NORSOK STANDARD R-002

Draft Edition 2, December 2008

Lifting equipment

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

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 Subject to development and publication of international standards, the relevant NORSOK standard will be withdrawn.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.

Introduction

The main purpose of this NORSOK standard is to contribute to an acceptable level of safety for humans, the environment and property in the petroleum industry by stating technical requirements for the various lifting equipment used.

During development of this NORSOK-standard, due consideration has been made to relevant EU Directives, Norwegian regulations, European Standard and International standard, as well as other rule setting documents which have been found relevant and suitable. It should, however, be noted that this NORSOK standard is neither a harmonised standard, nor contains all the technical and administrative requirements of the applicable regulations and directives, so that it is not sufficient itself for CE-marking of products. The manufacturer needs to comply with the relevant regulations and all applicable requirements regardless of the content of this NORSOK standard.

To a great extent references to standards have been used in this NORSOK standard in order to ensure quality and safety development when standards are revised, but also to avoid that this NORSOK standard is becoming very extensive and comprehensive.

The expert group responsible for this NORSOK standard has agreed that the main safety philosophy and principal requirements shall be based on the essential safety and health requirements stated in relevant EU directives, e.g. the Machinery directive 98/37EEC. This shall apply regardless of the type of installation or unit where the lifting equipment is installed. However, the administrative requirements, (e.g. CE marking, declaration of conformity, requirements for type approvals, etc.) are not part of this NORSOK standard.

Due consideration is also made to the requirements in the revised Machinery directive 2006/42/EC which will enter into force on 29 December 2009. In addition, the PSA aim of ensuring a high level as regards health, environment and safety in the petroleum activities, has been reflected.

1 Scope

This NORSOK standard states and develops a high technical safety level on lifting equipment for use in the petroleum industry.

This NORSOK standard is valid for lifting equipment on all fixed and floating installations, mobile offshore units, barges and vessels, as well as on land based plants where petroleum activities are performed.

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

CEN/TS 13001-3-2,	Cranes - General design - Part 3-2: Limit states and proof of competence of wire ropes in reeving systems
IEC 60034,	Rotating electrical machines
IEC 60204-1,	Safety of machinery Electrical equipment of machines - Part 1: General requirements
IEC 60204-32,	Safety of machinery - Electrical equipment of machines - Part 32: Requirements for hoisting machines
IEC 60529,	Degrees of protection provided by enclosures
NEK IEC 60300-3-11,	Dependability management - Part 3-11: Application guide - Reliability centred maintenance
NEK IEC 60812,	Analysis techniques for system reliability - Procedure for failure mode and effects analysis (FMEA)
NEK IEC 61000-6-4,	Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments
NEK EN IEC 61131-1,	Programmable controllers -- Part 1: General information
NEK IEC 61892 (all parts),	Mobile and fixed offshore units - Electrical installations
NEK EN/TR 61831,	On-line analyser systems - Guide to design and installation
ISO 3864,	Graphical symbols -- Safety colours and safety signs - Part 1: Design principles for safety signs in workplaces and public areas Graphical symbols -- Safety colours and safety signs -- Part 2: Design principles for product safety labels Graphical symbols -- Safety colours and safety signs -- Part 3: Design principles for graphical symbols for use in safety signs
ISO 6309,	Fire protection -- Safety signs
ISO 9001,	Quality management systems - Requirements
ISO 12482-1,	Cranes -- Condition monitoring -- Part 1: General
ISO 13200,	Cranes -- Safety signs and hazard pictorials General principles
ISO 13849-1,	Safety of machinery -- Safety-related parts of control systems -- Part 1: General principles for design
ISO 12482-1,	Cranes -- Condition monitoring -- Part 1: General
ISO/TR 14121-2,	Safety of machinery -- Risk assessment -- Part 2: Practical guidance and examples of methods
NS-EN 341,	Personal protective equipment against falls from a height - Descender devices
NS-EN 349,	Safety of machinery - Minimum gaps to avoid crushing of parts of the human body
NS-EN 361,	Personal protective equipment against falls from a height - Full body harnesses
NS-EN 364,	Personal protective equipment against falls from a height - Test methods
NS-EN 365,	Personal protective equipment against falls from a height - General requirements for instructions for use and for marking

NS-EN 614-1,	Safety of machinery - Ergonomic design principles - Part 1: Terminology and general principles
NS-EN 614-2,	Safety of machinery - Ergonomic design principles - Part 2: Interactions between the design of machinery and work tasks
NS-EN 795,	Protection against falls from a height - Anchor devices - Requirements and testing
NS-EN 818-1,	Short link chains for lifting purposes - Safety - Part 1: General conditions of acceptance
NS-EN 818-2,	Short link chain for lifting purposes - Safety - Part 2: Medium tolerance chain for chain slings - Grade 8
NS-EN 818-6,	Short link chain for lifting purposes - Safety - Part 6: Chains slings - Specification for information for use and maintenance to be provided by the manufacturer
NS-EN 842,	Safety of machinery - Visual danger signals - General requirements, design and testing
NS-EN 953,	Safety of machinery - Guards - General requirements for the design and construction of fixed and movable guards
NS-EN 982,	Safety of machinery - Safety requirements for fluid power systems and their components
NS-EN 983,	Safety of machinery - Safety requirements for fluid power systems and their components – Pneumatics
NS-EN-ISO 898,	Mechanical properties of fasteners made of carbon steel and alloy steel - Part 1: Bolts, screws and studs
NS-EN ISO 9001,	Quality management systems - Requirements (ISO 9001:2000)
NS-EN ISO 11688-1,	Acoustics - Recommended practice for the design of low-noise machinery and equipment - Part 1: Planning (ISO/TR 11688-1:1995)
NS-EN ISO 11688-2,	Acoustics - Recommended practice for the design of low-noise machinery and equipment - Part 2: Introduction to the physics of low-noise design (ISO/TR 11688-2:1998)
NS-EN ISO 12100-1,	Safety of machinery, Basic conceps, general principles for design – Part 1: Basic terminology, methodology
NS-EN ISO 12100-2,	Safety of machinery, Basic conceps, general principles for design – Part 2: Technical Principles
NS-EN ISO 12944,	Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 1: General introduction
NS-ISO 14121-1,	Safety of machinery – Risk assessment – Part 1: Principles
NS-EN ISO 13850,	Safety of machinery -- Emergency stop -- Principles for design
NS-EN ISO 13857,	Safety of machinery - Safety distances to prevent hazard zones being reached by upper and lower limbs
NS-ISO 2631-1,	Mechanical vibration and shock -- Evaluation of human exposure to whole-body vibration Part 1: General requirements
NS-EN ISO 1421,	Rubber- or plastics-coated fabrics -- Determination of tensile strength and elongation at break
NS-EN 1127-1,	Explosive atmospheres - Explosion prevention and protection – Part 1: Basic concepts and methodology
NS-EN 13586,	Cranes – Access
NS-EN 12644-1,	Cranes – Information for use and testing - Part 1: Instructions
NS-EN 12644-2,	Cranes – Information for use and testing - Part 2: Marking
NS-EN 1037,	Safety of machinery- Prevention of unexpected start-up
NS-EN 13001-1,	Cranes - General design - Part 1: General principles and requirements - (Corrigendum AC: 2006 incorporated)
NS-EN 13001-2,	Cranes - General design - Part 2: Load actions - (Corrigendum AC: 2006 incorporated)
NS-EN 1679-1,	Reciprocating internal combustion engines - Safety - Part 1: Compression ignition engines
NS-EN 1834-1,	Reciprocating internal combustion engines - Safety - Part 1: Compression ignition engines
NS-EN 12198,	Safety of machinery - Assessment and reduction of risks arising from radiation emitted by machinery - Part 2: Radiation emission measurement procedure
NS-EN 13001-2,	Cranes - General design - Part 2: Load actions - (Corrigendum AC: 2006 incorporated*)*

NS-EN 13135-1,	Cranes - Safety - Design - Requirements for equipment - Part 1: Electrotechnical equipment- (Corrigendum AC: 2006 incorporated)
NS-EN 13135-2,	Cranes - Equipment - Part 2: Non-electrotechnical equipment - (Corrigendum AC: 2005 incorporated)
NS-EN 13557,	Cranes - Controls and control stations
NS-EN 12077-2,	Cranes safety - Requirements for health and safety - Part 2: Limiting and indicating devices
NS-EN 13852-1,	Cranes - Offshore cranes - Part 1: General - purpose offshore cranes - (Corrigendum AC: 2004 incorporated)
NS-EN 12077-2,	Cranes safety - Requirements for health and safety - Part 2: Limiting and indicating devices
NS-EN 982,	Safety of machinery - Safety requirements for fluid power systems and their components - Hydraulics
NS-EN 12385-1,	Steel wire ropes - Safety - Part 1: General requirements
NS-EN 12385-2,	Steel wire ropes - Safety - Part 2: Definitions, designation and classification
NS-EN 12385-4,	Steel wire ropes - Safety - Part 4: Stranded ropes for general lifting applications
NS-EN 13155,	Cranes - Safety - Non-fixed load lifting attachments
NS-EN 13411-3,	Terminations for steel wire ropes - Safety - Part 3: Ferrules and ferrule-securing - (Corrigendum AC:2005 incorporated)
NS-EN 13411-4,	Terminations for steel wire ropes - Safety - Part 4: Metal and resin socketing
NS-EN 13411-5,	Terminations for steel wire ropes - Safety - Part 5: U-bolt wire rope grips
NS-EN 13411-7,	Terminations for steel wire ropes - Safety - Part 7: Symmetric wedge socket
NS-EN 1677-1,	Components for slings - Safety - Part 1: Forged steel components, Grade 8
NS-EN 1677-3,	Components for slings - Safety - Part 3: Forged steel self-locking hooks - Grade 8
NS-EN 1677-4,	Components for slings - Safety - Part 4: Links, Grade 8
NS-EN 12385-3,	Steel wire ropes - Safety - Part 3: Information for use and maintenance
NS-EN 14502-1	Cranes - Equipment for lifting persons - Part 1:Suspended baskets
NEK IEC 61000-6-2,	Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity for industrial environments
prEN 1497,	Rescue equipment - Rescue harnesses
NORSOK E-001,	Electrical systems (Rev. 3, Dec. 1997)
NORSOK N-003,	Actions and action effects (Edition 2, September 2007)
NORSOK N-004,	Design of steel structures (Rev. 2.October 2004)
NORSOK M-501,	M-501 Surface preparation and protective coating (Rev. 5. June 2004)
NORSOK S-001,	Technical Safety (Rev. 3.January 2000)
NORSOK S-002,	S-002 Working environment (Rev. 4. August 2004)
NORSOK Z-007,	Mechanical completion and commissioning (Rev. 2.december 1999)
NORSOK Z-008,	Petroleum- Criticality analysis for maintenance purposes
NORSOK Z-016,	Regularity management & reliability technology (Rev.1 December 1998)

Directive 97/68/EF,
2002/88/EF,
2004/26/EF,
DNV Rules for certification of lifting appliances 1994,
NMD Regulation 4.July 2007 No.853,
US Fed Spec RRC 271,
IMO Resolution A.760 (18),
IMO Resolution MSC.82 (70),
IMO SOLAS LSA Code,

2.2 Informative references

CEN/TS 13001-3-1,	Cranes- General design-Part 3-1: Limit states and proof of competence of steel structures
CEN/TS 13001-3-2,	Cranes - General design - Part 3-2: Limit states and proof of competence of wire ropes in reeving systems

prCEN/TS 13001-3-3, Cranes –General design-Part 3-3:Limit states and proof of competence of wheel/rail contacts
NOKSOK R-003, Safe use of lifting equipment
DNV OS-E406, Design of free fall lifeboats
DNV OSS-308, Verification of lifting appliances for the oil and gas industry
OLF guideline 124,

3 Terms, definitions and abbreviations

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

3.1.1
availability
availability of an item to be in a state to perform a required function under given conditions at a given instant of time, or in average over a given time interval, assuming that the required external resources are provided

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

3.1.3
complex lifting appliances
power driven lifting appliances with high capacity and or high risks

3.1.4
crane
lifting appliance whereby the load can be moved horizontally in one or more directions, in addition to the vertical movement

3.1.5
critical lifting operations
operations requiring a work permit and special safety measures in order to address the interface with adjacent activities

NOTE These operations include, but are not limited to

- lift over critical areas, process equipment and well equipment,
- personnel lifting,
- coordinated lift whereby the weight exceeds the maximum lifting capacity of one of the lifting appliances,
- overload testing of the lifting appliance with SWL over 10 tonnes,
- lift of special large loads such as structures, mobile cranes etc,
- heavy lifts that are not considered to be routine operations,
- subsea operations using offshore crane.

3.1.6
design temperature
lowest mean daily air temperature for the area of operation, used for the selection of steel grades

3.1.7
extended harm
damage to property or the environment

3.1.8
fail-safe component
component where the predominant failure mode is known in advance, and which is used such that the effect of such failure is less critical

3.1.9
harm
physical injury or damage to health

3.1.10

heavy lift
load that is more than 10 tonnes and more than half of the SWL of the lifting equipment

3.1.11
inherently safe design
system that can not cause harm

3.1.12
installation
facility, plant and other equipment for petroleum activities (excluding ships that transport petroleum in bulk)

NOTE In this NORSOK standard, supply and standby boats are included in the definition of an installation.
Examples of installations include fixed installations, floating production, storage and offshore loading (FPSO) vessels, rigs, barges, crane barges, service vessels etc.

3.1.13
launching and recovery appliances
lifting appliance for lifesaving equipment

3.1.14
lifesaving equipment
evacuation equipment and rescue equipment

3.1.15
lifting accessories
components or equipment used between the lifting appliance and the load or on the load to grip it, but which is not an integrated part of the lifting appliance

NOTE Also cover loose gear.

3.1.16
lifting appliance
machine or device used for vertical movement of a load, with or without horizontal movement

NOTE Include cranes, hoists, drilling hoisting equipment and launching and recovery appliances for life saving equipment, etc.

3.1.17
lifting equipment
common term for lifting appliances and lifting accessories

3.1.18
lifting operation
all administrative and operational activities before, during and after a load is moved and until the lifting equipment is ready for a new load

3.1.19
lifting and stacking truck
forklift truck and similar mobile motorised work equipment for combined lifting, moving and stacking

3.1.20
may
verbal form used to indicate a course of action permissible within the limits of this NORSOK standard

3.1.21
offshore container
transportable unit that can be handled in open sea for repeated transport of load or equipment to/from installations and vessels

NOTE 1 The unit includes equipment for lifting, handling, filling, emptying, cooling and heating etc.

3.1.22
offshore crane

slewing crane used offshore for lifting operations with relative movements between the crane and the loading area

3.1.23
primary means of launching
main lifeboat launching system, based on gravity free fall or skidding combined with free fall, or lowering by a lifting appliance

3.1.24
rated capacity (R)
maximum load that a lifting appliance is designed to lift under specific conditions

NOTE Rated capacity which corresponds to SWL used by ILO.

3.1.25
redundant component
if the component fails, another component or components continue to perform its purpose or function without affecting the safe operation

3.1.26
reliability
ability of an item to perform a required function under given conditions for a given time interval

3.1.27
reliable component
component which is capable of withstanding all load conditions, disturbances and stresses, with a low probability of failures or malfunctions.

3.1.28
rescue boat
boat equipped with a single lifting suspension for offshore use for rescue of personnel from sea

3.1.29
rescue equipment
rescue boats and personnel baskets

3.1.30
risk
combination of the probability of occurrence of harm and the severity of that harm

3.1.31
safe working load
SWL
maximum working load that the lifting equipment is designed to lift under specific conditions

Note Safe working load corresponds to the term rated capacity (R) used by many standards.

3.1.32
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

3.1.33
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

3.1.34
significant wave height
average height of the highest third of prevailing waves, typically measured over a period of three hours.

3.1.35
suspended work platform
mechanically operated work platform that can move freely

NOTE E.g. suspended on rope.

3.1.36
test
specific operation of lifting equipment, with or without a defined load, in order to determine whether the lifting equipment is suitable for use

3.1.37
test load
specified load that the lifting equipment shall withstand within the manufacturer's specified limits without resulting in permanent deformation or other defects

NOTE Thereby confirming that the design, materials and manufacture comply with specification and statutory requirements.

3.1.38
working load limit
WLL
the maximum load that a lifting accessory is designed to lift at a specific configuration

3.2 Abbreviations

ALARP	as low as reasonable practicable
ATEX	Atmosphères Explosibles
CE	Conformitè Europeene
EMC	electromagnetic compatibility
EU	European Union
FAT	factory acceptance test
FMECA	failure mode, effects and criticality analysis
FPSO	floating production, storage and offshore loading
HSE	health, safety and environment
HVAC	heat, ventilation and air conditioning
ILO	International Labour Organisation
IMO	International Maritime Organization
MOB	man over board
NMD	Norwegian Maritime Directorate
PSA	Petroleum Safety Authority
RCM	reliability centered maintenance
SWL	safe working load
UHF	ultra high frequency
VHF	very high frequency
WLL	working load limit

4 General safety requirements

4.1 Safety

Lifting equipment shall be designed, fabricated, tested, installed and maintained in such a way to reduce and minimise risks to humans, the environment and material assets.

All forms of energy including lifting and moving objects, represented or produced by lifting equipment shall be controlled at any time in a safe manner.

The lifting equipment shall be designed such that no single technical failure gives an unacceptable risk.

4.2 Fitness for use

The selection of type and specification of requirements for lifting equipment shall be based on the specific conditions at the workplace, the work itself, and any risk that may arise during the work.

4.3 Reliability and availability

Lifting equipment shall be designed and constructed using well-proven components and safety principles, to ensure reliability by withstanding

- the operating stresses and loadings,
- the environmental influences,
- other relevant influences.

Lifting equipment shall be designed to ensure high availability and a minimum of “down-time” during the design life. In case of conflict between availability and safety, safety shall always prevail.

4.4 Principle of safety integration

The designer shall aim to eliminate any risk of accident throughout the design lifetime of the lifting equipment, including the phases of assembly and dismantling.

In selecting the most appropriate methods, the manufacturer shall apply the following principle of safety integration in the order given:

1. Eliminate and reduce risks as far as possible by design (According to inherently safe design philosophy)
2. Safeguarding and complementary protection measures in relation to risks that cannot be eliminated
3. Inform the users of the residual risks due to any shortcomings of the protection measures adopted, etc.

The basic terminology, methodology and technical principles are given in NS-EN ISO 12100-1and NS-EN ISO 12100-2.

A documented risk assessment shall be worked out for all lifting appliances. The documentation of risk assessment shall demonstrate that the requirements for performing the risk assessment have been met, and that the results with respect to the acceptance criteria are fulfilled.

The risk assessment principles are given in NS-ISO 14121-1 and ISO/TR 14121-2.

For complex lifting appliances the risk assessment shall be developed using methods on component level, e.g. FMECA as described in NEK IEC 60812.

4.5 Inherently safe design

Inherently safe design principles using reliable components shall be applied. Dependent on the result of the risk assessment, fail-safe components or redundant components shall be used.

4.6 Safeguarding and complementary protective measures

Safeguarding and complementary protective measures shall be used to reduce or eliminate risks that can not be avoided or sufficiently limited by design.

4.7 Information for use

Information for use consists of communication links (e.g. text, words, signs, signals, symbols), or diagrams used separately or in a combination to convey information to the user. The information for use shall be an integral part of supply of lifting equipment.

4.8 Strength proportion

The strength elements (structural and mechanical) of lifting equipment shall be designed such that the consequences of accidental overloading or unexpected load conditions which causes break down are known and minimised. This requirement does not apply for lifting accessories and portable units.

For cranes this requirement may be achieved by ensuring that the first element to fail is not the foundation or any other element which is essential for the structural integrity of the entire crane.

4.9 Maintenance

Lifting equipment shall be designed and arranged with means for efficient maintenance which ensures that the safe condition can be maintained for the specified design life.

A high level of maintainability shall be ensured, i.e. that the maintenance can easily be performed.

Facilities, including safe access, for maintenance, inspection and testing of essential elements and functions shall be provided.

The maintenance shall be planned with the following priority:

1. Safety
2. Reliability
3. Availability

A maintenance program shall be provided for all lifting equipment and shall include all important maintenance tasks highlighted and recommended in the risk assessment, see 4.11.

For cranes reference is given to ISO12482-1, relevant parts of NORSOK Z-008 and NORSOK Z-016, as applicable.

If appropriate for complex lifting appliances, the maintenance program shall be developed using methods on component level, e.g. RCM as described in NEK IEC 60300-3-11.

4.10 Quality management system

The design, manufacturing and installation of lifting equipment shall be performed in accordance with a quality management system. The quality management system shall be in accordance with NS-EN ISO 9001 or equivalent.

4.11 Risk assessment

4.11.1 General

Risk assessment shall be an integral part of the supply of lifting equipment. This implies that the knowledge and experience of the design, manufacturing, installation, transportation, assembly, dismantling, use, maintenance, incidents, accidents and harm, etc. related to lifting equipment shall be brought together by the designer in order to assess the risks of lifting equipment during all phases.

Risk assessment shall be an iterative process, and repeated after using risk reduction measures until an acceptable level of safety is met, see principle of evaluation of risks stated in 4.12.

The risk assessment shall be carried out in accordance with NS-ISO 14121-1.

The relevant method of analysing hazards and estimating risk shall be selected depending on the lifting equipment characteristics and the type of risks that are dominating. Example of such methods is described in ISO/TR 14121-2, Annex A.

The risk assessment shall be documented as stated in 4.14 and used as input for the maintenance planning, see 4.4.

4.11.2 Determination of the limits

Determination of the limits of the lifting equipment is the first step in the risk assessment. Determination of the limits of the lifting equipment includes the technical properties and the performance of the lifting equipment, the personnel involved and the environment where the lifting equipment is located.

Determination of limits of the lifting equipment shall include, but not be limited to

- use limits including intended use and foreseeable misuse,
- different modes of operation and operator interventions,
- space limits,
- time limits,
- environmental limits.

4.11.3 Identification of hazards

All hazards, hazardous situations and events shall be systematically identified. The phases shall include, but not be limited to

- construction,
- assembly,
- FAT,
- transport,
- installation,
- commissioning,
- use and foreseeable misuse,
- maintenance and testing,
- repair,
- de-commissioning, dismantling and removal.

Further reference is given to ISO/TR 14121-1.

4.11.4 Estimation of risks

The risk is a combination of the severity of harm and the probability of occurrence of harm.

The severity of harm to health can be estimated by taking into account

a) the severity of injuries or damage:
1) slight;
2) serious;
3) death.

b) the extent of harm:
1) one person;
2) several persons.

Or, in case of an extended harm of an economic and/or environmental nature:

a) the severity of the extended harm to in terms of cost or environmental damage:
1) minor;
2) major;
3) catastrophic.

b) the extent of the extended harm in terms of cost or environmental damage:
1) slight;
2) moderate;
3) extensive.

The probability of occurrence of any harm shall be estimated by taking into account the exposure to a hazard, occurrence of a hazardous event, and the possibilities of avoiding the harm.

The exposure to a hazard is influenced by

a) need for access to the hazard zone,
b) time spent in the hazard zone,
c) number of persons exposed,
d) frequency of access.

The occurrence of a hazardous event is influenced by

a) reliability and other statistical data,
b) incident and accident history,
c) risk comparison.

The possibilities of avoiding the harm are influenced by

a) skill of persons,
b) how quickly the hazardous situation is developing,
c) any awareness of risk,
d) the possibility of escape.

4.12 Evaluation of risks

Risk evaluation shall be carried out to determine if risk reduction is required. If risk reduction is required, then appropriate risk reduction measures shall be selected and applied in accordance with 4.13, followed by a repeated evaluation of risks. As a part of this iterative process, the designer shall check whether additional hazards are created or other risks are increased, when new measures are applied. If additional hazards do occur, they shall be added to the list of identified hazards and evaluated.

For standardised lifting equipment which are fully covered by the standards referred to herein, and which fully complies with the requirements stated, without additional hazards, the acceptance criteria stated in this NORSOK standard and the applicable annexes of this NORSOK standard applies.

For non-standardised lifting equipment or standardised lifting equipment which partly or fully do not meet the requirements stated in this NORSOK standard, the remaining risks shall comply with the the As-Low-As-Reasonably-Practicable (ALARP) principle stated by PSA. The ALARP principle may be described as a reverse burden of proof, i.e. that risk reduction measures shall be implemented, if there is no evidence showing why not. The designer shall implement risk reduction measures unless it cannot be proven that there are a major inconsistency between cost and benefit.

4.13 Risk reduction

Risk reduction shall comprise all possibilities to reduce the risk, including redesign, design modification, protective measures and information for use.

The designer shall select the most appropriate measure following the three step method listed below:

Step 1. Inherently safe design
Step 2. Safeguarding and complementary protective measures
Step 3. Information for use

For reference, see 4.4.

4.14 Documentation of risk assessment

Documentation of risk assessment shall demonstrate that the requirements for performing the risk assessment have been met, and that the results with respect to the acceptance criteria are fulfilled.

The documentation shall include

a) the lifting equipment for which the assessment has been made (e.g. specifications, limits, intended use) and any relevant assumptions that have been made (e.g. loads, strengths, safety factors),

b) the hazards and hazardous situations identified and the hazardous events considered in the assessment as follows:
   1) the hazardous situations identified;
   2) the hazardous events considered in the assessment.

c) the information on which risk assessment was based,
   1) the data used and the sources (e.g. accident histories, experiences gained from risk reduction applied to similar lifting equipment);
   2) the uncertainty associated with the data used and its impact on the risk assessment.

d) the objectives to be achieved by protective measures,

e) the protective measures implemented to eliminate identified hazards or to reduce risk (e. g. from standards or other requirements),

f) residual risks associated with the lifting equipment,

g) the result of the risk assessment,

h) any forms completed during the assessment such as those given in ISO/TR 14121-2.

4.15 Verification

Lifting equipment shall be subject to internal verification to ensure compliance with the requirements by the manufacturer. Such internal verification shall be part of the technical construction file, see 5.25.

Before being taken in into use, the lifting equipment shall be certified by an enterprise of competence, in accordance with NORSOK R-003.

Devices for the lifting of persons or of persons and goods involving a hazard of falling from a vertical height of more than 3 m, shall be subject to an involvement by a Notified Body, if the Machinery Directive is applicable.

The user and the manufacturer shall evaluate and agree upon the need, extent, method and independency of third party verification of the lifting equipment, dependent on the criticality of the lifting operations to be performed. As a reference for such verification activities, DNV OSS-308 may be used.

Verification reports shall be a part of the final documentation and shall be made available for the end user.

5 Common requirements

5.1 Suitability

5.1.1 General

At the time of contract for the delivery of lifting equipment, the user and the manufacturer shall agree on essential parameters to ensure that the lifting appliance is suitable and fit for use. Such design parameters shall include but not be limited to

- location of installation,
- type of installation,
- area of installation, arrangement and lay-out,
- environment, including temperatures, radiation, wind and other weather conditions, if relevant,
- criticality of the loads to be lifted, and the importance of the lifting operation,
- rated capacity,
- utilization,
- design life,
- HSE requirements,
- noise and emissions,
- operational limitations.

5.1.2 Lifting of personnel

Lifting equipment for the lifting of personnel shall be designed and equipped to minimise the risk for the personnel to be lifted.

The structural and mechanical capacity of lifting equipment for the lifting of personnel shall be designed using an increased risk coefficient, see 5.9 and the relevant annexes.

Lifting appliances for the lifting of personnel shall be equipped with additional safety features compared to lifting appliances for the lifting of loads, see 5.15 and the relevant annexes.

5.1.3 Mechanical interference

Lifting appliances shall be arranged and located with the aim not to interfere with other machinery or equipment.

Warning signals and anti-collision systems shall be provided on lifting appliances where mechanical interference with other machinery or equipment represents an unacceptable risk.

5.2 Materials and products

Materials and products used to construct lifting equipment or contained or created by the use of lifting equipment shall not cause harm. The use of toxic or harmful liquids and substances shall be minimised.

5.3 Fire and explosion

5.3.1 Fire prevention and protection

Fire prevention and protection of lifting appliances shall be in accordance with NORSOK S-001 and EN13478

All equipment, electrical and non-electrical, installed and used in hazardous areas, shall comply with ATEX requirements (see EN 1127-1 as relevant of the hazardous area classification), i.e. Zone 0, Zone 1 or Zone 2.

Fire prevention and protection shall be marked with signs in accordance with ISO 6309.

5.3.2 Hazardous areas

Lifting equipment shall be compatible with the area classification where the lifting equipment is installed and used. Lifting appliances located in non-hazardous areas shall as a minimum have external equipment suitable for use in hazardous area Zone 2, see NORSOK S-002. If relevant, crane boom movements may require Zone 1 equipment.

Area classification shall be in accordance with NEK IEC 61892 (all parts).

5.3.3 HVAC

HVAC in enclosed spaces of lifting appliances shall be in accordance with NORSOK S-001, where applicable.

5.3.4 Fire and gas detection

Complex lifting appliances shall be equipped with fire and gas detection in accordance with NORSOK S-001 as applicable.

5.3.5 Fire and gas alarms

Lifting appliances with control cabins and launching and recovery appliances for the life saving equipment, shall be equipped with fire and gas alarms from the installation which enable the operator to terminate any lifting operations and bring the crane and the load to safe position before activating a manual shut down.

5.3.6 Shut-down system

Lifting appliances with built in ventilation system and/or combustion engines, shall be equipped with an automatic shut down system which activate upon confirmed gas detection at the crane ventilation system or in the combustion air inlet, without time delay, see NORSOK S-001.

5.4 Ergonomics

5.4.1 General

Lifting equipment shall be designed in accordance with ergonomic principles in accordance with NS-EN 614-1 and NS-EN 614-2.

5.4.2 Operator position

Control stations for lifting appliances shall be designed and constructed to avoid any risk to health and safety of the operator, and such that the operator can safely supervise and control the lifting operations.

5.4.3 Escape and access

Lifting appliances shall be arranged with access and escape routes for personnel in accordance with NS-EN 13586.

Lifting appliances shall be designed for safe access for operation, inspection and maintenance in accordance with NORSOK S-002.

Ladders where there is a danger of falling, shall have self closing gates.

Offshore cranes for daily operation shall be equipped with a main access route and a separate alternative escape route between the entrance to the cabin/machinery house and the deck of the installation. The main access route shall have stairway ladders between different levels and be designed for the transport of supplies and spares, and in an emergency to facilitate transport of a stretcher, smokediving and firefighting equipment.

5.4.4 Marking

Cranes shall be marked in accordance with NS-EN 12644-2.
Safety colours and safety signs of lifting equipment shall be in accordance with ISO 3864 and ISO 13200.

5.4.5 Illumination

A main electric lighting system shall provide illumination throughout those parts of the lifting appliances normally accessible to operators and maintenance personnel, and shall be supplied from the main source of electrical power.

An emergency lighting system shall provide illumination of the working area throughout those parts of the lifting appliance normally accessible to operators and maintenance personnel, and shall be supplied from the emergency source of electrical power. Upon loss of main source of power, all required emergency lighting shall be automatically supplied from the emergency source of power to ensure safe emergency operation and emergency escape.

Helicopter lights shall be installed on all lifting appliances representing a risk of obstruction or interference for helicopters.
Illumination of working area shall be in accordance with NORSOK S-002, 5.6

5.4.6 Prevention of unexpected start up

Powered lifting appliances shall be prevented against unexpected start up in accordance with NS-EN 1037.

Lifting appliances with enclosed cabins and/or remote operated control stations, shall be equipped with a switch/device by which the operator can disable the main control levers.

5.4.7 Guarding

Lifting appliances shall be equipped with fixed and moveable guards in accordance with NS-EN 953.

5.4.8 Crushing hazard

For both operation and regular maintenance activities, lifting appliances shall be designed with safety zones and distances to prevent personnel being harmed or injured due to moving parts. Reference is made to NS-EN ISO 13857 and NS-EN 349.

5.4.9 Falling objects

Mechanical components used in lifting equipment (e.g. bolts, shackles, wedge sockets, etc.) which may be subject to vibrations or impacts from contact with other objects during operation, shall be equipped with a double physical barrier against detachment.

NOTE An example of such mechanical component with a double physical barrier is a shackle pin secured in a shackle bow using a threaded nut locked by a split pin.

All equipment (e.g. flood lights, cameras etc.) which are mounted externally on lifting appliances by bolting etc. and which may represent a hazard of falling objects in case of loosening, shall be secured by a wire strap or a chain that is capable of catching and holding the falling object without damage.

Bolts used in lifting equipment shall normally be secured. Exceptions are bolts which represent no hazard.

The following methods/products are considered to be properly secured:

- controlled pretension to 70 % of yield;
- nut with split-pin through the bolt;
- sewing using stainless wire;

- through metal nuts;
- locking plates.

Other well proven methods and designs may also be used.

5.4.10 Mechanical vibration and shock

Lifting equipment shall be evaluated for mechanical vibration of shock to humans in accordance with NORSOK S-002 and NS-ISO 2631-1.

5.4.11 Handling and transport facilities

Lifting appliances shall be provided with facilities for handling and transport of major components, e.g. motors, gearboxes, pumps, sheaves, etc.

Parts of lifting appliances weighing more than 25 kg which are detachable shall facilitate strapping or be equipped with attachment points, i.e. lifting lugs etc.

Reference is made to Annex B.

5.4.12 Hot surfaces

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

Shields and guarding to avoid skin contact shall be arranged, where applicable.

5.5 Environmental conditions

5.5.1 Temperatures

The design temperature for the environment in which the lifting equipment shall operate, shall be in accordance with the agreement between the user and the manufacturer and shall be stated in the instructions for use.

The corresponding minimum and maximum operating temperatures shall be determined by the manufacturer and shall be stated in the instructions for use.

Lifting equipment designed to operate in cold climate where snow and ice may occur, shall be designed for minimum snow and ice accumulation and the instruction for use shall state any operational limitations due to snow and ice.

5.5.2 Atmosphere

A marine atmosphere with 100 % relative humidity shall be considered for the design and operation of lifting equipment, unless otherwise specified.

5.5.3 Radiation

Lifting equipment which may be influenced by heat radiation from flares or burner booms etc., shall have necessary heat radiation shielding and any operational limitations shall be stated in the instructions for use.

Wire ropes, sheaves etc., which are exposed to heat radiation shall have facilities for lubrication and replacement intervals which are compatible with local environmental condition with respect to radiation.

Lifting appliances shall be designed to limit their radiation generation in accordance with NS-EN 12198.

5.5.4 Wind

Where applicable for lifting appliances, wind loads shall be specified for both in service and out of service. Reference is made to specific requirements given in annexes for the equipment groups.

Where no specific wind load are specified, the requirements stated in NS-EN 13001-2, 4.2.3.1 and 4.2.4.2 apply.

5.5.5 Waves, sea induced motions and inclinations

Where applicable, lifting equipment shall be designed for dynamic impacts, load offsets and inclinations of the installation on which the lifting equipment is located, that may occur during in-service and out of service operations.

Reference is made to specific requirements given in annexes for the equipment groups.

5.6 Operational loads

Lifting equipment shall be designed for the in-service and out of service operational loads including the environmental conditions that may occur at the installation.

The operational limitations shall be stated in the instructions for use and in rated capacity information (e.g. load indicators, load tables, marking etc.) for the equipment.

5.7 Strength and stability – structure and mechanisms

The strength and stability design of lifting equipment shall be made in accordance with recognised international standards and design codes.

The following standards should be used:

- NS-EN 13001-1
- NS-EN 13001-2

The following technical specifications should be used:

- CEN/TS 13001-3-1
- CEN/TS 13001-3-2
- prCEN/TS 13001-3-3
- prCEN/TS 13001-3-4

For fatigue design of steel structures reference is made to DNV RP-C203.

5.8 Strength and stability – classification

The service condition should be specified according to NS-EN 13001-1 by the following classification:

- Working cycles Classification of U
- Average displacement Classification of D
- Load spectrum Classification of Q
- Number of accelerations Classification of P

5.9 High risk applications

Lifting equipment for critical lifting operations (e.g. equipment for the lifting of persons), shall be designed using an increased risk coefficient as stated in NS-EN 13001-2.

As a general rule, the risk coefficient for lifting of persons by the use of lifting appliances shall be taken as 1,5.

Other requirements for the high risk applications are stated in the annexes.

5.10 Power systems

5.10.1 Electrical installations

Electrical powered lifting appliances shall be provided with relevant power supplies from the installation in accordance with NORSOK E-001.

Electrical installations in lifting appliances shall be in accordance with NEK IEC 61892 (all parts).

5.10.2 Electrical motors

Electrical motors installed in lifting appliances shall fulfil applicable parts of NEK IEC 60034.

5.10.3 Combustion engines

Combustion engines installed in lifting appliances shall fulfil NS-EN 1679-1 and NS-EN 1834-1.

Arrangement and exhaust of combustion engines shall be in accordance with the applicable area classification where the lifting appliance is installed, see 5.4.

5.11 Electro technical equipment

Electro technical equipment of lifting equipment shall be in accordance with NS-EN 13135-1, EN 60204-1 and EN 60204-32.

Minimum requirements for protection of water and dust penetration to encapsulations shall be:

- For indoor located equipment: Grade IP55 according to NEK IEC 60529
- For outdoor located equipment: Grade IP66 according to NEK IEC 60529

5.12 Non-electro technical equipment

Non-electro technical equipment of lifting equipment shall be in accordance with NS-EN 13135-2.

5.13 Control systems and control station

Control systems and control stations including any remote control system, if relevant, shall be in accordance with NS-EN 13557.

Safety related parts of control systems shall be in accordance with ISO13849-1.

If not otherwise agreed, safety related parts of control systems for complex lifting appliances shall satisfy category 3 or better of ISO 13849-1.

Programmable controllers of complex lifting appliances shall be in accordance with EN 61131.

5.14 Limiting and indicating devices

Limiting and indicating devices on lifting appliances shall be in accordance with NS-EN 12077-2.

Visual danger signals shall be in accordance with NS-EN 842.

5.15 Emergency systems

5.15.1 Emergency stop

Lifting appliances shall be equipped with an emergency stop in accordance with NS_en ISO 13850, Category 0.

5.15.2 Emergency lowering

Power operated lifting appliances on floating installations shall be equipped with an emergency lowering system. This system is not required if an emergency operation system is provided in accordance with 5.15.3.

The emergency lowering system shall enable for a controlled lowering of the load upon a power failure, in order to safely land the load.

The activation switches or handles shall be of hold to run type, and shall be clearly and permanently marked for their purpose. The system shall be simple to operate and shall be available without undue delay. A clear and unambiguous operation procedure for the system shall be included in the instructions for use and shall be permanently displayed at the location for operation of the system.

5.15.3 Emergency operation

Complex lifting appliances and lifting appliances for the lifting of persons shall be equipped with an emergency operation system. The system shall be able to move the load in any direction, in case of a main power failure or a control system failure, utilising a secondary independent power supply system and a secondary independent control system.

The system shall be operational from the control station. The system shall be simple to operate and shall be available without undue delay. Hoisting and lowering speeds with full load shall be in the range of 20 % of the normal full speeds. Only one function and direction may be operated at the time.

The activation switches or handles shall be of hold to run type, and shall be clearly and permanently marked for their purpose.
A separate emergency stop for the emergency operation system shall be provided.

A clear and unambiguous operation procedure for the system shall be included in the instructions for use and shall be permanently displayed at the control station.

5.16 Communication

5.16.1 Telephone

Cranes and lifting appliances which have an enclosed control station shall have a permanently installed telephone communication system.

5.16.2 UHF/VHF radio

Lifting appliances with an enclosed control station shall have permanently installed UHF/VHF radio facilities. It shall be possible for the crane driver to send/receive messages without moving the hands from the main control levers.

5.16.3 Loudspeaker/alarm horn

Lifting appliances which have an enclosed control station shall have permanently installed a loudspeaker or an alarm horn that can be operated by the crane driver without moving the hands from the main control levers.

5.17 Pneumatics

Pneumatic systems and components of lifting equipment shall be in accordance with NS-EN 983.

5.18 Hydraulics

Hydraulic systems and components shall be in accordance with NS-EN 982.

The pressure testing of each part of the system is specified in NS-EN 982, 6.2. In addition, an extended hydrostatic pressure test of the assembled routing system (pipes, hoses and interconnection fittings) shall be carried out. The test pressure shall be 1,5 times the maximum working pressure, limited to 70 bar above the maximum working pressure.

The test pressure holding time shall be minimum 15 min and the oil temperature shall be minimum 7 °C.

5.19 Electromagnetic compatibility (EMC)

5.19.1 EMC immunity

EMC immunity of lifting appliances shall be in accordance with EN 61000-6-2.

5.19.2 EMC emission

EMC emission of lifting appliances shall be in accordance with EN 61000-6-4.

5.20 Exhaust and noise emissions

Exhaust from combustion engines used in lifting appliances shall not exceed the allowable emission limits given by directive 97/68/EF amended by 2002/88/EF and 2004/26/EF.

Lifting appliances shall be designed for minimum noise emission according to EN ISO 11688-1 and EN-ISO 11688-2. The A-weighted emission sound pressure level at the operator position with windows and doors closed and the HVAC turned on if applicable, shall be less than 80 dB(A).

5.21 Utility systems

5.21.1 Sight

Lifting appliances which have an enclosed control station shall have permanent facilities for window cleaning to be operated from inside the control station. In addition access means shall be provided for replacement of windshield wipers and manual cleaning of the windows from the outside.

5.21.2 Ventilation

Indoor climate of lifting appliances shall be in accordance with NORSOK S-002, 5.7.

5.21.3 Utility supplies

Lifting appliances shall have permanent arrangement for utility supplies (e.g. water, fuel, service air and electrical connections), as applicable.

Lifting appliances containing volumes of fuel, oil, grease etc. which represents a hazard for the environment, shall have permanent arrangement for enclosed drainage to tank.

5.22 Fabrication

Lifting appliances shall be fabricated in accordance with DNV Rules for certification of lifting appliances 1994, Section 2 Materials and fabrication. This include e.g.:

- material selection,
- material certificates,
- material quality,
- welding,
- forming,
- inspection and testing.

5.23 Installation and assembly

Lifting appliances shall be installed and assembled in accordance with DNV Rules for certification of lifting appliances 1994, Section 2 Materials and fabrication, and relevant parts of NORSOK Z-007.

5.24 Corrosion protection

5.24.1 General

In selection of materials and combination of materials used in lifting equipment, consideration shall be made to the applicable environmental condition with regards to the risk of corrosion. Methods and extent of maintenance due to corrosion shall be stated in the instructions for use.

5.24.2 Surface preparation and protective coating

The requirements of NORSOK M-501 and/or EN ISO 12944 shall apply for surface preparation and protective coating.

5.24.3 Bolting

Material for external bolting of ⌀10 mm and smaller, shall be made of corrosion resistant steel.

Larger bolting shall normally as a minimum be hot-dip galvanised low alloy steel. If other qualities are used, special corrosion protection measures shall be provided, e.g. protected cups grease filled.

Bolt assemblies for essential for mechanical safety shall be in accordance with ISO 898 and DNV Rules for certification of lifting appliances, Sec. 2, D500 and D700.

5.25 Technical construction file

5.25.1 General

A technical construction file shall be compiled by the manufacturer of lifting equipment.

The technical construction file shall address all requirements of this NORSOK standard, as applicable.

The technical construction file shall be elaborated and presented in such detail that a third party is able to perform a verification of the product according to all the requirements of this NORSOK standard without supplementary information.

The technical construction file shall be made available for the authorities, the Notified Body (when relevant), enterprice of competence, and verification body.

5.25.2 Content

The technical file shall contain as a minimum:

- unique identification details of the lifting equipment;
- design specification including design parameters;
- risk assessments including resulting measures;
- applicable requirements for the lifting appliance;
- standards and codes used;
- technical information, such as drawings, diagrams, calculations, test reports etc.;
- fabrication documentation, such as material certificates, fabrication procedures, welding documentation etc.;
- verification reports;
- formal statements, declarations and certificates;
- instructions for use, including maintenance instructions.

5.25.3 Instruction for use

The instruction for use shall be made available for the end user.

The instruction for use for lifting appliances shall be in accordance with NS-EN 12644-1.

The instruction for use of lifting accessories shall be in accordance with NS-EN 13155, 7.1.

The maintenance instructions shall include a maintenance program in accordance with 4.9.

The maintenance instructions shall include information for training of operators and maintenance personnel.

The information for training of operators and maintenance personnel for complex lifting appliances shall reflect local conditions of the installation.

Annex A
(Normative)
Launching and recovery appliances for life saving equipment

A.1 General (Group E)

A.1.1 General requirements

This annex contains technical requirements concerning lifting, suspension and lowering facilities of launching and recovery appliances for life saving equipment. Reference is made to NORSOK S-001.

This NORSOK standard does not cover operational aspects, outfitting, release hooks, lifting attachments, hang-off lugs, lifting frames, and other technical facilities which are integral parts of the life saving equipment. For such equipment, reference is made to DNV-OS-E406.

NOTE This document will be available 2009-04-01. Reference is made to OLF guideline 124.

The supplier shall ensure that interfaces regarding operational and technical aspects between launching and recovery appliances and the lifesaving equipment are in compliance with this NORSOK standard.

The structural strength of integral parts of lifesaving equipment (e.g. lifting attachments, hang-off lugs, lifting frames, etc.) shall comply with the requirements of this NORSOK standard. Dynamic coefficients and risk coefficients shall be applied in accordance A.1.4, A.1.5 and A.1.6.

Launching and recovery appliances for life saving equipment shall be in accordance with NMD Regulation 4.July 2007 No. 853 concerning evacuation and life-saving appliances on mobile offshore units, §§2, 7, 8, 9 1st paragraph g), 2nd paragraph c) and d), 11 and 12.

A.1.2 Group overview

Table A.1 – Groups of lifting appliances

Launching and recovery appliances for life saving equipment							
	Groups						
	Evacuation equipment					Rescue equipment	
	E.1 Free fall lifeboats	E.2 Conventional lifeboats	E.3 Escape chutes	E.4 Rafts	E.5 Escape lines	E.6 Rescue boats	E.7 Personnel baskets
Primary means of launching	Drop or skid launching	Gravity lowering	Gravity lowering	Gravity lowering	Gravity lowering	Offshore crane or davit/MOB boat crane	Offshore crane
Secondary means of launching	Gravity or power lowering	Power Lowering	Power lowering	Power lowering	NA	Secondary power and control system	Secondary power and control system
Recovery for installation and/or maintenance	Power hoisting	Power hoisting	Power hoisting	Power hoisting	NA	NA	NA
Rescue operations	NA	NA	NA	NA	NA	Offshore crane or davit/MOB boat crane	Offshore crane
NA – not applicable							

A.1.3 Operational limitations

Launching and recovery appliances for life saving equipment shall be designed to be installed, maintained, tested and used in accordance with the site-specific environmental conditions of the area where the appliances are to be used.

Unless otherwise agreed between the manufacturer and buyer, the minimum environmental conditions specified in Table A.2, shall be used.

Launching and recovery equipment on fixed and floating installations shall be designed for a maximum offlead/sidelead angle of 10º from vertical.

Table A.2 – Environmental conditions evacuation equipment

Evacuation equipment (Group E.1, E.2, E.3, E.4 and E.5)	Significant waveheight, H_s	Average wind velocity, U_{10} at 10 m height above sea (10 min)	Load combination according to NS-EN 13001-2, 4.3	Risk coefficient according to NS-EN 13001-2, 4.3.2
Installation, training and recovery operations, life boats only	1,0 m	10 m/s	Load combination A or B[1]	$\gamma_n = 1.5$
Emergency operations (ref. NORSOK N-003, edition 2)	16,0 m	41 m/s	Load combination C[1]	$\gamma_n = 1.5$

Evacuation equipment on floating installations shall be designed for emergency operations at a maximum trim or heel angle of 17° from the horizontal in any direction.

Table A.3 – Environmental conditions rescue equipment

Rescue equipment (Group E.6 and Group E.7)	Significant waveheight, H_s	Average wind velocity, U_{10} at 10 m height above sea (10 min)	Load combination according to NS-EN 13001-2, 4.3, or NS-EN 13852-1, Table B.3)	Risk coefficient according to NS-EN 13001-2, 4.3.2
Installation, training, recovery and transfer operations	3,0 m	15 m/s	Load combination A or B [1] Case I or II[1]	$\gamma_n = 1.5$
Emergency operations	6,0 m	25 m/s	Load combination C [1] Case III[2]	$\gamma_n = 1.5$

Rescue appliances shall be designed for emergency operations at a maximum trim or heel/inclination angle of 5° from the horizontal in any direction.

For launching and recovery appliances for both evacuation and rescue equipment the design temperature T_D shall be -20 ºC, unless otherwise agreed.

A.1.4 Inertial and gravity effects acting vertical on the hoist load

Offshore there will be relative motions between the base of the lifting appliance and the life saving equipment lifted from or lowered to the sea. For calculation of inertial and gravity effects acting on the hoist load, the method described in NS-EN 13001-2, 4.2.2.2, shall be replaced as described below: The factors ϕ_2 *and* ϕ_3 shall be substituted by a dynamic coefficient ϕ_n, see (A.1) or (A.2).

The dynamic coefficient ϕ_n shall be taken as the highest value resulting from calculations using the following two expressions:

[1] NS-EN 13001-2, 4.3
[2] NS-EN 13852-1, Table B.3

$$\phi_n = 1 + v_R \sqrt{\frac{C}{g * R_n}} \quad \text{or} \qquad \text{(A.1)}$$

$$\phi_n = \frac{F_{bra}}{R_n} \qquad \text{(A.2)}$$

where

C is the stiffness (hook load divided by the corresponding hook deflection) in N/m

R_n is the rated capacity in N (static weight of the hoist load, i.e the lifeboat, raft, and personnel basket or rescue boat)

v_R is the relative velocity between the load and hook at the time of pick-up in m/s

g is the gravity acceleration (9,81 m/s^2)

n is the index indicating the load case (significant wave height or braking)

F_{bra} is the maximum rope force during emergency braking in N

v_R shall be calculated as follows: $V_R = V_{H\max} + \sqrt{V_D^2 + V_C^2}$ (A.3)

where

V_{Hmax} is the maximum steady hoisting velocity for the rated capacity to be lifted in m/s

V_D is the vertical velocity of the sea surface or deck on which the life saving equipment is located in m/s

V_C is the vertical velocity of the lifting appliance due to wave motions in m/s

The stiffness (C) shall be calculated taking into account all elements from the hook via the ropes through to the support structure. Passive shock dampers, elastic pennant, if installed, may also be taken into consideration.

Crane stiffness may be calculated according to: $C = \frac{R_n}{\sum \Delta L_n}$ (N/m) (A.4)

where

$\sum \Delta L_n$ is the sum of all the contribution to the total hook deflection in m.

For ropes the elastic deflection may be taken from the following formula:

Elastic deflection of rope [m]: $\Delta L_s = \frac{R_n \cdot L_W}{E_w \cdot A_w \cdot 10^3}$ (m) (A.5)

where

L_w is the rope length in mm

NOTE For recovery operations, the hook position shall be taken as 1 m above the operational sea level or lowest deck level of the vessel. For emergency braking the hook elevation t should be taken to be not lower than 10 m below the upper position.

E_w is the modulus of elasticity as specified by the rope manufacturer for unused ropes in N/mm^2

Area of rope [mm^2]: $\mathrm{A_w} = \frac{\pi \cdot D_w^{\,2}}{4} \cdot C_F$ (A.6)

where

D_w is the nominal rope diameter in mm

C_F is the fill factor of the actual nominal rope construction

The minimum dynamic coefficient ϕ_n shall be no less than 1,5 in any load combinations except out of service stowing.

A.1.5 Hoisting and lowering velocities

During launching and pick-up and of a life saving equipment from sea it is essential that the lowering and hoisting velocities are sufficient to avoid re-entry, i.e. that the next waves hit the equipment causing repeated dynamic impacts and risk of harm.

For evacuation and rescue appliances, the minimum lowering and hoisting velocity $V_{H\min}$ for the specific operational limitation, shall be in accordance with the expression below.

$$V_{H\min} = K_0 * \sqrt{V_D^2 + V_C^2} \qquad \text{(A.7)}$$

where

$$V_D = \frac{K_1 * H_s}{H_s + K_2}$$

$$V_C = K_3 * H_s$$

H_s is the significant wave height for the operational limitation in m
K_0 = 0,40 Empty life saving equipment
K_0 = 0,25 Fully loaded life saving equipment, if applicable
K_1 = 4,00 (m/s)
K_2 = 3,10 (m)
K_3 = 0 for bottom fixed installations (/s)
K_3 = 0,25 for semi submersible installations (/s)
K_3 = 0,50 for monohull installations (FPSO, etc.) (/s)

However, the minimum lowering and hoisting velocity $V_{H\min}$, shall not be taken higher than 1,67 m/s.

A.1.6 Risk coefficient according to NS-EN 13001-2, 4.3.2

For the lifting of personnel all load carrying structure and machinery components including wire ropes and lifting accessories, and the anchorage in the life saving equipment shall be designed with a risk coefficient of $(\gamma_n = 1.5)$.

NOTE This requirement addresses the subject of increased mechanical strength during the lifting of persons, see Machinery Directive, Annex I, Clause 6.1.1.

A.1.7 Rated capacity limiter

Launching and recovery appliances including winches or boom luffing systems shall be equipped with a rated capacity limiter in accordance with NS-EN 12077-2, 5.2, 5.3 and 5.4.

A.1.8 Secondary brake

Winches and boom luffing systems for the lifting of personnel shall be equipped with a secondary brake. The secondary brake shall be able to retard and hold the maximum load without sag if the primary brake fails. The secondary brake shall be based on mechanical principles or hydraulic restriction.

The secondary brake shall preferably act directly on the winch drum, but a load path fully independent from the primary brake will be considered acceptable.

Where hydraulic cylinders are used, two independent cylinders shall be provided for each function such that one cylinder is capable to stop and hold the load, in case of a failure of the other cylinder.

Means shall be provided for individual testing of the primary and secondary brake.

Brakes based on hydraulic restriction (e.g. shut off valves etc.), shall be capable of withstanding shocks due to brake impacts. Fluid loss prevention shall be provided according to NS-EN 982.

Where hydraulic restriction is used as a brake, the following requirements apply:

a) the hydraulic motor/cylinder shall have a closing valve directly at the high-pressure (load) connection (no pipes of hose connections in between);
b) the closing valve shall close as a result of pressure loss at the low-pressure connection (inlet connection during lowering). This function shall be accomplished by direct bore or piping between the closing valve and the low-pressure connection;
c) the hydraulic motor/cylinder shall always be ensured sufficient working fluid, also in the event of power failure, i.e. by gravity feeding).

The automatic launching speed control shall not be considered as a secondary brake, unless it provides a second independent means to stop and hold the fully loaded life saving equipment from full lowering speed without sag.

A.1.9 Ropes, lifting accessories, suspension anchorage, links and blocks

The strength of the rope reeving system, lifting accessories and suspension anchorage, links and blocks shall be compatible with the forces induced by the launching and recovery arrangements in all conditions described in A.1.3 and A.1.13.

Strength requirements:
Limit states and proof of competence of suspension systems shall be calculated according to CEN/TS 13001-3-2.

The static strength shall be proven as follows:

$$F_{Sd,s} \leq F_{Rd,s} \quad \text{(A.8)}$$

where

$F_{Sd,s}$ is the design rope force according to CEN/TS 13001-3-2, 5.2.1

$F_{Rd,s}$ is the limit design force for the lifting accessories in consideration

The limit design force shall be proven as follows:

$$F_{Rd,s} = \frac{F_u}{\gamma_{rb}} \quad \text{(A.9)}$$

where

F_u is the minimum breaking force of the lifting accessories as specified by the manufacturer

γ_{rb} is the lifting accessories resistance factor where:

γ_{rb} = as given in CEN/TS 13001-3-2, 5.4, for the wire, but minimum set to 2,0

γ_{rb} = 3,0 minimum for elastic fibre rope

γ_{rb} = 2,0 minimum for chain, rings, hooks, suspension anchorage and shackles.

Component requirements
The minimum tensile strength for wire rope shall be 1770 N/mm^2 and the maximum tensile strength for wire rope shall be 1960 N/mm^2 according to NS-EN 12385-4.

Wire ropes shall be of rotation resistant construction preferably 35x7 with steel core or 6x36WS IWRC single layer round strand rope according to NS-EN 12385-1, NS-EN 12385-2 and NS-EN 12385-3.

An elastic pennant used for the lifting of rescue boats shall be of high tenacity Nylon fiber of 8 parts construction.

The corrosion protection of lifting accessories shall be hot dip galvanising or corrosion resistant material. Components with electric contact shall be compatible regarding electrostatic potential.

Bending diameters
The minimum bending diameter ratio on rope sheaves and drums shall be as follows:

- For 37x7 construction: D/d 25:1
- For 6x36WS IWRC construction: D/d 18:1

Terminations of wire ropes
Terminations of wire ropes shall be in accordance with the following standards:

- Ferrules and ferrule-securing NS-EN 13411-3
- Metal and resin socketing NS-EN 13411-4
- Assymetric wedge sockets NS-EN 13411-5
- Symmetric wedge sockets NS-EN 13411-7

Accessories
The following requirements apply:

- Chains NS-EN 818-1 and NS-EN 818-2 (Grade 8)
- Connection rings, etc. NS-EN 1677-1
- Hooks NS-EN 1677-3
- Masterrings NS-EN 1677-4
- Shackles US Fed Spec RRC 271

Maintenance and information to the user
The following requirements apply:

- Chains NS-EN 818-6
- Ropes NS-EN 12385-3

A.1.10 Secondary independent power and control system

Powered launching and recovery appliances for the lifting or lowering of persons, which are not designed for drop, skid launching or gravity lowering, shall be equipped with a secondary independent power and secondary independent control system. The secondary power system shall not be affected by failures in the primary power system, and the secondary control system shall not be affected by failures in the primary control system.

For such appliances, the secondary independent power and control system shall be operated from the control station and shall be simple to activate and operate. It shall be enabled by a switch that prevents the ordinary system to be operated. When the ordinary system is activated, the secondary system shall be disabled.

The secondary independent power and control system shall be able to hoist and lower fully loaded life saving equipment, but with reduced speed, see 5.15.3.

A.1.11 Securing arrangement for training and maintenance

For training and maintenance purposes, when the life saving equipment is not intended to be launched, a fail-safe securing arrangement including an interlock system is to be provided to prevent unintended operation or release.

The securing arrangement may be such that launching is not physically possible when the securing arrangement is in place and that launching is only possible when the securing arrangement is removed.

The securing arrangement including attachments to structure shall be durably marked for identification and for prevention of misuse

A.1.12 Procedures

Clear and unambiguous procedures shall be provided for

- primary means of launching,
- secondary means of launching,
- maintenance and installation facilities,

- rescue operations.

Easily understandable operations instruction and permanent sign plates in accordance with NS-EN 12644-2 and IMO Resolution A.760(18), as amended by resolution MSC.82 (70) shall be posted at the launching station.

A.1.13 Testing

A summary of the relevant installation test requirements are given in Table A.4.

Table A.4 – Installation test requirements

Installation testing of launching and recovery appliances for life saving equipment							
	Groups						
	Evacuation equipment					Rescue equipment	
	E.1 Free fall lifeboats	E.2 Conventional lifeboats	E.3 Escape chutes	E.4 Rafts	E.5 Escape lines	E.6 Rescue boats	E.7 Personnel baskets
Primary means of launching	[1), 2)]	[1), 3)]	[1)]	[1), 3)]	Function and load test at 2 times SWL	[1)]	Function and load test at 2 times SWL
Secondary means of launching	[1), 3)]	[1), 3)]	[1)]	[1), 3)]	NA	Test of secondary power and control system	Test of secondary power and control system
Recovery for installation and/or maintenance	[1)]	[1)]	[1)]	[1)]	NA	NA	NA
Rescue operations	NA	NA	NA	NA	NA	[1)]	Function test

[1)] Installation testing of launching and recovery appliances for life saving equipment shall be carried out in accordance with the IMO SOLAS LSA Code, Part 2, Chapter 5, 6 and 7. Testing also to include Part 1, Chapter 8, as applicable.

[2)] Test of launching may be replaced by simulation test, if agreed between the owner and the manufacturer

[3)] During the testing of the brakes, accurate measurements shall be taken of the maximum wire rope forces acting during emergency braking in order to determine the F_{bra} as stated in A.1.4.

A.2 Appliances for free fall lifeboats (Group E.1)

Free fall lifeboats and their primary means of launching shall be designed in accordance with the load effects and load combinations resulting from the requirements of this NORSOK standard.

Free fall lifeboats and their secondary means of launching shall be designed in accordance with the load effects and load combinations resulting from the requirements of this NORSOK standard.

The primary and secondary means of launching shall be able to operate a fully loaded lifeboat.

The means of recovery for installation and/or maintenance of conventional lifeboats shall be designed in accordance with the load effects and load combinations resulting from the requirements of this NORSOK standard. Such system may be designed to operate a lifeboat without crew or with minimum crew.

A.3 Appliances for conventional life boats (Group E.2)

Conventional lifeboats and their primary means of launching shall be designed in accordance with the load effects and load combinations resulting from the requirements of this NORSOK standard.

Conventional lifeboats and their secondary means of launching shall be designed in accordance with the load effects and load combinations resulting from the requirements of this NORSOK standard.

The primary and secondary means of launching shall be able to operate a fully loaded lifeboat.

The means of recovery for installation and/or maintenance of conventional lifeboats shall be designed in accordance with the load effects and load combinations resulting from the requirements of this NORSOK standard. Such system may be designed to operate a lifeboat without crew or with minimum crew.

A.4 Appliances for escape chutes (Group E.3)

Launching appliances for escape chutes and their primary means of launching shall be designed in accordance with the load effects and load combinations resulting from the requirements of this NORSOK standard.

Launching appliances for escape chutes and their secondary means of launching shall be designed in accordance with the load effects and load combinations resulting from the requirements of this NORSOK standard.

The primary and secondary means of launching shall be able to handle a fully equipped system of encapsulated life rafts.

A.5 Appliances for rafts (Group E.4)

Launching appliances for rafts and their primary means of launching shall be designed in accordance with the load effects and load combinations resulting from the requirements of this NORSOK standard.

Launching appliances for rafts and their secondary means of launching shall be designed in accordance with the load effects and load combinations resulting from the requirements of this NORSOK standard.

The primary and secondary means of launching shall be able to operate a fully loaded life raft.

The means of recovery for installation and/or maintenance of life rafts shall be designed in accordance with the load effects and load combinations resulting from the requirements of this standard. Such system may be designed to handle an encapsulated life raft.

A.6 Appliances for escape lines (Group E.5)

Appliances for escape lines from drilling derricks etc. shall be in accordance with the following standards:

- Harnesses NS-EN 361 or prEN1497
- Descender device NS-EN 341, NS-EN 364 and NS-EN 365
- Wire ropes NS-EN 12285-4
- Anchorages NS-EN 795

A.7 Appliances for rescue boats (Group E.6)

A.7.1 General

Launching and recovery of rescue boats may be performed by general purpose offshore cranes or dedicated MOB boat cranes or davits especially designed for such operations.

The requirement for maximum 50 % SWL when lifting personnel as described in NS-EN 13852-1, 5.8.2, is not applicable.

Dedicated MOB boat cranes or davits and their primary means of launching shall be designed in accordance with the load effects and load combinations resulting from the requirements of this NORSOK standard.

Dedicated MOB boat cranes or davits their secondary means of launching shall be designed in accordance with the load effects and load combinations resulting from the requirements of this NORSOK standard.

The primary and secondary means of launching shall be able to operate a fully loaded rescue boat in all positions.

Launching and recovery appliances for rescue boats shall provide a minimum horizontal clearance from the rescue boat to any fixed structure of 8 m for non-ship installations.

Launching and recovery appliances for rescue boats shall be designed taking into account the damping characteristics of a shock absorber, motion compensator or a elastic fibre sling (pennant), whichever used, see A.1.4. Any non-linear damping characteristic may be taken into account by use of an energy consideration. If for example, the use of a elastic fibre sling is based on “as new” characteristics, the instructions shall clearly state the conditions and limitations for use, including requirements for replacement.

A.7.2 Use of offshore cranes

The crane shall be equipped with a detailed instruction for rescue boat operations. The instruction shall be summarised in a procedure for training and emergency operations. The procedure shall be included in the emergency preparedness plan for the installation.

The procedure for rescue boat operations shall include, but not be limited to

- authority and responsibility for involved personnel,
- planning and precautions,
- announcement routines,
- crane information,
- rescue boat information,
- any equipment to be used,
- manning and personnel qualifications,
- personnel safety equipment,
- communication equipment and procedure,
- operational limitations, including dynamic load charts which describe the option for deliberate exceeding the suppliers recommendation during emergency operations.

A dynamic load chart shall be calculated for the actual rescue boat that is to be lifted.

The dynamic load chart shall clearly state the conditions upon which it is based and, if relevant, the type and specification of the elastic fibre rope sling that is to be used.

The dynamic load chart shall differentiate between training operations and emergency operations.

NOTE In an emergency where the offshore crane is to be used for handling the rescue boat, it is to be noted that this operation has to be authorised by the installation management in each case. In an emergency situation the operational risks as well as the technical risks for the rescue team have to be balanced towards the actual conditions and the probability of a successful rescue operation.

A.7.3 Use of dedicated MOB boat cranes or davits

The MOB boat crane or davit shall be equipped with a detailed instruction for rescue boat operations. The instruction shall be summarised in a procedures for training and emergency operations. The procedures shall be included in the emergency preparedness plan for the installation.

The procedure for rescue boat operations shall include but not be limited to

- authority and responsibility for involved personnel,
- planning and precautions,
- announcement routines,
- crane/davit information,
- setting of personnel lift mode,
- rescue boat information,
- any equipment to be used,
- manning and personnel qualifications,
- personnel safety equipment,
- communication equipment and procedure,

- operational limitations, including dynamic load charts which describe the option for deliberate exceeding the suppliers recommendation during emergency operations.

A dynamic load chart shall be calculated for the actual rescue boat that is to be lifted. The calculation shall take into account the applicable damping effect of an elastic sling, motion compensator or shock absorber.

The dynamic load chart shall clearly differentiate between training operations and emergency operations.

NOTE In an emergency where the crane or davit is to be used for handling the rescue boat, this operation has to be authorised by the installation management in each case. In such situations the operational risks as well as the technical risks for the rescue team, have to be balanced towards the actual conditions and the probability of a successful rescue operation.

A.8 Appliances for personnel transfer (Group E.7)

Launching and recovery appliances for personnel transfer and their primary means of launching shall be designed in accordance with the load effects and load combinations resulting from the requirements of this NORSOK standard.

Launching and recovery appliances for personnel transfer and their secondary means of launching shall be designed in accordance with the load effects and load combinations resulting from the requirements of this NORSOK standard.

The primary and secondary means of launching shall be able to operate a fully loaded personnel transfer basket in all positions.

Personnel transfer baskets shall be in accordance with applicable parts of NS-EN 14502-1.
Personnel transfer baskets shall facilitate personnel protection against horizontal and vertical impacts.

Passengers shall be secured by quick release harnesses to prevent the risk of falling, and facilitate easy access and escape

Personnel transfer baskets shall float upright and stable even when fully loaded

The colour of personnel transfer baskets shall be fluorescent, bright yellow.

The personnel transfer basket shall be visible from the lifting appliances control station in all positions.

An operating procedure shall be prepared for personnel transfer between vessel and installation. The procedure shall as a minimum include, the maximum rated capacity, descriptions of normal travel paths, personnel entering procedure in the personnel transfer basket, communication routines and how the personnel shall be evacuated in the event of a crane shut down.

The limitations for use shall be clearly stated in the operating procedure and in the user manual.

Annex B
(Normative)
Material handling principles

B.1 Concept principles

Areas shall be designed in such a way that all equipment in the area can be lifted in a safe manner.

Areas shall be dimensioned for the weight and size of the equipment that can be transported in and out from the area.

Concepts for lifting and transportation that are weather independent shall always be preferred.

When designing areas for maintenance, the safest lifting equipment and lifting concept shall always be preferred.

Care shall be taken towards dynamic motions on floating installations, vibrations from other equipment as well as the environment the lifting- and transport- equipment is used in.

The criticality and value of the load (special process equipment), shall be reflected in the quality and safety functions of the lifting and transport equipment that are specified.

B.2 General requirements

Transportation of equipment at the plant shall primarily be done by machine driven vehicles (EX forklift truck at offshore plants, lorries at onshore plants).

If the plant consists of more than one elevation, and is permanently manned, it should have a person and goods lift elevator with a minimum lifting capacity of 1 500 kg, for transportation of equipment between the different elevations of the plant area. The elevator shall be located in connection to the main transportation routes.

The main transportation routes shall be designed for forklift truck with a minimum capacity of 1 500 kg.

All main lay down areas shall be visible from the crane driver cabin for all cranes that handles loads at the lay down area.

Lifting of equipment above 25 kg shall be performed by means of mechanical lifting equipment.

There shall be enough space for the use of lifting and transportation gear, where lifting or transport of more than 25 kg is required.

Permanent arrangements (e.g. monorails, pad eyes) shall be installed for material handling of equipment/objects > 200 kg and which require regular maintenance, if it is not reachable for a fork lift truck or other movable lifting appliances.

Minimum requirements for material handling of equipment is given in Table B.1.

Table B.1 – Requirements for material handling

	Maintenance interval		
	Yearly	2 – 4 years	> 4 years
Weight			
25 – 200 kg	A	B	C
200 kg – 3 tonn	A	B	B
> 3 tonn	A	A	A

Key

A Permanent installed lifting arrangements, e.g. monorails/padeyes.

B A documented description (material handling report) for material handling of equipment with use of temporary lifting equipment. The plan shall include documentation of structural capacity of all lifting points of more than 200 kg.

C No requirements for documentation of material handling.

B.3 Working area

B.3.1 General

The working area shall be designed to withstand the loads that can be placed in the area. Working areas and lay down areas shall normally be located in a safe zone and provided with heavy-duty barriers to prevent damage to adjacent equipment.

Lifting appliances and their working areas shall be located so as to minimise the risk of load handling, impacts and dropped object damage to systems and structures.

Information regarding the extension and weight capacities of working and lay-down areas shall be available at the operator position for cranes.

B.3.2 Bumpers

Suitable bumpers for impact protection of horizontal and vertical load collisions shall be provided where necessary in the working and storage areas where lifting equipment is used. The impact protection shall be designed for the energy induced by the lifting appliances and their loads and shall facilitate means for personnel escape in danger zones.

Working and storage areas for loads on floating installations shall be equipped with reinforced impact protection designed for the installation motions in addition to those induced by the lifting appliances.

On floating installations, necessary attachment points for securing of deck loading shall be provided.

B.3.3 Dropped objects

The structure of working areas and lay-down areas shall be checked for accidental damage limit states due to impacts from dropped objects in accordance with NORSOK N-004.

Within the defined lifting zones, equipment, or piping containing hydrocarbons, flammable or toxic gas/liquids shall be protected form dropped objects. Lifting above high voltage equipment and cables shall be assessed, and protection shall be considered installed.

All deck areas within the working area of lifting appliances shall be classified according to the consequence of dropped objects, and documented in the lifting restriction charts for the installation:

Red areas	Areas where the consequence of dropped object are so serious for platform or personnel that lifting is forbidden. Typical areas with unprotected process equipment and or areas normally manned areas not without protection against dropped objects.
Yellow areas	Areas where the consequence of dropped objects are serious for platform and personnel and lifting shall be performed strictly according to specified restrictions. Typical areas with process equipment and normally manned areas protected against dropped objects.
Green areas	Areas where the consequence of dropped objects is only related to material damage and cost.

Within the defined lifting zones, equipment, or piping containing hydrocarbons, flammable or toxic gas/liquids shall be protected form dropped objects. Lifting above high voltage equipment and cables shall be assessed, and protection shall be considered installed.

Predefined lifting zones should be defined as green areas. Areas where lifting will be performed shall as a minimum be defined as yellow. All yellow areas shall have predefined lifting restrictions according to the expected loads handled over the area.

The working areas and dropped object protection devices shall be checked for impacts from dropped objects according to the accidental limit state defined in NORSOK N-004. The impact loads for design of the deck

area and protection devices shall be selected according to relevant weight, size and drop height expected for the specific location.

B.4 Material handling in a project

In parallel with the engineering of the process equipment, the engineering of lifting equipment for maintenance of the process equipment shall take place.

Permanent lifting equipment shall be installed and certified before the process equipment is installed, wherever possible. The permanent lifting equipment shall then be used to install the process equipment, and so, the suitability and the safety of the lifting equipment shall be verified.

B.5 Material handling philosophy

A general philosophy for material handling in the project/module/plant/platform shall be developed and approved by the company, early in the design phase. It shall be revised as the design changes, and finally issued in as-built version.

Material handling philosophy shall as a minimum describe the following:

- description of main material handling equipment, e.g. main cranes, goods lift, mobile lifting beams, forklift truck, etc. including sizes and capacities;
- description of main material handling routes: to and from warehouse, to and from workshops, to and from pipe deck, to and from drill floor, to and from kitchen, to and from supply vessel;
- design criteria for all transport routes/roads and parking spaces for mobile cranes, e.g. minimum design load, free width and free height;
- lifting restriction charts for the plant, including philosophy for lifting above process areas;
- description of maximum allowable lifting heights, coverage and restrictions for the main cranes;
- description of lay down and storage areas including function, size and location, also covering lay down/storage areas for and handling of temporary, company provided and hired equipment;
- descriptions, including sketches, of lifting areas, which are not visible from the crane cabins;
- description of weather constraints (waves and wind);
- definition of largest/heaviest item to be handled per area including description of transportation route and type of handling equipment;
- description of deck load/ground capacities on all areas in the plant. Both loading areas, transport routes and areas between equipment. The deck load/ground capacities shall include allowable evenly distributes load, point loads and forklift truck capacities;
- evaluation of concurrent crane operations on pipe deck;
- requirements for dropped object protection;
- description of goods handling to/from helideck;
- load categories for monorails, hoists and pad eyes;
- description of requirements for use of rigging equipment and loose lifting equipment at the plant.

B.6 Crane study

A crane study document based on the principles of the material handling philosophy shall be established and maintained through the engineering phase. The document shall as a minimum contain the following:

- definition of all relevant documents for transmittal to the Authorities;
- basis for location of main cranes;
- visibility to lay down areas, and exceptions, if any;
- description of handling with main cranes to and from the supply vessels and internally on the topsides;
- listing of the most common lifting operations including frequency of these;
- height of crane cabins above the highest elevated crane-handling area;
- description of maximum allowable lifting heights, coverage and restrictions;
- requirements for dropped object protection;
- description of crane outfitting related to safety, alarms, communication, lightning, etc.;
- description of situations where the crane booms has to be brought to the rest position and the frequency of these;
- description of weather constraints (waves and wind);
- evaluation of concurrent crane operations on pipe deck;
- description of crane operations where personnel are transported, e.g. MOB boat, personnel basket, etc.;
- plot plan showing

- crane locations,
- crane operation range with and without jib, minimum radius and radius for heaviest lift,
- maximum allowable lifting heights,
- maximum weight capacities for lay down areas and transportation ways,
- lay down areas, including allowable loads (areas not visible from the crane cabin shall be highlighted),
- hose loading stations,
- tote tank area,
- access and transportation ways, including allowable loads,
- permanent and temporary restriction areas,
- dropped object protection,
- crane maintenance platform(s),
- storage for crane hooks,
- crane boom rests,
- MOB-boat.

B.7 Material handling report/plan

The material handling report shall identify all equipment above 25 kg that requires regular maintenance or replacement during the design life of the installation.

This report shall describe the method, equipment and the transport route to be used when lifting out the unit, and transport it to its destiny, and replace it.

The material handling report shall as a minimum contain the following:

- description of all material handling equipment, e.g. main cranes, goods lift, fork lift truck, trolleys, air film transporters, elephant cranes, A-frames, mobile cranes etc. including tag numbers (when required), sizes and capacities and requirements for certification, marking and re-certification period;
- description of the main material handling philosophy for internal transport on the installation;
- description of function, size and location of lay down and storage areas including areas for and handling of temporary, company provided and hired equipment;
- description of all items above 25 kg to be handled, including tag numbers, location, weight, size, expected maintenance/replacement intervals, type of lifting equipment/ arrangement, lifting/ handling procedure, transport route etc. In cases where the equipment vendor has established thorough handling procedures in the maintenance manual, this can be referred to in the report. The material handling description for such equipment can be reduced to just defining the required lifting/transportation equipment and transport route;
- requirements for transportation ways/roads including width and height in the different areas;
- description of goods handling to/from helicopter deck;
- description of loading hose handling including hose replacement;
- description of areas where special protection of equipment is required, e.g. dropped object protection, truck barriers, swinging load protection etc.;
- material handling drawings based on equipment arrangement drawings or 3D plots including piping and valves containing the following:
  - all equipment to be handled including lifting lugs, monorails, access ways etc.;
  - table containing all tags to be handled with corresponding tags for the lifting equipment to be used;
  - load capacities for lay down areas and transportation routes/roads.