

NORSOK STANDARD

TECHNICAL SAFETY

S-001
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CONTENTS

FOREWORD	3
INTRODUCTION	3
1 SCOPE	4
2 NORMATIVE REFERENCES	4
3 DEFINITIONS AND ABBREVIATIONS	5
3.1 Definition	5
3.2 Abbreviations	8
4 SAFETY EVALUATION, MANAGEMENT AND DOCUMENTATION	9
4.1 General	9
4.2 Risk reduction principles	9
4.3 Analyses and optimisation	9
4.4 Documentation	10
5 EVACUATION AND EMERGENCY PREPAREDNESS	11
5.1 Introduction	11
5.2 Evacuation	11
5.3 Rescue	12
6 SAFETY REQUIREMENTS TO LAYOUT AND ARRANGEMENT	12
6.1 General requirements	12
6.2 Area Classification	13
6.3 Escape routes	13
6.4 HVAC	13
6.5 Helicopter deck	14
6.6 Emergency service areas	14
6.7 Process area	14
6.8 Riser area	15
6.9 Flare boom, flare tower, cold vent	15
6.10 Drilling and wellhead area	15
7 SAFETY REQUIREMENTS TO STRUCTURAL DESIGN	16
7.1 Design accidental loads	16
8 SAFETY REQUIREMENTS TO PROCESS AND AUXILIARY FACILITIES	17
8.1 General requirements	17
8.2 Safety shutdown systems	17
8.3 Process safety	17
9 REQUIREMENTS TO SAFETY AND COMMUNICATION SYSTEMS	18
9.1 General requirements	18
9.2 Fire and Gas detection	18
9.3 Emergency shutdown	19
9.4 Ignition source control	22
9.5 Alarm and communication system	23
9.6 Emergency power	24
9.7 Communication through signs and markings	26
10 REQUIREMENTS TO EXPLOSION AND FIRE PROTECTION	26

10.1 Fire and Explosion strategy (FES)	26
10.2 General requirements to fireprotection. FES	26
10.3 Requirements for passive fire protection of equipment, piping and secondary structures.	27
10.4 Fire technical requirements relating to materials	27
10.5 Passive fire protection	27
10.6 Storage and handling of explosives	28
10.7 Active Fire Protection	28
10.8 Explosion protection.	31
11 SAFETY ASPECTS RELATED TO FLOATING PRODUCTION, DRILLING AND STORAGE INSTALLATIONS	32
11.1 General	32
11.2 Crude storage	33
11.3 Layout	33
11.4 Turret	33
11.5 Drainage/Ballast water systems	34
11.6 Emergency re-positioning	34
11.7 Topside/floater interface	34
12 NORMALLY NOT MANNED INSTALLATIONS	34
12.1 General	34
12.2 Safety evaluation, management and documentation.	35
12.3 Design principles	35
12.4 System requirements.	36
ANNEX A - INFORMATIVE REFERENCES (INFORMATIVE)	37
ANNEX B - EVACUATION (NORMATIVE)	38
ANNEX C - MISCELLANIOUS SAFETY EQUIPMENT (NORMATIVE)	39
ANNEX D - LAYOUT (NORMATIVE)	42
ANNEX E - PRESSURE RELIEF (NORMATIVE)	44
ANNEX F - FIRE AND GAS DETECTION (NORMATIVE)	48
ANNEX G - PROTECTION OF PRESSURE VESSELS AND PROCESS PIPING AGAINST FIRE (NORMATIVE)	55
ANNEX H - FIRE FIGHTING SYSTEM (NORMATIVE)	57
ANNEX I - LIVING QUARTERS (NORMATIVE)	62
ANNEX J - FIRE PROTECTION DATA SHEET (INFORMATIVE)	63
ANNEX K - NORMALLY NOT MANNED INSTALLATIONS (INFORMATIVE)	64

FOREWORD

NORSOK (The competitive standing of the Norwegian offshore sector) is the industry initiative to add value, reduce cost and lead time and eliminate unnecessary activities in offshore field developments and operations.

The NORSOK standards are developed by the Norwegian petroleum industry as a part of the NORSOK initiative and supported by OLF (The Norwegian Oil Industry Association) and TBL (Federation of Norwegian Manufacturing Industries). NORSOK standards are administered and issued by NTS (Norwegian Technology Standards Institution).

The purpose of NORSOK standards is to contribute to meet the NORSOK goals, e.g. to develop standards that ensure adequate safety, value adding and cost effectiveness and thus are used in existing and future petroleum industry developments.

The NORSOK standards make extensive references to international standards. Where relevant, the contents of a NORSOK standard will be used to provide input to the international standardisation process. Subject to implementation into international standards, the NORSOK standard will be withdrawn.

Annexes B, C, D, E, F, G, H and I form a normative part of this standard.
Annexes A, J, and K are for information only.

INTRODUCTION

The purpose of this standard is to present the principles and requirements for safety design of offshore installations for production of petroleum.

ISO 13702 presents the general experiences and requirements from the International offshore industry and NORSOK S-001 adds the specific requirements/experiences from the Norwegian operators. Therefore ISO 13702 and NORSOK S-001 have to be read and understood in conjunction with each other.

1 SCOPE

This NORSOK standard for Technical Safety describes the principles and requirements for the development of the safety design for offshore production installations; fixed platforms, semisubmersibles and vessels. Where applicable this standard may also be used for Mobile Offshore Drilling Units. Installations intended for short term exploration drilling, shuttle of crude to harbour and general service are not covered by this standard.

This Standard together with ISO 13702 "Control and mitigation of fires and explosions- requirements and guidelines" 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. This standard will further have to be applied together with NORSOK standards for working environment and environmental care.

The principles and requirements for safety evaluation and safety management are described in ISO 13702 Chapter 4 while the objectives and functional requirements to installation layout are described in chapter 5. These methodologies are clarified and detailed in S-001 chapter 4.

Requirements to Risk and Emergency Preparedness Analyses are described in NORSOK Z-013 and are referenced concerning required input to the design process.

Requirements to Working environment are described in NORSOK S-002

2 NORMATIVE REFERENCES

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

API 6FA	Fire tests for valves
API RP 521	Guide for pressure-relieving and depressuring systems
BS 6755	Testing of valves. specification for fire type-testing requirements
E&P Forum	Guidelines for the Development and Application of HSE Management System.
ICAO BSL 5-1	International Civil Aviation Organisation Bestemmelser for Sivil Luftfart 5-1, Forskrift om kontinentalsokkelflygning – ervervsmessig luftfart til og fra helikopterdekk på faste og flyttbare innretninger til havs.
IEC 60079-10	Electric apparatus for explosive gas atmosphere- Part 10 Classification of hazardous areas.
IEC 60079-13	Electric apparatus for explosive gas atmosphere- Part 13 Construction and use of rooms or buildings protected by pressurisation.
IEC 61892-7	Mobile and fixed offshore units- Electrical installations. Part 7 area classification
IMO Resolution A653	Flame spread, surface materials and floorings
ISO 10418	Analysis, design, installation and testing of basic surface safety systems for offshore production platforms.

	(Replaces API RP14 C).
ISO 13702	Petroleum and natural gas industries — Offshore production installations- Control and mitigation of fires and explosions — Requirements and guidelines.
ISO 5660	Fire tests - Reaction to fire - Rate of heat release from building products.
NFPA 11A	National Fire Protection Association part 11 Standard for medium- and high-expansion foam systems
NFPA 13	National Fire Protection Association part 13 Installation of sprinkler systems
NFPA 14	National Fire Protection Association part 14 Standard for the Installation of Standpipe and Hose Systems
NFPA 16	National Fire Protection Association part 16 Deluge Foam-Water Sprinkler Systems and Foam-Water Spray Systems
NFPA 20	Standard for the Installation of Centrifugal Fire Pumps
NFPA 72	National Fire Protection Association part 72 National Fire Alarm Code
NORSOK C-001	Living quarters area
NORSOK C-002	Architectural components and equipment
NORSOK H-001	HVAC (Heating, ventilation and air conditioning)
NORSOK I-CR-002	Safety and Automation Systems (SAS)
NORSOK L-002	Piping Design, Layout and Stress Analysis
NORSOK M-501	Surface Preparation and Protective Coating.
NORSOK P-001	Process Design
NORSOK S-002	Working Environment
NORSOK S-003	Environmental Care
NORSOK S-011	Safety equipment data sheets
NORSOK T-100	Telecom Subsystems
NORSOK Z-013	Risk and emergency preparedness analysis.
NORSOK Z-016	Regularity, management & reliability technology

3 DEFINITIONS AND ABBREVIATIONS

3.1 Definition

Acceptance Criteria for risk	Criteria that are used to express a risk level that is considered acceptable for the activity in question, limited to the high level expressions of risk.
Accidental event	Event or chain of events that may cause loss of life, health, or damage to environment or assets.
Barrier	A measure which reduces the probability of realising a hazards potential for harm and of reducing its consequences. Barriers may be physical, (materials, protective devices shields, segregation etc) or non - physical (procedures, inspection, training, drills)
Can	Verbal form used for statements of possibility and capability, whether material, physical or casual.
Defined situations of hazard and accident (DFU)	A selection of possible events that the emergency preparedness in the activity should be able to handle, based on the activity's dimensioning

	accidental situations associated with a temporary increase of risk and less extensive accidental events.
Dimensional explosion	Explosion which in accordance with the defined acceptance criteria represents an unacceptable risk, and which consequently serves as a basis for design and operation of installations and for the implementation of the relevant activity in general.
Dimensional Fire	A fire which in accordance with the defined acceptance criteria represents an unacceptable risk, and which consequently serves as a basis for design and operation of installations and for the implementation of the relevant activity in general.
Dimensioning accidental events (DUH)	Accidental events that serve as the basis for layout, dimensioning and use of installations and the activity at large, in order to meet the defined risk acceptance criteria.
Dimensioning accidental load (DUL)	The 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
Dimensioning explosion	Explosion, which in accordance with the defined acceptance criteria represents an unacceptable risk and which consequently, serves as a basis for design and operation of installations and for the implementation of relevant activity in general.
Dimensioning fire	A fire which in accordance with the defined acceptance criteria represents an unacceptable risk, and which consequently serves as a basis for design and operation of installations and for the implementation of relevant activity in general.
Emergency lighting	Lighting which will ensure adequate light conditions on the installation in the event of failure of the main power supply.
Emergency power system	System to ensure continuous power supply to important equipment in the event of failure of the main power supply. This includes generators, control panels, hydraulic pumps, accumulators etc.
Emergency service areas	Safe areas by location where the emergency equipment such as fire pumps emergency generators are located.
Explosion load	The pressure generated by violent combustion of a flammable gas or mist which generates pressure effects due to confinement of the combustion induced flow and/or the acceleration of the flame front by obstacles in the flame front.
External communication Systems	Systems which ensure necessary communication to and from the installation.
Fire load	The total quantity of heat released in the case of complete combustion of all combustible materials in an area, including materials in walls, decks and ceiling.
Fire pump system	The total system, which supplies water for fire-fighting system, i.e. water inlets with filters, fire pumps, risers, power sources, power transmissions, fuel pipes/tanks and control systems.
Functional specification	As defined in ISO 13879 and 13880: Document that specifies the requirements expressed by features, characteristics, process conditions, boundaries and exclusions defining the performance of the product, process or service.
Hazard	Potential for human injury, damage to the environment, damage to property or a combination of these.

Hazard assessment	Process whereby the results of hazard analyses are considered against either judgement, standards, or criteria which have been developed as basis for decision making.
Hazards Register	A document providing a brief, but complete, overview of the identified hazards and the measures necessary to manage them. The hazards register also provides references to more detailed information relevant to a particular hazard.
Informative references	Shall mean informative in the application of NORSOK Standards.
Intermittently manned	Work area or work place where inspection, maintenance or other work is planned to last at least two hours a day for at least 50 per cent of the installation's operation time.
Internal communication Systems	Systems which ensure that messages can be communicated to and from various areas on the installation.
May	Verbal form used to indicate a course of action permissible within the limits of the standard.
Normally not manned	Work area or work place that is not permanently or intermittently manned.
Normative references	Shall mean normative (a requirement) in the application of NORSOK Standards.
NORSOK	Norsk Søkkel Konkurransesposisjon, the Competitive standing of the Norwegian Offshore Sector, the Norwegian initiative to reduce cost on offshore projects.
Permanently manned	Work area or work place manned at least 8 hours a day for at least 50 per cent of the installation's operation time.
Recognised institution	An institution which is internationally and/or nationally recognised within a professional field, and which possesses adequate competence and experience within that field.
Shall	Verbal form used to indicate requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted, unless accepted by all involved parties.
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.
Temporary Refuge (TR)	A place provided where personnel can take refuge for a pre-determined period whilst investigations, emergency response and evacuation pre-planning are undertaken.

All terms and phrases within the scope of this standard shall be regarded as defined in the regulations and international codes and standards referred to in this document. Where this is not unambiguous, the definition in this standard shall be used.

3.2 Abbreviations

AFFF	Aqueous film forming foam
API	American Petroleum Institute (US)
APS	Abandon Platform Shutdown
ASC	Area safety charts
BOP	Blow Out Preventer
CCR	Central Control Room
CFD	Computerised flow dynamic
DAL	Design Accidental Load
DHSV	Down Hole Safety Valve
DUH	Dimensioning Accidental Event
DUL	Dimensioning Accidental Load
EERS	Evacuation, Escape and Rescue Strategy (ISO 13702)
ESD	Emergency Shut Down
ESDV	Emergency Shut Down Valve
F&G	Fire and Gas
FES	Fire Explosion Strategy (ISO 13702)
FPDS	Fire protection data sheet
HAZID	Hazard identification
HAZOP	Hazard and operability
HC	Hydrocarbons
HSE	Health, Safety and Environment
HVAC	Heating, Ventilation and Air Conditioning
IEC	International Electrotechnical Commission
IMO	International maritime organisation
IP	Institute of Petroleum (UK)
IR	Infra Red
KO	Knock Out
LEL	Lower Explosion Limit
LQ	Living Quarter
MOB	Man Over Board
MSF	Module support frame
NFPA	National Fire Protection Association (US)
NNMI	Normally Not Manned Installations
NPD	Norwegian Petroleum Directorate
PA	Public Address
PCDA	Process control and data acquisition
PCS	Process Control System
PSD	Process Shut Down
RAL	Deutsches Institut für Gutesicherung und Kennzeichnung e.V., Bonn
RP	Recommended practice
SAS	Safety and Automation Systems
TR	Temporary Refuge
UPS	Uninterrupted Power Supply
UV	Ultra Violet
VDU	Visual Display Unit

4 SAFETY EVALUATION, MANAGEMENT AND DOCUMENTATION

4.1 General

A Health, Safety and Environmental Program (HSE) shall be developed according to the E&P forum guideline: "Guidelines for the Development and Application of HSE Management Systems". This program shall among other issues address the follow up and closing of specific safety problem areas. Safety objectives established by operator/project other than those specified by this NORSOK standard and ISO 13702 shall be identified and expressed in the form of design objectives and performance standards (See 4.4). These shall be developed specifically for each development or modification project.

The FES shall reflect the mitigating and consequence reduction measures to be implemented. Ambient conditions (normal operations or emergencies) shall be clearly defined and included in requirements to equipment and systems covered by this standard.

4.2 Risk reduction principles

The probability reducing measures shall be given priority over consequence reducing measures. The incorporation of this overall principle in the design calls for consideration of the following, listed in order of priority:

- Inherent safety
- Simplicity, comprehensibility, maintainability and recognisability e.g. by elimination of complexity that may lead to human failure
- Failure mechanisms. E.g. leading to leaks and releases of hazardous substances, ignitions or mechanisms reducing the reliability and survivability of barriers and safety systems.
- Escalation prevention, e.g. by safety barriers
- Experience retention from operational reliability and incident databases.

4.3 Analyses and optimisation

The design principles presented in clauses 5 to 12 reflect a normally adequate standard for safe design, whereas the project risk acceptance criteria are reflecting the maximum risk level, not necessarily achieved through a standard design. This is because the safety level depends on several factors, partly outside the range of standardisation, e.g. detailed layout and arrangement, operational aspects, environmental conditions, and new technology.

Therefore a fit for purpose approach shall be performed through consideration of possible Hazards and Hazardous events in the design. The Hazards and Hazardous events shall be systematically identified and updated regularly along with the development of the project. This process shall be documented, e.g. in a Hazards Register.

Risk and emergency preparedness analysis shall be carried out with the objective to identify the hazards, their frequency, causes and consequences and to verify that the risk acceptance criteria are met. Timing, scope and method of risk and emergency preparedness analysis shall allow for the analysis to be both a tool for decision making as well as, when relevant, a verification of acceptance criteria being met through implementation of technical and operational safety requirements.

NORSOK Z-013 states the requirements on the planning, execution and use of risk and emergency preparedness analysis.

A vulnerability/availability analysis shall be carried out to ensure that safety critical systems and functions maintain their integrity and perform their duty during credible accident scenarios for the time period their functions are required. The effects from fires and explosions on operation and stability on ESD, Fire & Gas detection and PA/alarm systems are typical examples of targets for such analysis. See Norsok Z-013 Clause 5.3.8.

HAZOP according to ISO 10418 shall be used as a tool in the system optimisation process to achieve system safety and operability.

Cost/benefit evaluation should be applied to study different design alternatives. See Norsok Z-013 and Norsok Z-016.

4.4 Documentation

The safety design shall be documented to present how the design fulfils regulations, standards and norms as required by the internal control system and to document the basis and assumptions for Risk and Emergency preparedness evaluations. Further, the project documentation provides the basis and necessary information for safe operation, modifications and development of the facility.

Documentation should be produced as follows, but with the necessary additions where this is considered necessary the particular needs of each project. The documentation may be one or several documents.

1. HSE program
2. FES (Fire and Explosion Strategy).
3. EERS (Evacuation, Escape and Rescue strategy).
4. Performance Standard for Safety systems. See Note 1
5. Design accidental load requirements
6. Documented sectionalisation of the process plant including categorization and location of ESD and PSD valves.
7. Fire and gas detection arrangements.
8. Fire Protection Data Sheets / Area Safety Charts
9. Reliability/sensitivity/availability/vulnerability analyses for safety systems
10. Safety arrangements drawings as follows:
 - Passive fire and blast protection.
 - Escape ways, muster areas, means of evacuation
 - Area classification- schedule of sources
 - Miscellaneous safety equipment.
 - Active fire protection

Safety interface documents shall be produced where relevant to demonstrate how these safety requirements are met, e.g. between:

- Fixed platform and mobile offshore units, e.g. drilling rig or accommodation rig.
- Fixed platform and storage units
- Different contractors.

Safety evaluations as required by this standard shall be documented.

Note 1 Performance standard for Safety systems shall define the functional and specific requirements for the design of the ESD/PSD/F&G systems, firewater system, HVAC and isolation of ignition sources. Further it will be presented how these systems is meant to work together to minimize escalation and consequences of mishaps and accidents.

5 EVACUATION AND EMERGENCY PREPAREDNESS

5.1 Introduction

An EERS shall be developed for the installation based on ISO 13702 Chapter 4/Annex B 12 and Emergency preparedness analyses as described in NORSOK Z-013. The EERS for the installation will define and document the adequate strategy and requirements to escape evacuation and rescue installations and equipment.

In addition to the requirements in the referred standards the following requirements shall apply:

- All evacuation equipment shall be type approved according to SOLAS and national maritime regulatory requirements.
- The layout of presentation mimics and monitors in the Central Control Room shall consider management of emergency situations.
- The design of the facilities shall consider and cater for an effective execution of the Emergency Preparedness activities.

See Annex B for details relating to evacuation principles.

5.2 Evacuation

The requirements relating to safe evacuation will be met by using a combination of means of evacuation according to current practice i.e.:

- a) Helicopter.
- b) Free fall lifeboats.
- c) Escape chute with life raft.
- d) Bridge to neighbouring installation

Number, size and location of evacuation means shall be established based on manning, risk analyses (e.g. risk exposure of escape routes towards main shelter area), and emergency preparedness analysis. The time for evacuation, together with the required search and rescue operations shall be established and the escape routes and other facilities as firewalls, radiation shields etc. designed accordingly.

The minimum number of free fall lifeboats for fixed installations available during a dimensional accidental event shall be corresponding to the maximum number of personnel (100%) on board plus one additional boat. Latter is meant to provide escape for the damage control team. If there is an additional lifeboat located in an area on the installation other than the main evacuation area, this lifeboat shall not be counted, as the additional lifeboat required

The number of free fall lifeboats for floating installations shall correspond to the maximum number of people onboard and be available in design weather conditions and with dimensional accidental heel angles, plus the significant dynamic heel in the same weather and accidental condition.

The manning to be considered shall comprise all personnel on board, including day visitors.

The total life raft capacity at escape chutes shall as a minimum correspond to the total number of personnel (100%) on board as documented in the EERS and according to the emergency preparedness analyses. The life raft and boarding rafts shall be lowered together with the chute. By lowering the chute, the boarding chute shall automatically inflate.

The distance between lifeboats and escape chute shall be large enough to ensure that a dropped boat will not hit a lowered escape chute.

For detailed recommendations related to safety equipment see Annex C.

5.3 Rescue

Generally the installation shall be covered by one Man Overboard Boats (MOB's). This one should be evaluated for use together with the one on the stand by vessel. Other combinations will be acceptable as proven by the emergency preparedness analyses.

The functional requirements for time from man overboard alarm until being seaborne shall be defined by the emergency preparedness analyses. Utilisation of the deck crane to lift the MOB on to the installation shall be evaluated.

6 SAFETY REQUIREMENTS TO LAYOUT AND ARRANGEMENT

6.1 General requirements

Reference is given to clauses 5, 7 and 13 in ISO 13702 for layout, orientation and location of equipment and functions. The main principles for layouts are listed below.

For further details see Annex D.

- The wellhead area should be located and designed so as to allow for external fire fighting assistance.
- Allow for identification of the blowing well in a possible blow out situation.
- The utility area should serve as a barrier between hazardous areas and LQ/emergency service areas. Good access to areas and equipment shall be ensured in order to achieve effective manual fire fighting both from the installation and by external assistance.
- Routing of hydrocarbon piping to, or through, the utility area shall be minimised and flanges avoided. One flange connection can be arranged in each fuel line to combustion engines in utility the area.
- Routing of hydrocarbon piping is not allowed in the living quarter areas.
- Routing of liquid piping of any kind is not allowed through electrical, instrument and control room
- Routing of hydrocarbon piping within emergency service areas shall be limited to diesel fuel supply lines for the emergency services themselves.
- The use of explosion panels and weather protection shields shall be kept to a minimum, with a preference to open naturally ventilated areas. 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.

- Where explosions panels, walls or shields are provided, the possible utilisation of fire fighting vessels during emergencies should be considered. 6.1.1 Area classification

6.2 Area Classification

The definition of hazardous areas shall be in accordance with IEC 60079-10 and IEC 61892-7. For design principles related to pressurisation of rooms, alarms and disconnection upon loss of pressurisation, ref. is made to IEC 60079-13.

Gases with molecular weight between 21 and 35 shall be regarded as both heavier and lighter than air (molecular weight air = 29).

The classification of hazardous areas shall be based on events and situations associated with normal platform operations, e.g. continuous or periodic venting, evaporation from open handling systems, small leaks from flanges and gaskets, escape of flammable substances during maintenance and work-over operations. See Annex D Layout.

All electrical equipment in naturally ventilated areas shall be certified safe type apparatus. Where certified safe type apparatus is not available, the apparatus shall be electrically isolated on single gas detection or confirmed gas detection dependent on the importance of the equipment.

6.3 Escape routes

The escape routes and the temporary refuge shall be in accordance with ISO 13702 clause 14. Guidelines for the design of escape routes are listed in Annex B. For large manned installations the escape route system and the temporary refuge (TR) shall be available for at least 1 hour, i.e. at least one route of escape from each area not directly affected by the event shall be available.

Escape routes shall be well marked, including signs. Escape routes on decks shall be provided with a non-skid, oil resistant coating in the “safety yellow colour” RAL 1023. On deck grating, two parallel 100mm wide yellow lines shall be painted indicating the width of the escape route. Marking shall show the preferred direction of escape.

6.4 HVAC

Natural ventilation and open modules shall be preferred and the effect of natural ventilation shall be assessed and documented.

A strategy for active control of possible smoke from fire in living quarters, TR and other mechanically ventilated areas shall be developed and included in the design of HVAC system. Ref. NORSOK H-001 HVAC.

All air inlets shall be located in non-hazardous areas, as far as practicable away from possible HC leakage sources, and minimum 3 m from any zones 2 boundary. Simulation studies or wind tunnel tests should be used for location of main HVAC air inlets to ensure operation of HVAC systems serving quarters and emergency equipment rooms to be minimal affected by smoke and escaped gases from incidents onboard.

For arrangement and protection of non-hazardous rooms with access to hazardous areas, ref. is made to IEC 60079-13 and IEC-61892-7.

6.5 Helicopter deck

The helicopter deck is subject to approval by the national civil aviation administration, ref. BSL D 5-1.

The turbulence effects from wind across and around the installation as well as influence from turbine exhausts and flare/vent shall be considered. Simulation studies or wind tunnel tests shall be performed during design of new installations or modifications of existing ones.

The arrangement shall be evaluated with the assistance of an experienced helicopter pilot.

The helicopter deck should have 3 access ways, sufficiently separated from each other (one pr. 120 degrees).

A continuous walkway around the helicopter deck edge at a level below helicopter deck surface should be provided. (Approximately 1500 to 1200 mm below the level of the helicopter deck)

The helicopter deck surface shall be self-draining type, suitable for use by trolleys. The friction coefficient on a wet deck shall be minimum 0,65.

The helicopter deck should be provided with an AFFF system (Pop-up, Safedek or similar). The system shall be functioning according to specification within 20 seconds after activation. The system shall be activated and deactivated from the helicopter deck control room. The system shall be protected against unplanned activation.

Details regarding drain system on helicopter deck are covered in Annex D.7.

6.6 Emergency service areas

An emergency service area is defined, as an area containing equipment and systems required during emergency conditions. This includes firewater systems, emergency generators and emergency power distribution systems, safety and automation system, communication equipment, emergency ventilation, ballast system and position keeping system. (Ref. ISO 13702).

The location and protection of these systems as well as system design shall secure operations during and after an emergency condition. The equipment necessary during evacuation is of particular importance.

6.7 Process area

Fire and explosion evaluations shall be made along with the development of the lay out to minimise the built in escalation potential. This shall be ensured through the following principles:

1. Equipment and piping containing high-pressure gas should be located in the upper decks above the Module Support Frame or main hull.
2. Liquid vessels should be located lower than gas equipment.
3. Low-pressure equipment containing large amount of liquids should be located and arranged so that exposure to jet fires is minimised. If jet fire exposure can not be eliminated, the need for passive fire protection shall be evaluated.

Process piping, pig launchers and receivers and 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.

The flare system shall be protected from fire and explosion loads so that its integrity is maintained until the process plant has been depressurised.

6.8 Riser area

For all hydrocarbon risers; protection from external impact such as ship collisions and drifting objects shall be evaluated. Locating the risers behind main support structures or dedicated protection structures may be required to mitigate the risk.

The following means of protection shall be considered:

- For two or more gas risers, or one gas riser together with several oil risers: passive fire protection.
- Pig launchers and receivers: location in open, naturally ventilated areas, at the periphery of the platform, and with hatches directed away from equipment and structures.
- ESDV's: location in open naturally ventilated areas as close to the sea as practicable to minimise exposure of the risers from topside accidental events.
- Flanges and instrument connections on the riser side of the ESDV shall not be used on fixed risers. For flexible risers special considerations have to be made.
- Subsea barriers.
- Utilisation factor

6.9 Flare boom, flare tower, cold vent

Flare booms and flare towers shall be located and designed with due attention to all relevant flaring rates and wind conditions to ensure that the heat radiation level (ref. Annex E, clause E.4 Flaring) will be within acceptance limits in all areas of the installation, with due regard to exposure of operators, structures such as cranes and towers, electrical and mechanical equipment and piping.

The flare flame or hot gases shall not represent a hazard due to increased surface temperature in exposed areas. Particular attention should be paid to crane and drill tower wires/structures and personnel in exposed areas. Further the design of the cold vent systems shall cater for heat loads caused by a possible ignition of the discharge.

A flare/vent study is required, identifying the potential effects in all exposed areas.

6.10 Drilling and wellhead area

The drilling and well head areas shall be located with maximum distance to the living quarters and areas with emergency equipment and functions, and be separated from utility and processing areas in order to minimise the consequences from a blow out.

Possible collapse of the derrick shall be evaluated.

The well heads shall be located as high as practicable and above the main support frame or main hull in order to minimise exposure from a well head fire, and to facilitate control of a blow out on the installation.

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

Simultaneous drilling, work over and/or production shall be evaluated in detail taking into account operational procedures to ensure an acceptable safety level of the operation of the installation.

7 SAFETY REQUIREMENTS TO STRUCTURAL DESIGN

7.1 Design accidental loads

Accidental loads shall be identified and taken into account in the structural design. The probability, magnitude and potential consequences of identified loads shall be assessed and analysed.

Relevant loads are:

- Impact loads caused by dropped object, ship collision or others.
- Dropped objects:
 - Protection of structure to be dimensioned for falling container, pipes etc. based on estimated weight, probable drop height, vulnerability and criticality of the exposed areas.
- Ship collision:
 - The possibility of collisions caused by merchant vessels and the need for adequate sea traffic surveillance system shall be evaluated. For supply vessels operating alongside the installation, a collision load of 14MJ shall be assumed.
- Explosion loads:
 - Explosion loads affecting main structures
 - Explosion loads affecting secondary structures, e.g. walls acting as barriers between main areas.
 - Explosion loads acting on support of pressure vessels, flare headers, fire ring main, ESD valves etc. shall be considered.
 - Explosion loads shall be established by use of recognized computer models, e.g. FLACS. See clause 10.8.
- Heat loads caused by jet fires or pool fires on the installation or adjacent installation, from risers or from the sea surface in case of large oil releases to the sea or in case of sub sea gas releases.
 - Fire:
 - Installations that can be exposed to a dimensioning fire on the sea shall be able to withstand this for a time period sufficient for safe evacuation of the installation. The endurance shall not be less than 1 hour. Fixed installations shall be protected against fire on sea, as identified by risk analyses. For blow-out/fire on sea concerning floating installations, see clause 11.6.
- Loads caused by extreme weather, earthquake, damage to structural elements (damaged condition) or extreme temperatures.
- Design accidental loads shall be specified in the design accidental load specification.
- A weight control database shall be maintained to ensure that jacket or hull loads do not exceed their design weight limit.

8 SAFETY REQUIREMENTS TO PROCESS AND AUXILIARY FACILITIES

8.1 General requirements

Process and auxiliary systems shall be designed, manufactured, equipped and installed in such a way that the installations can be operated and maintained safely.

Process and auxiliary facilities shall be designed such that no single failure during operations can lead to unacceptable hazardous situations. This principle shall apply to operational errors as well as equipment failure.

8.2 Safety shutdown systems

A safety shutdown system shall be independent of and in addition to other systems and equipment used for normal operation, control and monitoring, and shall act as a safety barrier in case of malfunction or maloperation of these systems and equipment.

The safety shutdown system shall be logically divided into three main levels of shutdown:

- Abandon platform shutdown (APS).
- Emergency shutdown (ESD).
- Process shutdown (PSD).

Basic system philosophy is that a signal on a certain level should never initiate shutdowns or actions on higher levels, but shall always include shutdowns on lower levels.

The APS and ESD system shall be separate from the PSD - system

For more details reference is given to clause 9.3 Emergency shutdown.

8.3 Process safety

Two levels of protection according to ISO 10418 shall control abnormal operating conditions leading to potential hydrocarbon release:

- Primary level of protection.
- Secondary level of protection.

As far as possible, the two levels of protection shall operate on functionally different basis.

Duplication of identical safety devices given different set points does not satisfy the requirement of two levels of protection.

The PSD system shall automatically detect abnormal operating conditions within systems or equipment and initiate actions so that uncontrolled release of hydrocarbons is prevented.

The systems shall be designed to avoid cascading effects due to partial shutdown within PSD, i.e. shutdown signals should trip all affected systems so that a new abnormality is not developed as a result of the initial trip action.

The system philosophy shall ensure that the fail safe principle is applied. I.e. components shall move to, or stay in the predetermined safest position upon loss of signal or power.

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

Pressure relief and depressurising of hydrocarbon systems is covered in Annex E.

9 REQUIREMENTS TO SAFETY AND COMMUNICATION SYSTEMS

9.1 General requirements

The general requirements to safety and communication systems shall be in accordance with ISO 13702 clause 10 and 14.

The line of actions performed by personnel and automatic safety system during emergencies shall be automatically recorded to the extent it can ease investigations and experience retention after any incident.

9.2 Fire and Gas detection

9.2.1 General

All F&G detection system display and information facilities shall be centralised, and located in a continuously manned area, normally the central control room

Loop faults and -supervision shall be identified according to NFPA 72.

With the installation divided into fire areas the design of the F&G system shall presume that each fire area shall be covered by a sufficient number of detectors suitable for detection of probable fires or accidental releases of toxic or flammable gases in the area.

The gas detection system shall have detectors for hydrogen sulphide in relevant areas on installations where such gas can occur. The alarm presentation in CCR should in addition to screens (VDUs) be given on a simple fire and gas mimic. Further details regarding screen presentation is found in NORSOK I-CR-002 Safety and Automation Systems (SAS).

Local F&G display and status facilities shall be provided in the drilling area incorporating F&G monitoring of the drilling facilities.

The F&G system shall be designed so that maintenance, function testing etc. can be carried out without disabling the system. The location of fire - and gas detectors shall be based on defined scenarios, simulations and actual tests.

Detail requirements for F & G system is incorporated in Annex F.

9.3 Emergency shutdown

9.3.1 General

References are given to ISO 13702 clause 6.

The installation shall be analysed to identify potential hazardous conditions and their consequences. The critical operating parameters shall be selected and emergency shutdown logic developed. Due consideration shall be given to the event sequence in relation to the overall installation safety. In the detail assessments of ESD philosophy, actions associated with time delays in the achievement of a state of no escalation potential shall be identified and the implications on ESD philosophy determined. Consideration shall be given to interrelations between fields and installations interconnected e.g. by pipelines or control systems.

The ESD hierarchy shall be kept simple with respect to sub-levels. This to ease understanding and future updating. Three main shutdown levels shall be included, see clause 8.2.

The ESD principle hierarchy presented in figure 9.1 shall be applied for complex installations and used as guidance for simpler installations. For drilling operations see clause 9.3.4.

9.3.2 ESD valves

ESD-valves shall be located and arranged in such a way that the exposure from fires and explosions is minimised. Pneumatic and hydraulic tubing shall be capable of resisting loads from fire and explosion until they have completed the shut down sequence.

Instrument tubing from accumulators and hydraulic oil return lines should be protected from mechanical damage, which could adversely affect valve performance.

If hydraulic or pneumatic accumulators are used to move emergency shutdown valves to safe position, they should be positioned as close to the valve as possible to ensure the best possible availability. The accumulator capacity should be adequate for at least three operations (close-open-close). Spring return type of valves shall be used when required size is available.

On installations that are normally manned, only manual, local to the valve resetting of emergency shutdown valves shall be possible, as advised from the control centre.

If an emergency shutdown valve is used as process safety valve, the signal from the emergency shutdown system shall be conducted to the actuator or to a hydraulic/pneumatic control valve for the actuator separate from the process safety system. An evaluation shall be carried out to determine which system design will represent the highest availability during an emergency shutdown.

If an ESD valve is connected to the PCS system, the process control function shall be performed completely separate from the ESD functions.

Emergency shutdown valves that may be exposed to fire shall preferably have metal to metal seats. If other seats are used, the valve shall be fire tested in accordance with API 6FA or BS 6755.

The location of ESD valves shall be determined based on the FES.

The design of the emergency shutdown system shall be such as to allow extensive function testing to be carried out without interrupting the operations.

Valve leak testing procedures with acceptance criteria shall be developed.