low level directional lighting, showing correct escape direction. Other enclosed and regularly manned utility and process areas should be considered separately.

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.

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. Upon loss of main power supply, lifts shall automatically go to next floor level and stop. Escape from legs/shafts/columns of an installation shall be considered separately. 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, power supply.

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.

An emergency preparedness plan shall be strategically located around the platform.

21.4.2 Escape exits

There shall be no dead end corridors exceeding 5 m in length.

Internal room arrangement should be evaluated for possible blocking of exits following an accident as well as external blockage. Any room where more than 15 persons may assemble shall have at least two exits.

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 escape route.

21.4.3 Evacuation means

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
2. Free-fall lifeboats
3. Escape chute with life rafts

For installations connected by bridge to other installations and/or floating accommodation installations, the bridge may be considered as 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 EERS.

The minimum number of free-fall lifeboats in the main evacuation area available during a dimensional accidental event shall be corresponding to the maximum number of personnel (100 %) on board plus one additional boat to compensate for unavailability. The maximum number of personnel on board shall include day visitors.

Minimum requirements for floating installations is 100 % free fall lifeboat capacity to be available in dimensioning scenarios resulting in dimensioning accidental heel angels, combined with the one year weather condition. 100 % lifeboat capacity shall be available after a 10 000 year storm condition.

One additional evacuation system in the far end of the installation should be installed if escape to the main evacuation area is impossible during dimensioning accidental events.

All evacuation equipment shall be type approved and tested according to SOLAS and national maritime regulatory requirements. Stricter requirements may be necessary to fulfil survivability requirements.

All free-fall lifeboats shall be launched as part of commissioning of the evacuation means.

The total life raft capacity (sum of all escape chutes at the installation) shall as a minimum correspond to the maximum number of personnel onboard, unless an analysis show that a smaller capacity can be accepted.

The life rafts and boarding rafts shall be lowered together with the chute and the boarding raft shall automatically inflate.

In the vicinity of the muster area at least one escape chute with minimum capacity of the largest lifeboat shall be included.

The distance between lifeboats and escape chute shall be large enough to ensure that a dropped boat will not hit a lowered escape chute and boarding platform. The distance between lifeboats and platform structure shall be large enough to ensure a safe drop of the lifeboats.

For NNMI adequate life saving appliances shall be available. The need shall be evaluated and described in the EERS. Installation of at least one free fall lifeboat is recommended, but other arrangements may be used.

Lifeboats:

- Should be designed for 10 min running in a gas cloud or fire on sea. The external equipment including the engine exhaust system shall not act as ignition sources.
- Recovery from sea shall be possible in up to 2 m wave height. Winches for recovery should be fed by main power.
- The hoisting speed for recovery should be minimum 3 m/min.
- Emergency power should be provided for charging of lifeboat batteries. The disconnection point should be in the vicinity of the lifeboat and disconnection shall be automatic when dropping or lowering the lifeboat.
- Access ways should be provided with anti-skid coating.
- Cabinet housing should be arranged for winches and consoles.
- Heaters should be provided for electric motors for the winches.

Easy access for inspection and lifting of heavier components (e.g. air bottles) during periodical maintenance shall be provided.

Escape chutes:

- Shall be readily available and easy to operate with clear operating instructions located on the wall inside the container.
- 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.

21.4.4 Survival suits and life jackets

Survival suits for 50 % of lifeboat capacity, or as required in EERS, shall be available at the lifeboat and escape chutes. A sufficient number of lifejackets shall be available if necessary in a defined situation of hazards and accidents.

Survival suits and life jackets shall be type approved according to SOLAS requirements.

Life jackets should be possible to wear during evacuation in escape chute.

21.4.5 Muster area

There shall be a muster area, outdoors by lifeboat embarkation point or in a protected area with direct access to lifeboats.

The muster area and the access to the evacuation station shall be arranged and protected in order to evacuate the actual number of personnel in an organised and efficient way. Area allocation shall be 0,4 m^2 per lifeboat seat.

21.5 Survivability requirements

21.5.1 Survivability of escape routes

Escape routes outside the area for the initial event shall be designed and protected so that at least one route of escape is available for the required period of time during a dimensioning accidental event, including possible search and rescue operations if defined in EERS.

Personnel shall be able to use the escape routes without being exposed to excessive toxic fumes, smoke nor unacceptable heat loads, hot liquids or falling objects.

Steel should be the preferable material used in escape routes that may be exposed to hydrocarbon fires including handrails and stairs. Other materials may only be used if documented acceptable with respect to survivability also when considering use of the emergency response team.

21.5.2 Survivability of evacuation means and muster area

The muster area shall provide refuge on the installation for as long as required for evacuation of the installation.

Evacuation means shall be designed and protected to ensure safe abandonment of the installation during a dimensioning accidental event for the period of time required for evacuation, and search and rescue operations if defined in EERS. Requirements for combinations of accidental loads and environmental loads shall be defined in EERS.

22 Rescue and safety equipment

22.1 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.

22.2 Interfaces

The rescue and safety equipment have no interfaces with other safety systems/functions.

22.3 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.

22.4 Functional requirements

22.4.1 Man over board (MOB) boat

Minimum one MOB boat shall be installed on the installation. The MOB boat shall be in accordance with NMD Regulation No. 492. The MOB boat shall be able to maintain a speed of minimum 25 knots in calm sea with three persons onboard.

There shall be two different launching arrangements, e.g. two deck cranes. If cranes are used for launching, the MOB boat shall be visible from the crane cabins during handling. The MOB boat shall have a fixed lifting frame with one point suspension for handling by cranes.

It should be possible to launch and recover the MOB in 5 m significant wave height.

The functional requirements for time from man overboard alarm until being sea born shall be defined by the emergency preparedness analyses.

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,
- 1 thermal protection blanket,
- 1 VHF radio with suitable charger,
- 3 life jackets,
- 2 bags, each containing:
  - 30 m lifeline,
  - 1 pair of flippers,
  - 1 divers knife,

- 1 divers mask with breathing tube,
- 1 standard size waterproof torch,
- 1 mini size waterproof torch and one 6 kg lead belt,
- 1 pair of night glasses (for installations with moon pool work).

22.4.2 Safety equipment

22.4.2.1 Personnel basket

The installation shall be provided with a basket suitable for transport of personnel and for transport of injured personnel. The basket shall float.

22.4.2.2 Safety showers and eyebaths

Strategic locations shall be identified through a separate evaluation considering the chemicals handled and spillage that may occur or risk for burns or exposure of hot fluids to personnel.

NOTE The following list is considering typical areas and is not to be interpreted as a complete list replacing the need for the evaluation.

The following areas should be equipped with both safety showers and eye baths:

- methanol pump and injection area;
- chemical injection pump and injection area;
- production lab;
- tote tank area;
- process utility area.

The following areas should be provided with eye baths:

- workshops;
- cement room, shale shaker room, sack storage room;
- drill floor;
- mudpit area;
- battery room, paint store, and mud lab.

The following areas should be provided with safety showers:

- process areas;
- drilling areas.

Potable water quality shall be used for safety showers and eyebaths.

22.4.2.3 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.

The cabinets shall be painted green (RAL 6002).

22.4.2.4 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.

22.4.2.5 Lifebuoys

Lifebuoys shall be located at regular intervals along the periphery of the lower levels of the installation, according to MODU Code 10.12.

22.4.2.6 Firemen's equipment

Firemen's equipment should be stored in sets at not 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.

22.4.2.7 Smoke hoods/breathing masks

Smoke hoods/breathing masks shall be installed as follows:

- one smoke hood per bed in LQ cabins;
- breathing masks/smoke hoods for escape through areas exposed to toxic fumes or smoke shall be evaluated.

22.5 Survivability requirements

There are no special survivability requirements.

23 Marine systems and position keeping

23.1 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.

23.2 Interfaces

The marine system has interfaces with the emergency power system.

23.3 Required utilities

The marine systems performance is dependent on

- hydraulic system,
- cargo handling system including loading computer,
- telecommunications for positioning.

23.4 Functional requirements

23.4.1 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

- NMD Regulations No.879 concerning ballast systems on mobile offshore units,
- NMD Regulations No.123 for mobile offshore units with production plants and equipment.

In addition the following requirements apply:

- ballast system shall 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;
- for ballast tanks which are not always accessible for checking of tank level, two independent remote sounding systems shall be arranged. The sounding systems should be functionally different;
- 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.

23.4.2 Position keeping system

The position mooring system shall maintain the installation on location and if applicable enable relocation of the installation. Heading control shall be kept within defined design limits. The system should comply with NMD Regulations No. 857 concerning anchoring/positioning 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 in this evaluation are number and types of risers, riser pressures, SSIVs and mooring arrangement.

23.5 Survivability requirements

System and components incorporated in systems shall resist DALs to which they may be exposed for the required period of time.

Vulnerability evaluation of all systems and functions necessary to maintain floating capability and stability should be performed.

Measures to avoid unintentional internal filling of compartments from pressurized fluid systems shall be implemented, e.g. routing of pressurized piping outside enclosed compartments, if possible. 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 and FW pumps on high water level detection within the compartments.

24 Ship collision barrier

24.1 Role

The ship collision avoidance system shall reduce the risk for ship collisions.

24.2 Interfaces

The ship collision barrier has interfaces with the following safety systems/functions:

- alarm and emergency communication;
- emergency power;
- escape and evacuation;
- structural integrity.

24.3 Required utilities

Ship collision barrier performance is not dependent on any specific utility.

24.4 Functional requirements

There shall be a collision monitoring system able to detect a vessel on collision course typically within 50 min 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 radar system shall be able to register the course and speed of the object, and plotting facilities shall be included, e.g. automatic radar plotting aid. Radar signals shall be transmitted to unit responsible for surveillance.

The radar system shall be provided with proximity alarm to warn the observer of an approaching vessel with time to closest point of approach.

Automatic identification system coverage around the installation shall be sufficient to detect automatic identification system signals from vessels at a distance of minimum 20 nautical miles.

If there is no dedicated stand-by vessel, the following equipment shall be installed:

- signal lamps with luminous intensity of minimum 1000 candelas;
- typhoon with strength of 110 dB at a distance of minimum 100 m;
- megaphone with sound intensity of 80 dB.

Tension leg platforms shall be equipped with an underwater warning device to warn submarines on collision course.

24.5 Survivability requirements

There are no special survivability requirements.

Annex A (Informative)
Fire protection data sheet

FIRE & GAS CAUSE & EFFECT / AREA SAFE CHART

Platform: **Fire area:**

Area description:

Doc. no.:		Made by:	
Rev. no.:		Checked by:	
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

Output signals | Ventilation and dampers | Active fire fighting | Isolation of ignition sources | Shutdowns | Alarms

Tag ref.

ID	Input signals	Tag ref.	Notes
	Gas detection		
	Flame detection		
	Activations		
	Status alarms		

Id ref. **A** **B** **C** **D** **E** **F** **G** **NOTES:**

Tag nos

standard
norge