NORSOK STANDARD S-002

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Working environment

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, insofar 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 Subject to development and publication of international standards, the relevant NORSOK standard will be withdrawn.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) and Federation of Norwegian Manufacturing Industries (TBL).

NORSOK standards are administered and published by Standards Norway.

Annexes A, B, C, D, E and H are normative. Annexes F and G are for information only.

Introduction

Revision 4 includes the following changes:

- Implementation of unique ID reference tag number for both existing and new requirements information. All new requirements/supplementary information is identified with revision mark.
- Clause 4 is changed considerably in order to highlight the importance of early-qualified execution of studies/analyses for validation and verification in line with industry and authorities expectations. In addition, there are, through the clauses/annexes, several changes both in textual descriptions as well as to tabular information.
- The following annexes in the previous revision have been voided:
  Annex D "Typical hazardous substances"
  Annex G "List of applicable acts, regulations, standards and guidelines for the Norwegian continental shelf"
- Updating according to regular revision cycle and in view of International Standards (ISO) and European Standards (EN).
- Capture the good practices and project user experience reported by the oil and gas industry since issue of revision 3.

1 Scope

This NORSOK standard applies to the design of new installations and modification or upgrading of existing installations for offshore drilling, production, and utilisation and pipeline transportation of petroleum, including accommodation units for such activities.

This NORSOK standard stipulates design requirements related to the working environment of petroleum installations as well as requirements regarding systematic management of working environment issues in project development and the design process.

The purpose of this NORSOK standard is to ensure that the design of the installation promotes the quality of the working environment during the operational phase.

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 recognised standards may be used provided it can be shown that they meet or exceed the requirements and guidelines of the standards referenced below.

2.1 Normative references

API RP 521	Guide for Pressure-relieving and Depressing Systems
Dangerous Chemicals Regulations	Regulation related to classification, labelling of waste of hazardous chemicals, The Norwegian Pollution Control Authority (SFT 2002) (Merkeforskriften)
DLI 361	Directorate of Labour Inspection, order no. 361
DLI 444	Directorate of Labour Inspection, order no. 444
DLI 528	Directorate of Labour Inspection, order no. 528
EN 292-1,	Safety of machinery - Basic concepts, general principles for design – Part 1: Basic terminology, methodology.
EN 292-2,	Safety of machinery - Basic concepts, general principles for design – Part 2: Technical principles and specifications.
EN 349,	Safety of machinery - Minimum gaps to avoid crushing of parts of the human body.
EN 563	Safety of machinery - Temperature of touchable surfaces - Ergonomics data to establish temperature limit values for hot surfaces.
EN 614-1,	Safety of machinery - Ergonomic design principles – Part 1: Terminology and general principles.
EN 614-2,	Safety of machinery - Ergonomic design principles – Part 2: Interactions between the design of machinery and work tasks.
EN 626	Safety of machinery - Reduction of risks to health from hazardous substances emitted by machinery.
EN 894-1,	Safety of machinery - Ergonomic requirements for the design of displays and control actuators - Part 1: General principles for human interactions with displays and control actuators.
EN 894-2,	Safety of machinery - Ergonomic requirements for the design of displays and control actuators - Part 2: Displays.
EN 894-3,	Safety of machinery - Ergonomic requirements for the design of displays and control actuators - Part 3: Control actuators.
EN 1005-2,	Safety of machinery - Human physical performance – Part 2: Manual handling of machinery and component parts of machinery.
EN 1005-3,	Safety of machinery - Human physical performance – Part 3: Recommended force limits for machinery operation.
EN 12464-1,	Light and lighting - Lighting of workplaces - Part 1: Indoor workplaces.
prEN 12464-2,	Light and lighting – Lighting of workplaces – Part 2: Outdoor workplaces.
ISO 14122-1,	Safety of machinery - Permanent means of access to machinery – Part 1: Choice of fixed means of access between two levels.
ISO 14122-2,	Safety of machinery - Permanent means of access to machinery – Part 2: Working platforms and walkways.

ISO 14122-3,	Safety of machinery - Permanent means of access to machinery – Part 3: Stairs, stepladders and guard rails.
ISO 14122-4,	Safety of machinery - Permanent means of access to machinery – Part 4: Fixed ladders.
ISO 15534-1,	Ergonomic design for the safety of machinery – Part 1: Principles for determining the dimensions required for openings for whole-body access into machinery.
ISO 11064-1,	Ergonomic design of control centers - Part 1: Principles for the design of control centres.
ISO 11064-2,	Ergonomic design of control centers - Part 2: Principles for the arrangement of control suites.
ISO 11064-3,	Ergonomic design of control centers - Part 3: Control room layout.
EN ISO 11690-1,	Acoustics - Recommended practice for the design of low-noise workplaces containing machinery - Part 1: Noise control strategies.
EN ISO 11690-2,	Acoustics - Recommended practice for the design of low-noise workplaces containing machinery - Part 2: Noise control measures.
EN ISO 11690-3,	Acoustics - Recommended practice for the design of low-noise workplaces containing machinery - Part 3: Sound propagation and noise prediction in workrooms.
ISO 717-1,	Acoustics - Rating of sound insulation in buildings and of building elements – Part 1: Airborne sound insulation.
ISO 2631-1,	Mechanical vibration and shock - Evaluation of human exposure to whole body vibration - Part 1: General requirements.
ISO 5349-1,	Mechanical vibration - Measurement of human exposure to hand-transmitted vibration – Part 1: General requirements.
ISO 5349-2,	Mechanical vibration - Measurement of human exposure to hand-transmitted vibration – Part 2: Practical guidance for measurement at the workplace.
ISO 17776	Petroleum and natural gas industries - Offshore production installations - Guidelines on tools and techniques for hazard identification and risk assessments.
NORSOK C-001,	Living quarters area.
NORSOK C-002,	Architectural components and equipment.
NORSOK E-001,	Electrical systems.
NORSOK S-001,	Technical safety.
NORSOK S-005,	Machinery - working environment analyses and documentation.
NORSOK S-012,	Health, Safety and Environment (HSE) in construction-related activities.
NS 3150,	Dører – Lydisolasjon – Klassifisering/Sound insulation doors – Classification.
YA 711,	Petroleum Safety Authority Publication: Principles for alarm system design (YA 710 is the Norwegian edition).

2.2 Informative references

Concawe Report 87/59,	The prediction of noise radiated from pipe systems - An engineering procedure for plant design.
EN ISO 11688-1,	Acoustics - Recommended practice for design of low-noise machinery and equipment - Part 1: Planning.
EN ISO 11688-2,	Acoustics - Recommended practice for design of low-noise machinery and equipment - Part 2: Introduction to the physics of low-noise design.
ISO 6385,	Ergonomic principles in the design of work systems.
ISO/TR 11079,	Evaluation of cold environments - Determination of required clothing insulation (IREC).
ISO 14163	Acoustics. Guidelines for noise control by silencers.
ISO 15667	Acoustics. Guidelines for noise control by enclosures and cabins.
Kjellén, U.	Prevention of Accidents Through Experience Feedback. Taylor & Francis, London and New York, 2000.
Nordtest,	Proposal 1566-01-01: NT ACOU 114 Measurement of occupational noise exposure of workers - Survey method. Proposal 1566-01-02: NT ACOU 115 Measurement of occupational noise exposure of workers - Engineering method.
Kirwan, B., Ainsworth, L.K.	A guide to task analysis. Taylor and Francis, 1992.

Salvendy, G. (Ed.) Handbook of Human Factors. Whiley, 1986.
Stig Ole Johnsen et al, CRIOP - A scenario method for Crisis Intervention and Operability Analysis (Draft) SINTEF Report STF38 - ISBN 82-14-02723-3, Trondheim 27.01.2004.

3 Terms, definitions and abbreviations

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

3.1 Terms and definitions

3.1.1
can
verbal form used for statements of possibility and capability, whether material, physical or causal

3.1.2
enclosed work area
area that is fully protected against exposure to the open air and ambient conditions

3.1.3
hazard
source of possible damage that may be caused by human error

3.1.4
manning
Three levels of manning of work areas and workplaces are defined as follows:

Permanently manned: work area or workplace manned at least 8 h a day for at least 50 % of the installation's operation time.

Intermittently manned: work area or workplace where inspection, maintenance or other work is planned to last at least 2 h a day for at least 50 % of the installation's operation time.

Normally unmanned: work area or workplace that is not permanently or intermittently manned.

3.1.5
may
verbal form used to indicate a course of action permissible within the limits of the standard

3.1.6
open work area
area with no substantial obstacles to the open air and completely exposed to ambient conditions

3.1.7
semi-open work area
area that is weather-protected (e.g. with weather louvers) and partially exposed to the open air

3.1.8
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

3.1.9
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

3.1.10
validation
confirmation by examination and provision of objective evidence that the particular requirements for a specified intended use are fulfilled

NOTE In design and development, validation concerns the process of examining a product to determine conformity with user needs.

3.1.11
verification
confirmation by examination and provision of objective evidence that specified requirements have been fulfilled

NOTE In design and development, verification concerns the process of examining the result of a given activity to determine conformity with the stated requirements for that activity. Tangible evidence is regarded as being information that can be proved to be true, based on facts obtained through observation, measurement, test or any other means.

3.1.12
work area
area of the installation where personnel stay or move in connection with work

3.1.13
workplace
space within a work area, allocated to one or more persons to complete work tasks related to production, inspection or maintenance

3.1.14
work system
combination of people and work equipment, acting together in the work process, at the workplace, in the work environment, and under the conditions imposed by the work task

NOTE For information, see ISO 6583.

3.1.15
working environment
totality of all physical, chemical, biological and psychological factors at work that may affect the employees' health and well-being through acute trauma or lasting exposure

NOTE The influences from lasting exposure may be positive and negative.

3.1.16
working environment analysis
systematic work process including the following:

- definition, limitation and breakdown of the installation, work systems and work areas with respect to one or more parameters to reduce risk of human error and improve task performance, e.g. area, activities during operation, type of equipment, chemical substance;
- hazard identification;
- estimation of potential consequences to the employees' health and, if feasible, of probability of occurrence;
- evaluation of needs for remedial actions;
- development of recommendations for remedial actions and/or follow-up activities;
- identification of nonconformities and problems in meeting specified requirements.

3.2 Abbreviations

ALARP	as low as reasonably practicable
CCR	central control room
Concawe	The oil companies' European association for environment, health and safety in refining and distribution
CRIOP	crisis intervention and operability analysis
DRA	demand-resource analysis
FEED	front-end engineering design
HRA	health risk assessment
HSE	health, safety and environment
HVAC	heating, ventilation and air conditioning
JHA	job hazard analysis (equivalent to job safety analysis)
LQ	living quarter
MSDS	material safety data sheet

OEL	occupational exposure limits
OLF	The Norwegian Oil Industry Association
PA	public address
TCO	Tjenstemennens Centralorganisation
VDU	visual display unit
WCI	wind chill index
WE	working environment
WEAC	working environment area chart
WEIA	working environment impact assessment

4 Systematic management of working environment in design and fabrication

4.1 General

4.1.0-1 Systematic management of WE in project development and the design process comprises activities to define WE objectives, management tools and the WE design basis, as well as activities to control and verify that the design requirements in Clause 5 and normative annexes are implemented. The role of analyses and verification activities in relation to the design process is outlined in Figure G.1.

4.1.0-2 Clause 4 stipulates the WE management activities that shall be performed and documented for new installations.

4.1.0-3 For modification projects (e.g. upgrading of existing installation/module, tie-in of satellite field), WE management activities adjusted to project scope and complexity shall be performed, including new analyses or updating of existing analyses for the WE factors that are considered to be affected by the modification.

4.1.0-4 In concept optimisation and design development, priority shall always be given to the use of preventive measures/exposure barriers and inherently safer design principles to reduce occupational health and safety risks. ISO 17776, 5.4.1, and Annex A are referred to.

4.2 Management system

4.2.1 Working environment programme

4.2.1.0-1 A WE programme shall be established for every project phase. The WE programme may be a separate document or integrated into the project's HSE programme, and shall be linked to the project execution plan.

4.2.1.0-2 The WE programme shall define the project's WE objectives and risk acceptance criteria for occupational safety, human error and health risks, state references to applicable WE requirements and procedures, and describe means of ensuring the statutory worker participation in the design process. The WE programme shall include an activity plan stipulating the responsibilities, schedule and deliverables for the various activities to manage WE in the design process. In particular, the WE analyses shall be planned with due consideration of the needs for timely input to design and procurement, and needs for verification and documentation. The WE activity plan shall be maintained to provide status regarding execution and documentation of the various WE management activities.

4.2.2 Procedures and work instructions

4.2.2.0-1 Procedures and work instructions for execution of the various WE management activities shall be developed and maintained in order to ensure implementation of Clause 4 requirements. In general, the documentation shall describe the following:

- scope and objectives,
- definitions and references,
- responsibilities for initiation and execution, and follow-up of the results,
- organisation of the analysis, including requirements to personnel qualification and participation of operations/worker representatives,
- it shall be shown how the different analyses interact and how they are scheduled in relation to

each other,
- scheduling in relation to project progress,
- types of input required for the analysis,
- types of work to be done, including methods for estimation, calculation and/or measurement, with reference to relevant standards and codes,
- documentation and follow-up of the results.

4.2.2.0-2 Deviations from WE requirements shall be subject to the project's nonconformity procedures. The nonconformity request shall describe the reason for, and consequences of, accepting the deviation, including the compensating measures that will be implemented. Operation's project representative and worker representatives (e.g. safety delegates) shall participate in handling of the nonconformity requests. I

4.2.3 System for follow-up

4.2.3.0-1 A follow-up system shall be established that enables proper documentation, handling, follow-up and closeout of agreed actions and recommendations from the various WE studies and analyses in the project. The WE follow-up system shall be integrated in the overall HSE management system in the project. The system shall be applied from concept selection throughout all project phases, and shall be maintained to enable an updated status at any time. After commissioning, the system shall be able to convey to operations important assumptions, decisions and other WE-related issues that shall be passed on to later life cycle phases for follow-up or information. I

4.2.3.0-2 To document status regarding implementation of WE requirements, WEACs according to Annex E or equivalent shall be issued at predefined project milestones. In principle, a working environment area status shall be prepared for each room and area on the installation. However, to maintain a manageable number of area charts, several identical areas (e.g. offices, cabins, escape routes) can be covered by one typical WEAC. I

4.2.3.0-3 The WEACs shall include the results of predictions and verification measurements (e.g. as-built data for illuminance and noise), and shall describe identified problem areas and nonconformities as well as the status regarding decisions on remedial actions. I

4.2.3.0-4 A WE status report shall be prepared based on WEAC and final inspections. The report shall document status according to design requirements and include reference to analyses, summary of other relevant control activities and summarise any deviations. I

4.3 Working environment (WE) design basis

I

4.3.1 General

4.3.1.0-1 During early phases of project development, functional and specific WE requirements in regulations, company specifications and applicable standards and codes shall be identified as input-appropriate philosophies for engineering. Reference is made to the design requirements in Clause 4 and Annex C. I

4.3.1.0-2 WE analyses (see 4.4) shall be performed to identify basic assumptions and actions necessary for implementation of the WE requirements, including development of functional/goal-oriented requirements into specific/prescriptive design requirements. I

4.3.1.0-3 The processes of implementing functional and specific WE requirements into design is outlined in Figure G. 1. I

I

4.3.2 Working environment area limits

4.3.2.0-1 Detailed specifications of working environment area limits for each room/work area that is readily accessible shall be established as input to engineering. In the specifications of the installation's working environment area limits, the following applies: I

4.3.2.0-2 Annex A stipulates applicable area limits for illuminance, temperature, vibration, total noise levels and HVAC noise levels for typical areas of an installation. I

4.3.2.0-3 The area limits shall be documented in the WEACs, see 4.2.3 and Annex E. I

4.3.2.0-4 Adequate calculations shall be performed in order to ensure implementation of the area requirements in design and data sheets for vendor packages. These calculations shall be documented in the WEACs where relevant. I

4.3.2.0-5 Implementation of the area limits shall be verified by appropriate measurement methods and documented in the WEACs. I

4.3.2.0-6 When establishing noise area limits above 85 dB (A), the individual worker's exposure time in noisy areas shall be considered in relation to noise exposure limits, see 5.5.2. The highest permissible noise limit [110 dB (A)] should only be allowed in connection with brief inspections or work tasks that are to be carried out in an area where there is no passage through to other areas. Provisions should be made for noise-deflection of noisy equipment when maintenance or other work is carried out in the area. I

4.3.2.0-7 Area limits for the number of air changes per hour shall be established. For Norway, the limits shall be based on the calculation method recommended in DLI 444. I

I

4.3.3 Experience transfer

4.3.3.0-1 To ensure transfer of WE-related experience from relevant installations in operation, the company shall issue an experience report as input to engineering. Sources of experience should include I

- earlier modifications to improve WE,
- good technical solutions,
- solutions/equipment to be avoided,
- statistics on occupational accidents and injuries, near-accidents and work-related diseases,
- results of WE surveys and risk assessments.

4.3.3.0-2 The experience report shall be used to identify installation areas and vendor packages that need particular attention during design development, and for development of adequate requirements based on experience transfer through end-user involvement. I

I

4.3.4 Organisation and manning

4.3.4.0-1 The company shall issue an organisation and manning study. The study shall be elaborated with sufficient details regarding frequency/ duration of task to be used as basic information/ support in establishing WE area requirements and for WE analyses. I

4.3.4.0-2 The study shall describe the various personnel categories in the platform organisation, their skills, experience, responsibilities and operations/maintenance tasks, and the distribution of working hours by area. The study shall be elaborated with sufficient details regarding frequency/duration of tasks to be able to I

- determine the means of access,
- perform ergonomic task analyses,
- perform risk assessment of chemical exposures,
- perform personnel noise exposure calculations,
- identify outdoor work exposed to cold stress,
- perform psychosocial analyses, determine mental workload, control at work and social interaction.

I

4.3.5 Psychosocial preconditions

4.3.5.0-1 As input to detailed engineering, the company shall perform a systematic analysis of the preconditions for a safe, efficient and health-promoting interaction between the worker and the environment. The purpose is to analyse organisation, manning, and workplace design in order to identify potential problem areas related to psychosocial WE in particular. I

4.3.5.0-2 For various positions on the installation, the analysis should, as a minimum, include an evaluation of the psychological job demands and the preconditions for social interaction/support and control at work. The analysis should also consider the preconditions for restitution during the time off at the installation. I

4.3.5.0-3 Reference is made to the psychosocial analysis method in G.2. I

4.3.6 Arrangements/means of access

4.3.6.0-1 The requirements to access for operation and maintenance of equipment shall be defined and documented as input to engineering, see the requirements for means of access in 5.1.2.

4.3.6.0-2 In selecting type of access, consideration shall be given to the access frequency (daily, weekly, yearly, or less frequently) and the needs for access in the event of an emergency. The following method is recommended, and the results shall be documented (e.g. in a table):

1. Identify all equipment needing access by area and system and tag number.
2. Determine access frequency and whether there is need for emergency access.
3. Decide about means of access.

4.3.6.0-3 For equipment without permanent access, the methods for providing temporary access shall be described in each case.

4.4 Working environment analyses

4.4.1 General

4.4.1.0-1 The WE analyses presented here shall be performed to identify and assess occupational safety and health risks, and potential problem areas associated with the various WE factors, as input to design development, see 4.3. This includes how WE factors influence task performance in work systems where human error may have severe consequences. Regarding execution responsibilities and schedule, reference is made to the management system, see 4.2. The results of one analysis may cause an update of other analyses performed earlier as new information has been brought forward. Typical timing of the various analyses relative to project development is outlined in Figure G. 2.

4.4.1.0-2 In cases where the design represents a standard and previously accepted solution, and provided earlier analyses can be used as a basis, experience from use shall be collected and the need for reassessing the design shall be evaluated.

4.4.1.0-3 Where practicable, and taking into account project scope and complexity, execution and/or documentation of the various analyses should be combined.

4.4.1.0-4 For WE analysis and documentation of machinery, see NORSOK S-005.

4.4.1.0-5 Personnel and/or teams conducting the analyses shall have adequate WE expertise for the subjects considered (e.g. machinery safety, ergonomics, acoustics, occupational hygiene, human factors) and general knowledge of the project development to ensure that relevant input data is identified and used.

4.4.1.0-6 Operations' project representatives and worker representatives (e.g. safety delegates) from the company's organisation shall participate in the analyses.

4.4.1.0-7 Examples of methods for WE analysis are presented in Annex G.

4.4.2 Concept WE impact assessment (WEIA)

4.4.2.0-1 A concept WEIA analysis shall be performed during the concept selection phase to identify installation areas and vendor packages that need particular attention during design development and to provide input to concept selection and validation of the selected concept. The analysis shall be updated during concept definition and optimisation/FEED, to summarise WE aspects of the selected concept as input to detailed engineering.

4.4.2.0-2 The analysis shall cover but not be limited to the following potential problem areas:

4.4.2.0-3 - accidents and musculoskeletal injuries when handling heavy materials and drilling equipment. The analysis shall include important issues regarding arrangements of permanent access and transportation routes, lifts, platform crane operations, laydown areas, and material handling of equipment > 1000 kg. For drilling modules, the pipehandling arrangements and equipment shall be included.

4.4.2.0-4 - exposure to cold stress/wind chill in open and semi-open areas. When considered necessary, the analysis shall include preliminary calculations of WCI, see 4.4.9, I
4.4.2.0-5 - storage and handling of hazardous substances, I
4.4.2.0-6 - storage of bulky equipment and materials, e.g. containers, scaffolding, I
4.4.2.0-7 - noise and vibration-emitting equipment and areas with noisy activities adjacent to quiet areas, see H.5.1, I
4.4.2.0-8 - solitary work in permanently manned areas. I

4.4.2.0-9 WEIA shall include 4.4.3 to 4.4.10 and the resulting extent of relevant analyses shall be based on qualified identification. I

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4.4.3 Job hazard/risk of occupational injuries

4.4.3.0-1 During engineering, the risk of occupational injuries shall be analysed and compared to the risk acceptance criteria in the WE programme. The risk analysis method shall be adapted to the applicable acceptance criteria. Reference is made to the JHA and comparison risk analysis methods in G.1. I

4.4.3.0-2 A coarse JHA shall be carried out for each work area on the installation. The analysis shall include the following: I

4.4.3.0-3 - tasks associated with operation/drilling, repair/maintenance, material handling, waste handling/housekeeping activities, and personnel traffic/walking shall be analysed, I
4.4.3.0-4 - risks of severe injury or fatality due to moving parts of machinery, trapping/entanglement, falling to a lower level, sliding/stumbling/collision, ejected materials, fire/explosion, and/or toxic/corrosive chemicals shall be identified and evaluated, I
4.4.3.0-5 - causes and potential consequences shall be identified, and decisions on follow-up actions shall be made for identified hazards. I

4.4.3.0-6 For critical workplaces, which involve tasks with a high risk of accidents, a detailed JHA shall be carried out. Minor accident risks should also be covered. Criteria for the selection of workplaces for the analyses include: I

4.4.3.0-7 - frequently repeated manual tasks, especially in material handling, I
4.4.3.0-8 - manual tasks in the risk zone of mechanical equipment, I
4.4.3.0-9 - manual tasks involving hazards with potentially severe consequences. I

4.4.3.0-10 For risk assessment of machinery, see NORSOK S-005. I

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4.4.4 Ergonomics/prevention of musculoskeletal strains and Injuries

4.4.4.0-1 During engineering, ergonomic task analyses shall be performed to identify potential problem areas in workplace design and to ensure that the maximum workload requirements can be met, see 5.2.1. I

4.4.4.0-2 The analyses shall be performed for all relevant workplaces involving tasks in operation or maintenance with a significant risk of musculoskeletal injuries. Input concerning manning, work sequences, frequency of operation, inspection and maintenance tasks, necessary equipment for performance of the tasks, personnel selection, and previous experience in similar tasks should be ensured prior to the analysis. I

4.4.4.0-3 The analyses shall include, but not be limited to, evaluations of I

- layout,
- access and clearances for performance of tasks,
- location of work functions (displays, control actuators, manually operated valves, etc.),
- view conditions,
- repetitive movements,
- lifting and transportation aids,
- manual handling,
- sedentary work.

4.4.4.0-4 The analyses of material handling tasks shall be integrated with the material handling study. I

4.4.5 Ergonomics/human factors in work systems

4.4.5.0-1 During project development, analyses shall be performed to ensure that the design complies with main objectives and philosophies, and minimises the potential for human error in work systems that control safety-critical activities on the installation, and to enhance the system's capacity for recovery from incorrect actions.

4.4.5.0-2 Control rooms.

4.4.5.0-3 The ergonomic/human factor principles and design process stipulated in ISO 11064 (all parts) shall be applied in the design of the CCR and the driller's control room/cabin. For mobile offshore units, ISO 11064 (all parts) should also be applied in design of the wheelhouse/bridge and the machine control room.

4.4.5.0-4 During concept definition and optimisation/FEED, the activity shall include

4.4.5.0-5 - a functional analysis and allocation describing functions to be performed, defining system performance requirements, and allocating manual and/or automatic functions,

4.4.5.0-6 - a task analysis defining tasks based on allocated functions, and defining requirements (time, cognitive demands, etc.) for operator tasks, including information needed and the interface devices necessary to handle these tasks.

4.4.5.0-7 During engineering, a job and work organisation analysis shall be performed to provide input regarding job design and organisation of operator work, including requirements to communications, operating procedures, operator training and information and control.

4.4.5.0-8 The analyses shall be updated and elaborated in an iterative process to ensure that further development of requirements is in compliance with the main objectives and philosophies.

4.4.5.0-9 As part of validation of the design, manning and procedures, and the ability to control process disturbances and emergencies, the CCR and driller's control room/cabin shall be subject to a scenario analysis (e.g. CRIOP or similar). For guidance on the CRIOP method, see G.3.2. Depending on the issue in focus, the use of additional verification and validation tools (e.g. questionnaires, simulators) may be justified, see ISO 11064-1.

4.4.5.0-10 Other work systems

4.4.5.0-11 During engineering, an evaluation shall be made in order to determine in which work systems human error may cause accidents with severe consequences to personnel, environment or material (e.g. crane cabins, control units/panels for pipehandling equipment and remotely operated vehicles.) For these systems, analyses of allocated functions, tasks and job organisation shall be performed to evaluate and minimise the potential for human error during all operational modes including start-up and shutdown, emergency operations, and maintenance.
For guidance on task analysis, see G.3.1, EN 614-1 and EN 614-2.

4.4.6 Hazardous chemicals

4.4.6.0-1 During project development, a chemicals HRA shall be performed to identify, evaluate and control chemical health risks to an acceptable level, see the risk acceptance criteria in the WE programme.

4.4.6.0-2 The chemicals HRA shall be performed for all activities where hazardous chemicals are planned to be used during operations or maintenance, and for all processes containing hazardous chemicals that are, or can be, emitted to the working environment. Processes in this respect means production systems, drilling and well operations, combustion (exhaust), workshop activities (e.g. hot work, handling of coating products), evaporation from storage tanks, etc. If the actual identity and composition of a chemical is not known, the chemicals HRA shall be based on the composition of a typical chemical. For hazard classification of chemicals, reference is made to the regulations relating to Dangerous Chemicals (Merkeforskriften).

4.4.6.0-3 Risk assessment methods/tools shall be adapted to the complexity of the activity and the potential risk levels according to the industry’s best available practice. For Norway, they shall at least comply with the regulations relating to the Protection against Chemical Exposure at the Workplace

(Kjemikalieforskriften). An example is given in G.1.2.

4.4.6.0-4 When completed, the chemicals HRA shall document: I

- health hazards for all chemicals (actual or typical) to be used, including substances used in, and/or released from, processes,
- elimination or substitution of hazardous substances/products to less harmful,
- estimated/calculated exposure levels of airborne chemicals and skin contaminants related to planned activities, including inspection, sampling, maintenance and cleaning activities,
- a risk assessment combining information about health hazards, exposure levels, and duration and frequency of exposure related to planned activities,
- the quality of established exposure barriers,
- need for storage areas,
- need for emergency showers and eyewash stations.

4.4.6.0-5 During concept definition and optimisation/FEED, the activity shall ensure that I

4.4.6.0-6 - major chemicals emitting sources are identified, I
4.4.6.0-7 - possible enclosure of sources is evaluated, I
4.4.6.0-8 - a review of the localisation of high emitting sources in relation to permanently manned work areas is performed, I
4.4.6.0-9 - need for storage areas is defined. I

4.4.6.0-10 During engineering, the activity shall ensure that I

4.4.6.0-11 - all chemicals (actual or typical) that are planned to be used or can be released to the working environment are identified, I
4.4.6.0-12 - significant chemical emissions are identified and their effects evaluated, I
4.4.6.0-13 - elimination, or substitution of less hazardous chemicals are evaluated, I
4.4.6.0-14 - chemicals HRA is performed and documented, I
4.4.6.0-15 - need for exposure barriers is specified, including need for general and/or local ventilation, I
4.4.6.0-16 - need for emergency showers and eyewash stations is defined, I
4.4.6.0-17 - additional administrative and personal barriers necessary to control the chemical health risk in accordance with the acceptance criteria in the WE programme shall be described and agreed by the company. I

4.4.6.0-18 During construction/commissioning, the proper function of exposure barriers shall be tested and documented in the WEACs, including smoke tests of general/local ventilation used to control exposures to chemicals. I

4.4.7 Noise and vibration control

4.4.7.0-1 During project development, the procedure for noise control in Annex H, or a procedure documented to be of equivalent functionality and quality, shall be applied. I

4.4.7.0-2 During concept definition and optimisation/FEED, the activity shall ensure that: I

4.4.7.0-3 - major noise and vibration sources are identified, I
4.4.7.0-4 - possible use of low-noise equipment is evaluated, I
4.4.7.0-5 - a review of the localisation of noisy equipment and noise-exposed areas in relation to quiet areas is performed, and the use of "buffer" zones is evaluated, I
4.4.7.0-6 - area noise level limits (total and HVAC) are specified, I
4.4.7.0-7 - preliminary predictions of area noise levels and personnel exposure levels are performed, I
4.4.7.0-8 - noise data sheets are issued for high-noise equipment to be ordered in the FEED phase. The equipment noise level limits shall be based on the project's area limits, and shall take into account other noise sources that are planned in the area, and area/room characteristics. I

4.4.7.0-9 During engineering, the activity shall ensure that: I

4.4.7.0-10 - significant noise and vibration sources are identified and their influences evaluated, I
4.4.7.0-11 - sound absorption treatment for all enclosed work areas, sound insulation and vibration isolation for equipment and machinery are specified, I

4.4.7.0-12 - maximum noise and vibration levels for significant noise and vibration sources are specified on the basis of area noise and vibration limits, the area's acoustic properties, and the adequate sound insulation between areas. The additive effects of several sources in the same area and room acoustic characteristics shall be taken into account. A minimum safety margin of 3 dB shall be applied unless it is documented that the supplier includes correction for measurement uncertainty (K-value) in the guaranteed noise level data, I

4.4.7.0-13 - noise data sheets for all potential noisy equipment are established and included in the inquiries, see Annex F, I

4.4.7.0-14 - suppliers shall submit guaranteed noise level data for the contract object, and prepare a procedure for testing and control of the guaranteed levels. The procedure shall be part of the contract, see NORSOK S-005, I

4.4.7.0-15 - requirements to acoustic pipe insulation are specified. For piping identified to be on the borderline for required acoustic insulation, space for future installation shall be implemented in the design, including in the 3D model, I

4.4.7.0-16 - noise and vibration levels are predicted and documented for the various areas of the installation at a stage of the project where all requirements have been stated, I

4.4.7.0-17 - the individual noise exposure is calculated for typical categories of personnel working in areas with a noise level above 83 dB (A). No use of hearing protection shall be assumed for the calculations, except for exposures in unmanned machinery room and helicopter handling where hearing protection is mandatory and the protector's expected real life attenuation can be included in the calculations. Calculations of personal noise exposure shall take into consideration the actual noise levels and the duration and frequency of the noise exposure. Experience data and operations participation shall be used to collect exposure information and validate the predictions, I

4.4.7.0-18 - the need for anti-vibration mounting is considered for all rotating equipment, in particular for equipment in work areas with motor effect > 200 kW, I

4.4.7.0-19 - in areas where whole body vibration limits may be exceeded, structural vibration analysis shall be performed, I

4.4.7.0-20 - noise and vibration predictions are updated, based on supplier-guaranteed noise and vibration data and the detailed engineering of the installation. I

4.4.7.0-21 During construction, the activity shall ensure that I

4.4.7.0-22 - all noisy non-standard equipment is tested according to the predefined test procedure during the fabrication acceptance test. For standard equipment, data from earlier tests may be accepted, I

4.4.7.0-23 - noise tests on main equipment are executed or witnessed by a qualified project noise control engineer, see NORSOK S-005, I

4.4.7.0-24 - detailed acoustic measurements are conducted for the mock-up cabin. I

4.4.7.0-25 During commissioning, the activity shall ensure that I

4.4.7.0-26 - where feasible, a full noise level mapping of the various areas of the installation is performed, I

4.4.7.0-27 - as-built data are recorded in the working environment area charts. I

I

4.4.8 Illumination

4.4.8.0-1 During engineering, quality of illumination should be analysed in all relevant rooms, including control rooms, offices, recreation areas and galley. I
The illumination should be analysed especially in the control room, cabins and other rooms where work with high visual demands takes place, where display screen equipment is used and where the work requires good visibility during various weather conditions. The studies should include how to avoid reflection and glare.

I

4.4.9 Outdoor operations/cold stress

4.4.9.0-1 Outdoor operations analyses shall be carried out for open work areas and semi-open work areas, in order to identify and remedy potential problem areas due to overall exposure to temperature, wind, icing and precipitation, including investigation of the weather protection necessary to comply with WCI and other functional requirements identified in the analysis. I

4.4.9.0-2 The analysis shall be performed early in design/layout development, and shall be updated when design changes are made that will affect personnel’s exposure to cold stress. I

The activity shall ensure that

4.4.9.0-3 - workplaces in open and semi-open areas where there is frequent work with a duration of 10 min or more are identified, I

4.4.9.0-4 - the analysis includes WCI calculations for the identified workplaces, in combination with explosion load calculations. When calculating the WCI, verified meteorological data (combined wind and temperature) for the past five years or more should be used. The formula in ISO/TR 11079, Annex D, should be used to calculate WCI, I

4.4.9.0-5 - simulations shall be made for the seven coldest months of the year, for each of the following WCIs: 1000, 1200, 1400 and 1600 W/m^2, I

4.4.9.0-6 - the acceptability of the exposure to high WCIs is determined, taking into account the type of work, activity level and duration of stay in exposed areas, and assuming normal winter work clothing, I

4.4.9.0-7 - where necessary, measures to avoid exposed workplaces or reduce the exposure to wind and/or precipitation are evaluated, e.g. redesign/relocation of equipment, windbreaks. Design/layout measures that are feasible with respect to both technical safety and working environment shall be identified for implementation in the design. I

I

4.4.10 Constructability

4.4.10.0-1 During detailed engineering, a constructability analysis shall be performed to ensure that the design of the contract object promotes a satisfactory HSE standard during construction. In particular, the following shall be considered: I

4.4.10.0-2 - accessibility (with respect to installation, lifting, cutting, welding, shot blasting, and surface treatment), including selection of steel details and profiles, I

4.4.10.0-3 - selection of materials and chemicals, I

4.4.10.0-4 - relevant experience related to health, safety and environmental pollution during construction. I

4.4.10.0-5 Reference is made to NORSOK S-012, Clause 7. I

I

4.5 Verification and validation of design

I

4.5.1 Working environment design reviews

4.5.1.0-1 During design development, design reviews shall be performed as necessary to verify compliance with specific WE requirements applicable to the contract object. Further validation shall be performed to ensure that design is in accordance with specific intended use. I

4.5.1.0-2 Design reviews shall be performed in the early phases of engineering, and shall be repeated prior to construction. I

4.5.1.0-3 Special checklists shall be prepared for review purposes, and shall be used to document the results and findings. For machinery, see NORSOK S-005, 5.3. I

4.5.1.0-4 In particular, design reviews shall be used for: I

4.5.1.0-5 - machinery and vendor packages that are considered critical from a WE point of view. For such equipment, suppliers shall be requested to submit the completed checklist as part of the bid documentation, and WE aspects of the delivery shall be evaluated in the bid clarification process, I

4.5.1.0-6 - installation areas/systems to verify arrangements, material handling and access to equipment. Use of the 3D model is recommended. Reference is also made to the valve and instrument access and operability review in G.3.3, I

4.5.1.0-7 - layout and physical work environment of control centres/CCR, I

4.5.1.0-8 - installation areas to verify illumination predictions and evaluations. I

4.5.1.0-9 Personnel/teams performing WE design reviews shall have adequate WE qualifications, and shall be familiar with operation and maintenance activities associated with the contract object. I

I

4.5.2 Working environment inspections

4.5.2.0-1 During construction and mechanical completion of installation areas/modules and vendor packages, WE inspections shall be carried out to verify that the fabricated contract object is in compliance with established design requirements and that actions from WE analyses are implemented. Inspections during construction should take place while rectification work is still possible, e.g. 80 % complete. I

4.5.2.0-2 Special checklists shall be prepared for inspection purposes, and shall be used to document the results and findings. I

5 Working environment requirements

5.1 Arrangements

5.1.1 General

5.1.1.0-1 Safe distances according to EN 349 shall apply between moving machinery parts and fixed objects.

5.1.1.0-2 Provisions shall be made for safe and efficient transportation of materials, both horizontally and vertically.

5.1.1.0-3 Storage areas and lay down areas belonging to them should be located in the vicinity of each other and on the same level.

5.1.1.0-4 Dedicated storage areas shall be provided for scaffolding. I

5.1.1.0-5 To enable an effective and efficient waste handling system for segregation of waste, permanent waste handling stations shall be located on the same deck level as the main waste sources, i.e. workshop, galley etc. I

5.1.1.0-6 Offices, coffee bars and recreation rooms should have access to daylight if possible. I

5.1.1.0-7 Workplaces shall be arranged to provide for contact with others. Solitary work shall be avoided in permanently and intermittently manned areas.

5.1.1.0-8 Sensitive equipment near transportation routes shall have protection to prevent damage caused by the handling and transport of equipment. I

5.1.1.0-9 Piping, ducting, cable installations, lighting fixtures and floodlights, loudspeakers, and fire and gas detectors should be avoided in lifting areas. If such equipment is installed, it shall be mechanically protected. I

5.1.1.0-10 For vertical and horizontal clearances, see Annex B.

5.1.2 Means of access

5.1.2.0-1 All work areas shall have a layout that provides for safe and easy access for operation, inspection, readings and maintenance. I

5.1.2.0-2 Ladders may replace stairs where stairs are not feasible or where daily access is not required. I

5.1.2.0-3 Floors in work areas and walkways shall be designed in accordance with the following:

5.1.2.0-4 Walkways for access to permanently and intermittently manned workplaces shall be arranged. These shall be shown on relevant drawings.

5.1.2.0-5 Drips of oil and slippery liquid onto floors shall be avoided, e.g. by using drip trays.

5.1.2.0-6 Protruding objects shall be avoided in walkways, access ways and transportation ways.

5.1.2.0-7 Preferred means of access shall be in following order: I

- ground level or floor,
- ramp,
- stair,
- fixed inclined stepladders,
- fixed vertical ladders.

See ISO 14122-1.

5.1.2.0-8 Permanent means of access shall be provided for all equipment (including junction boxes, floodlights, lighting fixtures, motors, valves, instruments, emergency stop switches, gas/smoke detectors, etc.) that needs to be accessible for operator attention during start-up, normal operation, shutdown or in an emergency situation. I
The need for permanent access shall be evaluated with respect to frequency and criticality. Where frequent access is necessary or easy access is critical, the access shall be permanent. The means of access shall be designed to meet the maintenance requirements of the equipment.

5.1.2.0-9 For other equipment that needs maintenance and/or operator attention, as well as monorails/lifting lugs, permanent means of access shall be provided unless one of the following conditions is met: I

- the equipment is accessible from a stepladder/footstool of maximum elevation 1 250 mm, e.g. lighting fixtures, junction boxes;
- safe access is possible from a temporary/mobile platform that does not require scaffolding, e.g. scissors lift. The space required for storage, transport and operation of such a platform shall be taken into account, e.g. fire and gas detectors, thermocouples, floodlights;
- the activity can be planned for, and executed during scheduled, campaigns/turnarounds, and safe access can be provided using scaffolding, e.g. access for manholes, vents for pressure testing.

5.1.2.0-10 For primary stairs and secondary stairs, NORSOK C-002 shall apply. I

5.1.2.0-11 For other stairs, reference is made to Annex B and ISO 14122 (all parts). I

5.1.2.0-12 Stairs, ladders and platforms shall be designed in accordance with Annex B and recognised standards listed therein.

5.1.2.0-13 At the top of vertical and inclined ladders, self-closing gates shall be installed. Such gates shall not open towards the ladder, and shall not be of the gravity falling bar type. I

5.1.2.0-14 Fixed stepladders shall be provided with handrail on both sides.

5.1.2.0-15 A safety cage shall be installed on all vertical ladders where the ladder flight is more than 3 000 mm. I

5.1.2.0-16 All ladders (also with ladder flights < 3 000 mm) where there is a risk of falling to a lower level than the ladder's departure area, shall be identified and the necessary fall protection shall be provided. I

5.1.2.0-17 Access openings in vertical partitions into cofferdams, tanks etc. shall be equipped with handgrips on both sides above the opening.

5.1.2.0-18 Storage tanks (fixed tanks for diesel, water, mud etc.) shall have internal ladders (internal/external height > 450 mm). I

5.1.2.0-19 Slippery floor surfaces shall be avoided in work areas and access ways. I

5.1.2.0-20 Non-slip systems shall be installed in exposed stairways and stepladders, including the uppermost step at deck/platform elevation. I

5.2 Ergonomics

5.2.1 Prevention of musculoskeletal injuries

5.2.1.1 General

5.2.1.0-1 Workplaces shall be designed such that the personnel are not exposed to excessive workloads with risks of musculoskeletal injury.

5.2.1.0-2 For determination of maximum workload and force limits, see EN 1005-2, EN 1005-3 and EN 894-3. I
The requirements above entail that efforts should be made to avoid

- monotonous muscular load,
- excessive muscular load,
- work in fixed or static position,
- work with joints in extreme position,
- work requiring high precision and which at the same time requires substantial use of force,
- work in kneeling, squatting and lying positions,
- work of long duration and of repetitive nature with hand above shoulders or below knees,
- continuous asymmetric load on the body.

5.2.1.2 Manual handling, transportation

5.2.1.1.0-1 Transportation ways where trolleys and carts are used shall not contain steps and thresholds.

5.2.1.1.0-2 There shall be enough space for the use of lifting and transportation gear where lifting or transportation of more than 25 kg is required.

5.2.1.1.0-3 For equipment/objects of mass 25 kg to 200 kg, space for use of adequate lifting and transportation devices (permanent or temporary, e.g. elephant cranes, A-frames, beam clamps, etc.) shall be provided. I

5.2.1.1.0-4 Trolleys, transportation tables and similar means of transportation should be easily manoeuvrable and have a low rolling resistance. Minimum two of the wheels shall be lockable.

5.2.1.1.0-5 Units in everyday use shall not be stored above shoulder height (1 500 mm) and should not be stored below 900 mm.

5.2.1.1.0-6 Permanent arrangements (e.g. monorails, pad eyes) shall be installed for material handling of equipment/objects > 200 kg. I

5.2.1.1.0-7 In addition, when designing for permanent or temporary lifting equipment, the estimated frequency of the lifting operations shall also be taken into account. For frequent/routine lifting operations, permanent equipment shall be installed. I

5.2.1.1.0-8 Manual lifting of gas bottles shall be avoided. I

5.2.1.1.0-9 Cupboards for gas bottles shall be of a non-threshold type. I

5.2.1.3 Elevators

5.2.1.2.0-1 For installations with more than one deck, an elevator for handling of equipment and daily heavy loads shall be installed, unless other acceptable solutions are documented. I

5.2.1.2.0-2 The elevator shall provide access to all main deck levels, and in particular, easy access to/from the mechanical workshop and main stores, and other decks where handling of heavy equipment is needed. I

5.2.1.2.0-3 Floating production units shall be equipped with suitable elevators capable of handling equipment placed in the substructure. I

5.2.1.4 Hatches and doors

5.2.1.3.0-1 Vertical inspection hatches should be side-hinged.

5.2.1.3.0-2 The opening force of doors in frequent use shall not exceed 65 N for side-hinged, and 50 N for sliding doors respectively.

5.2.1.3.0-3 No doors shall have an opening force in excess of 130 N for side-hinged, and 105 N for sliding doors.

5.2.1.3.0-4 Mechanically assisted opening of doors shall be considered in the main walkways.

5.2.1.3.0-5 Hinged doors leading to open areas shall be provided with a damping mechanism to prevent crushing injuries.

5.2.1.3.0-6 It shall be possible to secure hatches in an open position. I

5.2.1.3.0-7 External doors exposed to wind pressure shall be sliding doors. I

5.2.1.5 Adaption for cleaning

5.2.1.4.0-1 A ring main for high-pressure wash down stations shall be considered in areas where heavy cleaning will take place.

5.2.1.4.0-2 Drains shall be located in order to facilitate cleaning.

5.2.1.4.0-3 Materials and surfaces of structural members, installations and equipment shall be easy to clean and maintain.

5.2.1.4.0-4 Maintenance and/or cleaning equipment and associated consumables should be stored in the vicinity of areas with frequent maintenance or cleaning.

5.2.1.4.0-5 Equipment and fixtures should be mounted on plinths or fixed to walls in order to provide maximum free floor space for easy cleaning.

5.2.1.4.0-6 There shall be dedicated space for the necessary cleaning equipment adjacent to rooms requiring cleaning by hand such as offices, coffee bars and toilets.

5.2.1.4.0-7 The space shall be equipped with cold and hot water, utility sink with grid (height 600 mm above floor) and sufficient vertical distance to the tap for filling buckets.

5.2.1.4.0-8 There shall be sufficient floor space to park a cleaning trolley. I

5.2.2 Human-machine interfaces/human factors

5.2.2.0-1 For control rooms, cabins and control panels where human error may cause accidents with severe consequences to personnel, the environment or material, or where recovery by human operator is important to avoid such accidents, the following shall apply: I

5.2.2.0-2 The design shall be based on task analyses of functions, see 4.4.5. I

5.2.2.0-3 Controls and displays shall be located in a logical manner with respect to frequency of use and importance for safe operation; the movement of a control device should be consistent with the effect in direction and magnitude. They shall be clearly marked in the language of the relevant country. I

5.2.2.0-4 Information shall be organised and presented according to recognised principles (e.g. grouped, coded and prioritised) in a manner that facilitates correct operator response to safety-critical information. I

5.2.2.0-5 Alarm systems shall be designed according to the principles stated in YA 711. I

5.2.2.0-6 Displays and controls shall be designed in accordance with acknowledged ergonomic principles and in order to allow the operator to carry out his tasks in a safe manner. The number and type of displays should, however, be minimised. I

5.2.2.0-7 Screens, panels and lighting fixtures shall have a location that provides a satisfactory view in a normal working posture. I

5.2.2.0-8 It shall be easy to adjust the height and angle of computer screens and keyboards, as well as their distance to the operator. I

5.2.2.0-9 If VDUs are used, information given to operators shall support task performance and be given in a manner that ensures adequate workload. I

5.2.2.0-10 Total system overviews should be available from the displays, giving the operator opportunities to watch process performance. I

5.2.2.0-11 For the design of displays and control actuators, reference is made to EN 614-1 and EN 894 (all parts). I

5.2.2.0-12 Visual displays, gauges, level glasses etc. shall be within the operator's field of vision and easy to read when standing on the floor or a working platform. I

5.2.2.0-13 For detailed requirements to workplaces with VDUs, see C.4. The requirements apply to all VDU workplaces, also outside LQ/CCR. I
In Norway, DLI 528 is applicable.

5.3 Technical appliances

5.3.1 General

5.3.1.0-1 Machinery shall be designed in accordance with the methods and technical principles according to EN 292-1 and EN 292-2.
Relevant type B European standards shall be identified and implemented.

5.3.1.0-2 NORSOK S-005 shall be applied for procurement of machinery. I

5.3.2 Hot/cold surfaces

5.3.2.0-1 It shall not be possible to reach surfaces with a temperature above +70 °C or below -10 °C from work areas, walkways, ladders, stairs or other passageways, see EN 563.

5.4 Chemical substances and products

I

5.4.1 General

5.4.1.0-1 The design shall ensure that the exposure to chemical substances and products containing hazardous substances is minimised. For Norway, the design shall be in accordance with the stipulations in the regulations relating to the Protection against Chemical Exposure at the Workplace (Kjemikalieforskriften). I

5.4.1.0-2 Hazardous chemicals shall be handled automatically and in closed systems. I

5.4.1.0-3 Residual risks shall be stated and dealt with in the instructions for use. Typical examples of chemical products are process and drilling chemicals, paint, lube oil and preservation chemicals. I

5.4.1.0-4 Sampling shall be possible without hazardous exposure to chemicals or process streams. I

5.4.1.0-5 The installation shall be designed such that all spillage is properly handled. The need for drains and their effectiveness shall be evaluated for all work areas. I

I

5.4.2 Selection and documentation of hazardous chemicals

5.4.2.0-1 The following substances and products are prohibited: I

- asbestos and asbestos-containing materials,
- mercury compounds,
- cadmium compounds,
- polychlorinated biphenyl and polychlorinated biphenyl-containing materials,
- halon type chemicals,
- chlorofluorocarbon type chemicals,
- tetrachloromethane,
- 1,1,1-Trichloroethane.

5.4.2.0-2 Norwegian statutory restrictions on marketing and use of chemicals and materials shall be complied with, [see regulations from The Norwegian Pollution Control Authority (SFT)]. I

5.4.2.0-3 Use of substances and products classified as very toxic, toxic, carcinogenic, allergenic, mutagenic, substances toxic to reproduction or strongly corrosive should be minimised, cf. the regulations relating to Dangerous Chemicals (Merkeforskriften). Use of these substances and products shall be eliminated or substituted with less hazardous alternatives. For Norway, the stipulations in section 8 of I

the regulations relating to the Protection against Chemical Exposure at the Workplace (Kjemikalieforskriften) shall apply. If elimination or substitution is not possible, this shall be documented.

5.4.2.0-4 All chemicals that accompany the installation offshore, or are included in instructions for operation and maintenance, shall be listed in a chemical inventory according to national legislation. For Norway, the regulations relating to the Construction and Use of a Chemical Inventory for Hazardous Substances at the Workplace (Stoffkartotekforskriften) shall apply. I

5.4.2.0-5 All chemicals shall be documented on MSDSs according to national legislation. For Norway, the regulations relating to the Preparation and Distribution of MSDSs for Hazardous Chemicals (Databladforskriften) shall apply. I

5.4.2.0-6 In Norway, the MSDSs shall, as a minimum, be in the Norwegian language. I

5.4.3 Occupational chemical exposure control and limits

5.4.3.0-1 Under normal operation, the concentration of hazardous substances in the working atmosphere, and skin contact with these chemicals, shall be as low as reasonably practicable. This means that the installation shall be designed such that, under normal conditions, the atmospheric concentrations of hazardous substances in permanently manned work areas do not exceed 1/6 of the OELs according to the regulatory requirements in the country. I

5.4.3.0-2 For other areas, an area limit of 1/3 of the OELs applies. I

5.4.3.0-3 For Norway, the OELs specified in DLI 361 shall apply. I

5.4.3.0-4 Area limits for concentrations of chemical substances in the working atmosphere shall be established when there is a possibility of exceeding 10 % of the chemical's OEL. I

5.4.3.0-5 Control of hazardous emissions shall be achieved by the following technical measures/barriers (in order of priority): I

1. Efficient enclosure of emission sources.
2. Efficient extraction/exhaust ventilation systems to remove pollutants near the source.
3. General ventilation/dilution of contamination.

In order to be considered an exposure barrier, the effectiveness has to be documented, see 4.4.6.

5.4.3.0-6 Emissions of hazardous substances from machines shall be controlled, see EN 626. I

5.4.3.0-7 Extraction systems should efficiently pick up the pollutants near the source. I

5.4.4 Storage of chemicals

5.4.4.0-1 There shall be a dedicated storage area for each type of chemical. I

5.4.4.0-2 These areas shall not be used for other purposes. I

5.4.4.0-3 The areas shall be properly ventilated and protected against fire. I

5.4.4.0-4 Chemicals that may react with each other shall not be stored together. I

5.4.4.0-5 All hazardous vapours shall be routed/treated in such a way that they do not come in contact with personnel. The possibility of routing into main exhaust/vent pipes shall be assessed. I

5.4.4.0-6 Chemical storage tanks shall have unique couplings to prevent mixing of chemicals. I

5.5 Noise and vibration

5.5.1 General

5.5.1.0-1 Installation of low-noise equipment shall be the primary noise control measure.

5.5.1.0-2 For piping systems, selection of low-noise valves and other components with low-noise properties shall be given priority. I

5.5.1.0-3 Noisy equipment and equipment with high structure-borne sound emission levels and areas with noisy activities (e.g. lay down areas, workshops), shall not be located in the immediate vicinity of areas with a noise level limit of 50 dB(A) or below, e.g. offices, hospital, central control room, sleeping/recreation areas.

5.5.1.0-4 No noise sources that may significantly reduce the speech intelligibility shall be installed in the immediate vicinity of lifeboat stations and muster points. I

5.5.1.0-5 There shall only be a need for brief stays for inspection purposes in unmanned machinery rooms while machinery is running. I

5.5.1.0-6 If possible, low-noise and high-noise areas shall be separated, and high-noise equipment shall be located in separate room. Unmanned machine rooms with several noise sources shall be separated in such a way that maintenance work can be performed on machines not in operation without being exposed to noise levels above 90 dB(A). I

5.5.1.0-7 There shall be no regular access ways through unmanned machinery rooms to other workplaces. I

5.5.2 Noise limits

5.5.2.0-1 The following noise level limits reflect the requirements for conservation of hearing:

5.5.2.0-2 The individual employee's maximum exposure to noise during a 12 h working day is 83 dB(A).

5.5.2.0-3 The maximum allowable noise level in any situation is 130 dB(C) ("peak"). This limit also applies to enclosed "normally unmanned areas".

5.5.2.0-4 Annex A deals with vibration limits and area noise level limits, total and for HVAC.

5.5.2.0-5 The area noise level limits shall apply as the maximum sound pressure level at any location within an area, but not closer than 1 m to equipment and other noisy installations. I

5.5.2.0-6 All limits refer to broadband noise without any distinct tonal characteristics. In case of tonal characteristics, the noise level limit shall be set 5dB lower.

5.5.2.0-7 For areas where the area noise limit is 85 dB(A) or 90 dB(A), the limit of 90 dB(A) shall apply only where a lower limit is unfeasible. If an area limit of 90 dB(A) is incompatible with the individual employee's maximum noise exposure, technical measures to reduce the need to stay in the noise zone shall be implemented. I

5.5.2.0-8 In workshops and galley, the noise limits refer to background noise including ventilation system and external noise sources, but not manually controlled operations. For these operations, the maximum noise exposure for a 12 h working day applies. However, low-noise equipment shall be used.

5.5.2.0-9 In control rooms, offices, computer rooms, radio rooms, galley, workshops and laboratories, the noise level limits refer to background noise including HVAC as well as noise sources in continuous use within the actual room.

5.5.2.0-10 During emergency conditions (e.g. near safety relief valves, fire pumps or outdoor areas during full emergency flaring, etc.) only maximum allowable noise level of 130 dB(C) applies. I

5.5.2.0-11 During emergency conditions, the noise level in the muster areas shall not exceed 90 dB(A) and the noise level in the radio room, the emergency management room and the central control room shall not exceed 60 dB(A) during emergency conditions. I

5.5.2.0-12 Access to control rooms, offices, laboratories etc. from noisy areas should be via corridors or buffer zones in which the noise levels do not exceed the quiet room noise level by more than 5 dB.

5.5.2.0-13 Access from walkways to permanently manned areas should be provided without passing a zone with noise level above 83 dB(A).

5.5.2.0-14 When selecting the design of enclosed spaces (i.e. when decisions on acoustic treatment shall be taken) the requirements to PA system and speech intelligibility shall be taken into account. Low reverberation times shall be adhered to.

5.5.2.0-15 The noise level in cabins for day-sleeping personnel shall not exceed 55dB (A) during helicopter take-off/landing.

5.5.2.0-16 Noise from foghorns or production flaring shall not exceed the noise level limits in affected areas.

5.5.3 Other acoustic requirements

5.5.3.0-1 For workshops, laboratories, control rooms, radio room, meeting rooms, coffee bars, rest/television rooms, dining room and offices, the average octave band sound absorption coefficient shall not be less than 0,2 in the frequency range 250 Hz to 2 kHz.

5.5.3.0-2 The partitions between rooms shall be designed in order to achieve an adequate sound insulation. Minimum permissible airborne sound insulation indices for horizontal, vertical and diagonal sound transmission between adjacent rooms are shown in Table 1.

5.5.3.0-3 Acoustic rating of sound insulation shall comply with ISO 717-1.

5.5.3.0-4 **Table 1 - Minimum permissible field-measured weighted sound reduction index (R'w) between rooms in the living quarters**

	Noisy rooms dB	Work rooms dB	Quiet rooms dB	Corridors/ staircases dB
Noisy rooms	40 [a]	40	45 [b]	35
Work rooms		40	40	35
Quiet rooms			40 to 45 [d]	40 [c]

Notes
[a] Does not apply to partition between galley and dining room.
[b] Common partition with hospital/ward shall be avoided.
[c] Doors into cabins shall have minimum sound reduction properties of 40 dB, see NS 3150.
[d] The requirement of 45 dB(A) only applies to one-man cabins.

Examples of "Noisy rooms" are gymnasium, television rooms/cinema, printer room, galley, dining room, and changing room.
"Work rooms" are offices, meeting rooms, radio room, and control rooms.
"Quiet rooms" require a high degree of privacy and include cabins, hospital/ward, and rest rooms, e.g. reading rooms.

5.5.4 Noise requirements in connection with modification

5.5.4.0-1 The noise requirements in Annex A apply for all modification of installation built according to this NORSOK standard. For modifications of older installations (pre-1995), company-specific noise requirements shall apply for engineering.

5.5.4.0-2 For procurement of new equipment, noise requirements shall be established such that noise from the new equipment does not result in exceeding the area noise level stated in Annex A. Noise requirements for new equipment shall have a safety margin of 3 dB.

5.5.4.0-3 For areas where noise level exceeds area noise level limits in Annex A before modification, the following apply:

5.5.4.0-4
- when the extent of modification work gives possibilities for improvements so that the area limits in Annex A can be met, these possibilities shall be explored according to the ALARP principle;

5.5.4.0-5 • in areas where the noise level exceeds area limits, the modification shall not increase the noise level. I

5.5.4.0-6 In areas where the noise level is in accordance with the area limits, the noise level shall still be in accordance after modifications. I

5.5.5 Vibrations

5.5.5.0-1 Annex D shows the maximum limits for continuous whole body vibration from machinery and equipment that shall apply. Vibration limits are based on boundaries given in ISO 2631-1. The limits are derived from the acceptability of the exposure of human beings to vibrations and are based on a 12 h working day.

5.5.5.0-2 The vibration limits are specified graphically as combined levels for vertical and horizontal movements. The limits cover the range 1 Hz to 80 Hz in which the major body resonance occurs. They shall not be extrapolated beyond this range.

5.5.5.0-3 The vibration limits are categorised as follows:

5.5.5.0-4 – Category 1 - Limits for central control room and living quarter areas, I

5.5.5.0-5 – Category 2 - Limits for workshops, laboratories, control rooms, offices and equipment rooms outside living quarters, I

5.5.5.0-6 – Category 3 - Limits for process, utilities and drilling areas, I

5.5.5.0-7 – Category 4 - Limits for vibration locally to equipment,

5.5.5.0-8 – Category 5 - Maximum limits (normally unmanned areas).

5.5.5.0-9 Higher levels than those given in category 4 may be tolerated for shorter exposure than 12 h. Category 1, category 2 and category 5 shall also apply for intermittent operation.

5.5.5.0-10 Hand/arm vibrations shall meet the requirements stated in ISO 5349 (all parts).

5.6 Illumination

5.6.0-1 For the general level of illuminance at 1 m of elevation, the area requirements according to Annex A apply.

5.6.0-2 The uniformity of the illuminance shall be equal to, or better than, E_{min}/E_{mean} = 0.5 in process, utility and drilling areas.

5.6.0-3 The uniformity of the illuminance for individual work areas shall be equal to or better than E_{min}/E_{mean} = 0,7. I

5.6.0-4 For lighting calculations, a maintenance factor reflecting the environment and time between maintenance intervals shall be established and applied. Maintenance factor 0.7 is recommended. I

5.6.0-5 Lighting shall be specified for each workplace that requires at least daily access or is critical from a safety point of view. The guidelines in EN 12464-1 shall be applied in the specification of task lighting. I

5.6.0-6 Task lighting shall, as a minimum, be included for workplaces that require daily access or detailed reading of information, or is critical from a safety point of view. I
This includes gauges, indicators, areas that need to be checked for leakage, and areas that frequently need maintenance.

5.6.0-7 To avoid shadows, illumination planning shall take the location of fixtures, racks and mechanical equipment into consideration.

5.6.0-8 The difference in illuminance level between adjacent indoor areas should not exceed 5:1.

5.6.0-9 In enclosed work areas, the difference shall never be more than 40:1 within the total field of vision.

5.6.0-10 Provision shall be made to avoid direct glare from sunshine, from artificial light sources and from reflecting surfaces.

5.6.0-11 Glare in visual display units from reflecting surfaces, lamps and windows shall be avoided.

5.6.0-12 In the design of the lighting, the level of illumination and location of lamps shall make it easy to see obstructions, steps in corridors, walkways etc.

5.6.0-13 Different levels of illuminance require different light colours if the lighting is to be comfortable. Warm colours should be used in cabins and recreation areas where the lighting levels are below 500 lux. High colour temperature, whiter light, should be used in areas with high lighting levels.

5.6.0-14 In areas monitored by closed circuit television, the illuminance shall be sufficient to produce quality video pictures. I

5.6.0-15 The need for adjustable workstation lighting shall be evaluated and provided as needed for fixed workplaces. I

5.7 Indoor climate

5.7.0-1 The design shall ensure that each individual room achieves an adequate indoor climate with respect to air quality, air demand, draught and temperature. I

5.7.0-2 Permanently manned work areas shall be enclosed and shall meet the climate requirements for such areas. Specific air temperature requirements are stated in Annex A. For Norway, the design shall also be in accordance with the principles laid down in DLI 444, and the Norwegian Institute of Public Health, see "Anbefalte faglige normer for inneklima". I

5.7.0-3 The minimum/maximum temperature limits in Annex A are operative temperatures (i.e. the sum of air temperature and any radiant heat), and specify the acceptable temperature ranges during both summer (see maximum limit) and winter (see minimum limit) conditions. For cabins, offices, control rooms, driller's cabin, and the crane cabin, the HVAC systems shall also have heating/cooling capacity to achieve I

- heating to operative temperature $\geq$ 22 °C during winter conditions,
- cooling to operative temperature $\leq$ 20 °C during summer conditions.

5.7.0-4 Cabins should have individual temperature control. I

5.7.0-5 The HVAC system shall be designed to be clean and dry. I

5.7.0-6 Air inlets shall be located in the open air and in areas not contaminated by exhaust outlets.

5.7.0-7 There shall be easy access for internal inspection and cleaning of ducts.

5.7.0-8 Supply air ducts in the living quarters and in manned areas outside the living quarters shall, after mechanical completion, be cleaned to achieve dust coverage in accordance with Table 2. I

Table 2 - Cleaning classes for supply air ducts

Cleaning class	Norm %	Maximum %	Applies to:
A: High	3	5	Cabins, hospital/ward, sensitive instrument rooms.
B: Normal	5	7	Permanently and intermittently manned areas in LQ, offices and coffee bars outside LQ, laboratories, permanently manned control rooms and control cabins.
C: Low	7	10	Workshops

5.7.0-9 Air extract ducts shall be cleaned to cleaning class C.

5.7.0-10 When extract ducts are a part of a local re-circulating loop, the same cleaning class as for the supply air ducts shall be applied. I

5.7.0-11 Local extract ventilation shall be provided for areas with contaminated air, e.g. welding shop, paint store/workshop, chemical storage cabinets, laboratories etc. I

5.7.0-12 Materials containing synthetic mineral fibres that are used in the living quarters or in permanently manned areas shall be fully sealed.

5.7.0-13 Printers, copy machines etc. to be used by more than one person shall not be placed in permanently manned rooms unless mounted in special cabinets.

5.7.0-14 Areas where smoking is allowed shall be separated from non-smoking areas by physical partition or equally effective ventilation control. I

5.7.0-15 Low emitting materials and equipment shall be used in offices, control rooms, cabins and accommodation areas. I

5.7.0-16 Carpeted floors should be avoided. I

5.7.0-17 A central vacuuming system should be installed in the LQ. I

5.8 Outdoor operations

5.8.0-1 The percentage of time that the individual employee is exposed to a WCI above 1 000 W/m^2 shall be reduced insofar as reasonably practicable for workplaces where there is frequent work with a duration of 10 min or more. The unavailability shall be less than 2 % on a yearly basis. I

5.8.0-2 For evaluations of the acceptability of a WCI above 1 000 W/m^2, the following operational restrictions should be assumed to prevent harmful effects of wind chill on unprotected skin:

- WCI > 1 600 W/m^2: No outdoor work to be performed;
- 1 600 W/m^2 > WCI > 1 500 W/m^2: The available working time per hour and person increases from 0 % to 33 % linearly;
- 1 500 W/m^2 > WCI > 1 000 W/m^2: The available working time per hour and person increases from 33 % to 100 % linearly.

5.8.0-3 On installations that are planned for use in areas with arctic climate, outdoor operations shall be identified and reduced to a minimum.

5.8.0-4 If the requirements are in conflict with explosion or wind load limits, it is acceptable to compensate with adequate enclosure of other areas that are also part of the operator's working environment, e.g. utility areas. I

5.8.0-5 Frequently manned areas shall be sheltered without exceeding the allowable explosion risks. I

5.8.0-6 It should be possible to operate outdoor handles, switches etc. while wearing gloves. I

5.8.0-7 A heated shelter shall be located on the drill floor in a safe place with respect to dropped objects. I

5.8.0-8 Work areas with flaring heat impact shall be shielded to meet the permissible heat radiation levels to personnel in API RP 521. I

5.9 Electromagnetic fields

5.9.0-1 The location of high voltage equipment (> 690 V) adjacent to permanently manned work areas and accommodation areas should be avoided.

5.9.0-2 Worker exposure to electromagnetic fields shall conform to the limits stated. I

5.10 Radioactive sources - Ionising radiation

5.10.0-1 For protection against radiation from radioactive sources, reference is made to the national legislation.

5.10.0-2 As a general rule, all occupational exposure to ionising radiation shall be kept as low as reasonably I

achievable.

5.10.0-3 The use of radioactive sources on an installation shall be minimised.

5.10.0-4 A separate list of all radioactive sources on the installation shall be prepared. This list shall provide information on location, type of equipment and radioactive source, radiation levels, and required protection.

5.10.0-5 The radioactive sources shall be adequately marked at the location.

5.10.0-6 The design shall ensure that radioactive sources can be safely transported, handled, applied and stored.

5.10.0-7 Storage lockers for radioactive sources shall be made from non-combustible material, and be lockable. I

5.10.0-8 The sources shall not be stored together with explosives or combustible materials. I

Annex A
(normative)
Working environment area limits

Table A.1 - Working environment area limits

6.1.0-1

Room description	Level of manning [a]	Average illuminance level (lux) [i]	Temperature min/max °C	Vibration limit	Noise total dB(A)	Noise HVAC dB(A)
External walkways and access ways		100	Outdoor		80 [j]	
Stairs, walkways and access ways in enclosed work areas		150			60 - 80	
Lay down area		200			75 [k]	
Muster area	U	200	Outdoor	2	75	
Fire pump room	U	200	5 - 35	3	110 [m]	80
Emergency generator room	U	200	5 - 35	3	110 [m]	
Unmanned machinery room	U	200	5 - 35	3	110 [m]	80
General process and utility area	I	200	Outdoor/5 - 35	3	85/90 [c]	
HVAC room	U	200	5 - 35	3	90	
Switchboard and transformer room	I	200	5 - 35	2	85	70
Central control room	M	500 Adjustable	20 - 24	1	45 [f]	40
Local control room	I	400	19 - 26	2	60	50
Coffee bars outside LQ	M	150	19 - 26	2	60 [f]	50
Battery room	U	200	5 - 35	3	85	70
Main generator room	U	200	5 - 35	3	85/90 [c]	70
Inst/El. workshop	M	500	19 - 26	2	65 [b f]	50
Mechanical workshop/ welding	M	500	16 - 26	2	65 [b f]	50
Stores - Large parts		200	16 - 26	2	65 [f]	60
Stores - Small parts		300	16 - 26	2	65 [f]	60
Laboratory	I/M	500	19 - 26	2	60	50
Paint shop	I	500	16 - 26	2	65 [f]	55
Sandblasting room	I	300	16 - 26	2	65 [b f]	55
Workshop office	M	500	19 - 26	2	55	50
Crane cabin	M	400	19 - 26	2	65 [g]	60
Driller's cabin	M	400 Adjustable	19 - 26	2	65	60
Drill floor	M	350	Outdoor	3	85	
Local instrument room	U	400	5 - 35	2	75	60
Coffee bars in LQ, television room etc.	I	150	20 - 24	1	45	40
Dining room	M	300	20 - 24	1	55	50
Galley	M	500	20 - 24	1	60 [b]	55
Serving area	M	400	20 - 24	1	55	50
Laundry - machinery area	M	300	20 - 24	2	75	60
Laundry - work area	M	300	20 - 24	2	65	60
Dish washing	M	min. 300	20 - 24	1	70 [h]	55
Gymnasium	I	min. 300	20 - 24	1	55	*50*
Cabins	M	150	20 - 24 [d]	1	40 [f]	35
Corridor in LQs	U	100	19 - 26	1	60	50
Corridor in work areas	U	100	5 - 35	-	60 [j]	-
Hospital/ward	M	min. 500	20 - 24	1	40 [f]	35
Offices/meeting rooms	M	500 Adjustable	20 - 24	1	45 [f l]	40
Radio room	M	500	20 - 24	1	50	45
Toilets/changing room	I	min. 200	20 - 24	1/2 [e]	60	50
Monkey board	M	200	Outdoor	3	85	
Pipe rack area	I	200	Outdoor	3	85	
Mud/well logging	I	500	16 - 26	2	60	50
Shale shaker	I	300	5 - 35	3	85/90 [c]	
Mud room, mixing area	I	200	Outdoor	3	85/90 [c]	
Mud room, test station	I	300	Outdoor	3	85/90 [c]	
Mud lab	I	300	16 - 26	2	60	55
Operator's cabin in drilling unit	I/M	400	16 - 26	2	60	55
Blowout preventer and well head area	I	150	Outdoor	3	85/90 [c]	

Notes

6.2.0-1 [a] M = permanently manned, I = intermittently manned, U = normally unmanned

6.2.0-2 [b] The noise limit refers to background noise including ventilation system and external noise sources, but not manually controlled operations. For these operations, the maximum noise exposure for a 12 h working day applies.

6.2.0-3 [c] 85 dB(A) is preferred in order to ensure that the individual employee's maximum exposure to noise during a 12 h working day is 83 dB(A). Where the lower limit is unfeasible, a maximum area noise level limit of 90 dB(A) shall apply.

6.2.0-4 [d] The control system shall allow for free cooling in cabins to 16 °C. This shall not be a thermo dynamic design requirement.

6.2.0-5 [e] Category 2 applies outside LQ.

6.2.0-6 [f] For mobile offshore installations, the noise requirement during operations is 5 dB(A) higher than the one given in the table.

6.2.0-7 [g] For crane cabins, the requirement refers to the equivalent sound level to which the crane driver is exposed during a time period defined by a typical crane cyclus.

6.2.0-8 [h] For rooms dedicated to coarse pot and pan washers that are unattended when operating, a limit of 85 dB(A) can be applied. I

6.2.0-9 [i] Based on EN 12464-1 and prEN 12464-2. I

6.2.0-10 [j] Walkways. For in-module walkways/access ways (e.g. between skids), a limit equivalent to the adjacent area applies, provided acceptable PA system audibility is maintained. I

6.2.0-11 [k] Laydown area. In-module laydown area can allow noise limit of maximum 80 dB (A) provided that in-module laydown area is not the main laydown area. I

6.2.0-12 [l] Intermittently manned and normally unmanned offices in work areas can allow 55 dB (A). I

6.2.0-13 [m] The highest permissible noise limit [110 dB (A)] should only be allowed in connection with brief inspections or work tasks that are to be carried out in an area where there is no passage through to other areas. Provisions should be made for noise deflection of noisy equipment when maintenance or other work is carried out in the area. I

Annex B
(normative)
Vertical and horizontal clearances and distances

Table B.1 - Vertical and horizontal clearances and distances

7.1.0-1

Topic	Vertical	Horizontal	Comments
MINIMUM CLEARANCES IN ACCESS WAYS AND WORK AREAS			
Main walkways	2 100 mm (2300 mm is recommended)	1 000 mm	
Access ways (inclusive stairs)	2 100 mm (2 050 mm in door openings and above each step in a fixed stepladder)	600 mm	Minimum width 900 mm for access to permanently and intermittently manned workplaces, see ISO 14122-2, 4.2.2.
Hatch openings	800 mm x 800 mm		Minimum 600 mm x 600 mm applies for access to cofferdams and tanks from floor/platform. Manholes shall have a minimum inner diameter of 600 mm and hand holes a minimum of 200 mm, see ISO15534-1.
Transportation ways for trolleys/trucks	2 100 mm (2 300 mm is recommended)	Trolley width + 300 mm/Truck width + 900 mm	
Work areas	2 300 mm		Down to minimum 2 100 mm acceptable in parts of work areas
At work position for access to fixed equipment during operation/maintenance		700 mm space for worker	The operator's reach distance to equipment: ≤ 500 mm
Between pipe bottom and floor	150 mm		Does not apply to drain pipes
Between external diameter of flange and fixed obstruction	250 mm	250 mm	Applies to flanges with diameter above 100 mm on pipes DN 100 and above. Clearances can be less than 250 mm, provided there is access and space to operate maintenance tool without excessive ergonomic strain
Space between fixed cabinets and floor	Minimum 250 mm		Preferably fixed on floor without space

Topic	Vertical	Horizontal	Comments
ARRANGEMENT OF WORK AREAS			
Table top, seated work	660 mm to 800 mm. Thickness maximum 50 mm		Easily adjustable from work position in permanently and intermittently manned workplaces
Clearances for legs below work surface, seated work	Width minimum 610 mm. Depth minimum 500 mm to 650 mm at knee level/floor level		
Table top, standing work	800 mm to 1 050 mm		Easily adjustable from work position in permanently and intermittently manned workplaces
Workbenches	800 mm to 1 150 mm		Workbenches in galley can allow 800 mm to 1 050 mm VDU workplaces 800 mm to 1 200 mm
Table top, standing work VDU workplaces	800 mm to 1 200 mm for VDU workplaces		Easily adjustable from work position in permanently and intermittently manned workplaces
The centre height of control devices above floor level (including valve handles)	Maximum 1 800 mm		Does not apply to controls in infrequent use (< once per month). Ergonomic position to work above floor 500 mm to 1 700 mm, see ISO 14122-2, 4.2.1 900 mm to 1 500 mm for control devices in frequent use
Visual displays above floor level, standing work	1 100 mm to 2 000 mm		For displays in daily use and for displays where reading in an emergency is required. Location of critical displays to be based on task analysis, see 4.4.5.
Electrical contacts and switches above floor	900 mm to 1500 mm		

Sink, heights above floor	600 mm		

Topic	Vertical	Horizontal	Comments
FLOOR, DECK SURFACES, PLATFORMS			
Maximum unprotected openings		100 mm x 100 mm	Larger openings shall be covered or secured by guard rail or similar. Hatches with coaming height below 750 mm to be equipped with railing.
Maximum opening in grating		Ø 20 mm	Grating shall not allow a ball with greater diameter to fall through. Applies above places with presence of persons, otherwise Ø 35 mm.
Maximum unsecured height drop to lower level	500 mm		Also applies to stairs. Higher drops to be secured by guard-rails, railings or bulk walk, see ISO 14122-2, 4.2.3, and ISO 14122-3, 7.1.2
Maximum height difference in one step between floor/deck levels in access ways	350 mm		
FIXED MEANS OF ACCESS BETWEEN LEVELS			
Stairs, stepladders and guard rails			Design for these items shall comply with EN ISO 14122-3.
Fixed ladders			Design for these items shall comply with EN ISO 14122-4.
Inclinations			Design of inclinations shall comply with EN ISO 14122-1.

Annex C
(normative)
Detailed requirements related to installation areas

C.1 Living quarters

8.1.0-1 Reference is made to NORSOK C-001 for requirements to LQs.

C.2 Drilling unit

C.2.1 General

8.2.0-1 There shall be anti-skid flooring in work and transportation areas.

8.2.0-2 There shall be sufficient storage space near the work area for auxiliary equipment that is used temporarily.

8.2.0-3 The heavy equipment storeroom shall have a location that makes transportation/lifting onto/from the drill floor easy.

8.2.0-4 Arrangements shall be made to avoid unnecessary traffic on the drill floor.

8.2.0-5 There shall be suitable conditions for appropriate handling of heavy logging instruments.

8.2.0-6 The design of the derrick man's cabin shall meet the requirements to crane driver's cabin, see C3.

8.2.0-7 The adding and mixing of powder to drilling mud shall be enclosed to reduce the danger of chemical exposure.

8.2.0-8 Adding and mixing operations (drilling mud) that involve manual lifting/carrying should be avoided.

8.2.0-9 The chemical sack room and the mud mixing room should be situated on the same floor and in the immediate vicinity of each other.

8.2.0-10 It shall be possible to put pallets of sacks on the lifting table near a sack-cutting machine (if available), using a forklift truck or pallet lift.

8.2.0-11 A separate mud laboratory with office facilities shall be provided.

C.2.2 Driller's cabin/control room

8.2.1.0-1 Walls and roof on the driller's cabin/control room shall be designed to withstand accidental loads from dropped objects and uncontrolled movements of drilling equipment and loads. I

C.2.3 Operator's chair

8.2.1.1.0-1 In the driller's cabin, the operators' chairs shall be easy to move both backwards and forwards, e.g. placed on rails. I

8.2.1.1.0-2 In the driller's cabin, there shall be easy access for both entering and leaving the operators' chairs. I

8.2.1.1.0-3 The chair shall meet general requirements for control room chairs, providing good individual adjustment qualities and resting comfort. I

8.2.1.1.0-4 The armrest supports shall be easily adaptable to the operator and the control levers. I

8.2.1.1.0-5 Control levers attached to the chair shall follow the chair's movement. Other controls and communication equipment shall be placed within recommended working areas for hands and/or feet when chair is in normal operating position. I

C.2.4 Pipehandling equipment and winches

8.2.2.0-1 Local control units/panels for pipehandling equipment and/or winches (e.g. man-rider) shall be arranged according to ergonomic/man-machine design principles: I

8.2.2.0-2 • with an unrestricted view of the equipment's hazard zone, I
8.2.2.0-3 • with good communication with the driller's cabin, I
8.2.2.0-4 • shall be protected against dropped objects. I

C.2.5 Shale shakers

8.2.3.0-1 The shale shaker and any slurry unit shall be provided with an operator's cabin. I

8.2.3.0-2 The cabin shall be provided with overpressure ventilation. I

8.2.3.0-3 Shale shakers and other equipment with potential for oil mist/vapour emissions shall meet the OEL requirements, see 5.4.3. If efficient enclosure of emissions is not reasonably practicable, the equipment shall be equipped with efficient exhaust ventilation. I

8.2.3.0-4 The supply air shall be controlled and documented to be impulse free in order not to disturb the required flow and the working environment around the equipment. I

C.2.6 Mud system

8.2.4.0-1 Design of mud systems shall ensure that spillage of mud and cuttings in mud treatment areas is avoided. I

8.2.4.0-2 Manual carrying of sacks for mud additives and cement chemicals shall be avoided. I

8.2.4.0-3 Sampling of mud shall be possible without excessive exposure to oil mist and vapour, see OELs. I

8.2.4.0-4 It shall be possible to take mud samples from inside the mud lab or the shale shaker operator cabin (if provided with adequate extraction ventilation). I

C.3 Control cabins

8.3.0-1 Included in this definition are cabins for drillers, crane drivers, derrickmen and pipehandler operators. I

8.3.0-2 From a normal working position, the operator shall have an unrestricted view of the hazard zone of the equipment that he controls, and of all loading positions. I

8.3.0-3 Windows shall have an effective cleaning system, which ensures satisfactory visibility in all kinds of situations. I

8.3.0-4 It shall be possible to maintain the cleaning system as well as cleaning and replacement of windshield wipers in a simple and safe manner. I

8.3.0-5 The crane driver's cabin shall be designed so that the crane driver, when sitting in a normal position, has an unrestricted view of all loading positions.

8.3.0-6 The operator’s chair shall be placed on rails in order to ensure ease of movement both backwards and forwards. This might not be necessary in cabins placed on floor where it is not necessary to look down. I

8.3.0-7 There shall be easy access for both entering and leaving the chair.

8.3.0-8 The chair shall meet the general requirements for chairs, have good individual adjustment qualities and shall be designed to provide good resting comfort. I

8.3.0-9 The support provided by the armrests shall be suitably adapted to the operator and the control levers.

8.3.0-10 Control levers shall be attached to the crane driver's chair and shall follow the chair's movements. Other controls shall be placed within the recommended working areas for hands and feet. I

8.3.0-11 Conditions shall be suitable for easy and safe cleaning of windows, both externally and internally. I

8.3.0-12 It shall be possible to use telephones and other communication equipment in a loudspeaker mode.

8.3.0-13 There should be a chair or seat for the instructor for use during on the job training.

8.3.0-14 The cabin shall be provided with adjustable lighting or with direct instrument lighting and a reading lamp.

C.4 Workplaces with visual display units

C.4.1 Variation in work I

8.4.1.1.0-1 The workplace shall be designed in such a way that variation in movements and work positions is possible. I

8.4.1.1.0-2 The software used shall allow variation between use of a mouse or other position instrument and the keyboard. I

C.4.2 Desk I

8.4.1.2.0-1 Reference is made to the table top requirements in Annex B. I

8.4.1.2.0-2 Depth of the desk shall allow for a viewing distance up to 900 mm. I

8.4.1.2.0-3 Furniture arrangements shall be flexible, including the options to position the computer equipment according to worker needs and tasks (e.g. to suspend the central processing unit) and to lower the display screen relative to the table top. I

8.4.1.2.0-4 The table top shall allow for support of the underarm when using the computer mouse or positioning instrument and keyboard. Distance between edge of table top and keyboard is minimum 250 mm. I

8.4.1.2.0-5 It shall be possible to alternate between the right and left arm for using the mouse or positioning instrument. I

8.4.1.2.0-6 Room for a well positioned document holder as needed. I

8.4.1.2.0-7 Sufficient room for writing, using the telephone and other equipment as needed. I

8.4.1.2.0-8 Low reflective surface. I

8.4.1.2.0-9 Cable holders shall be included. I

C.4.3 Chair I

8.4.1.3.0-1 Height regulation minimum 400 mm to 510 mm (when the seat is in use) for normal sitting work. I

8.4.1.3.0-2 Adjustable depth of seat minimum 400 mm to 450 mm. I

8.4.1.3.0-3 Adjustable seat angle enabling moveable tilt with locking possibility. I

8.4.1.3.0-4 Adjustable back support (height and angle) independent of the seat. I

8.4.1.3.0-5 Adjustable arm rests, which can easily be removed. I

C.4.4 Computer equipment I

8.4.1.4.0-1 The computer equipment, including the electromagnetic fields, shall meet the requirements of the Swedish TCO standard. I

8.4.1.4.0-2 The keyboard shall be detached from the monitor, and a tilted position shall be possible. I

8.4.1.4.0-3	It shall be possible to tilt the monitor 15° backwards.	I
8.4.1.4.0-4	The screen's refresh frequency is minimum 85 Hz.	I
8.4.1.4.0-5	Screen luminance shall be between 100 cd/m^2 and 150 cd/m^2.	I
8.4.1.4.0-6	The monitor and keyboard shall have low reflective surfaces.	I

C.4.5 Lighting

I

8.4.1.5.0-1	General lighting minimum 300 lux.	I
8.4.1.5.0-2	Work space lighting 300 lux to 500 lux.	I
8.4.1.5.0-3	Lighting and daylight shall not cause disturbing reflections or other sources of dazzling.	I
8.4.1.5.0-4	Luminance distribution in the work area: The recommended ratio between the immediate work area, the close vicinity and the distant area is 5: 3: 1	I

C.4.6 Particular requirements

I

8.4.2.0-1	All multi-user workstations shall have desks that can be quickly adjusted as needed to meet individual requirements.	I
8.4.2.0-2	For workplaces where the employees are expected to work actively in front of a screen for more than 75 % of their working day, it shall be possible to alternate between a sitting and standing work position, i.e. with a desk, which can be adjusted in height from 660 mm to 1 200 mm. This also applies to multi-user workstations that individuals frequently use for more than 75 % of their working day. Needs in connection with this point shall be documented.	I
8.4.2.0-3	For workplaces with more than one display screen, the requirements shall be met for each individual display screen.	I

Annex D
(normative)
Vibration limit curves

10.1.0-1

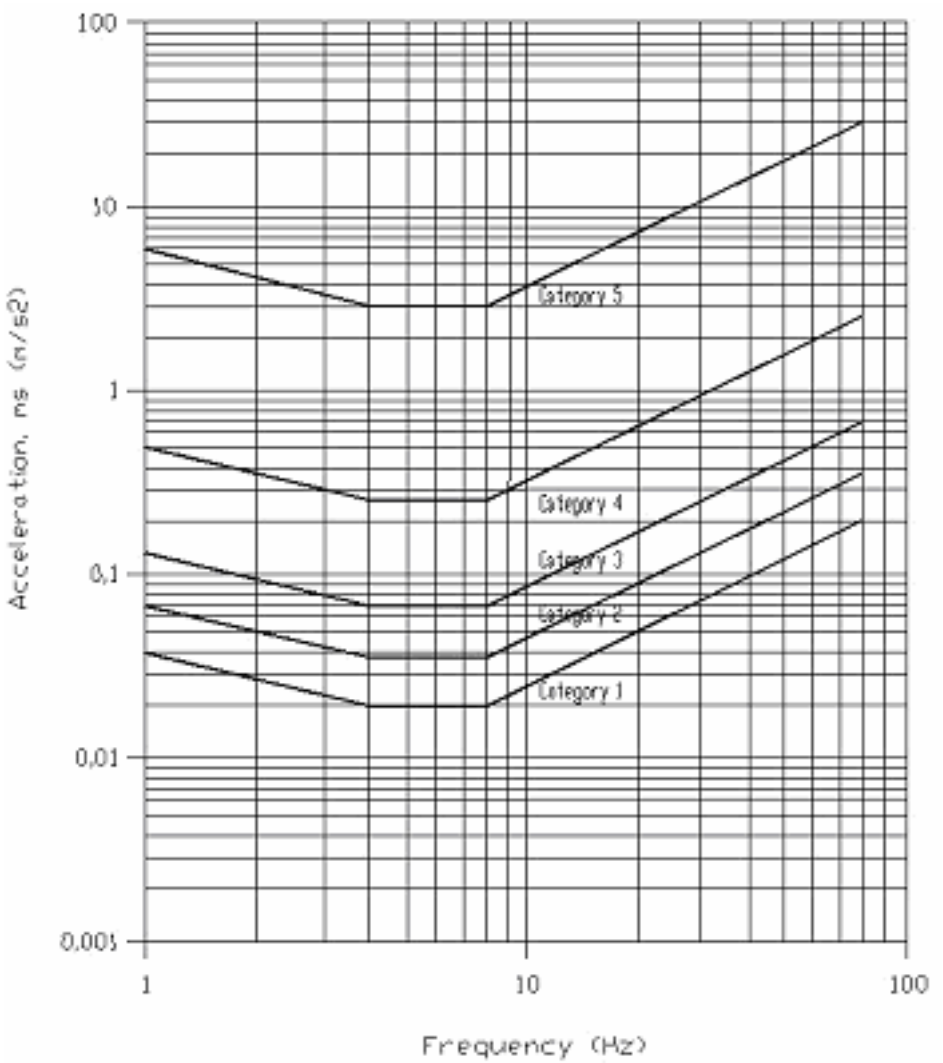


Figure D.1 – Vibration limit – Vertical axis

10.2.0-1

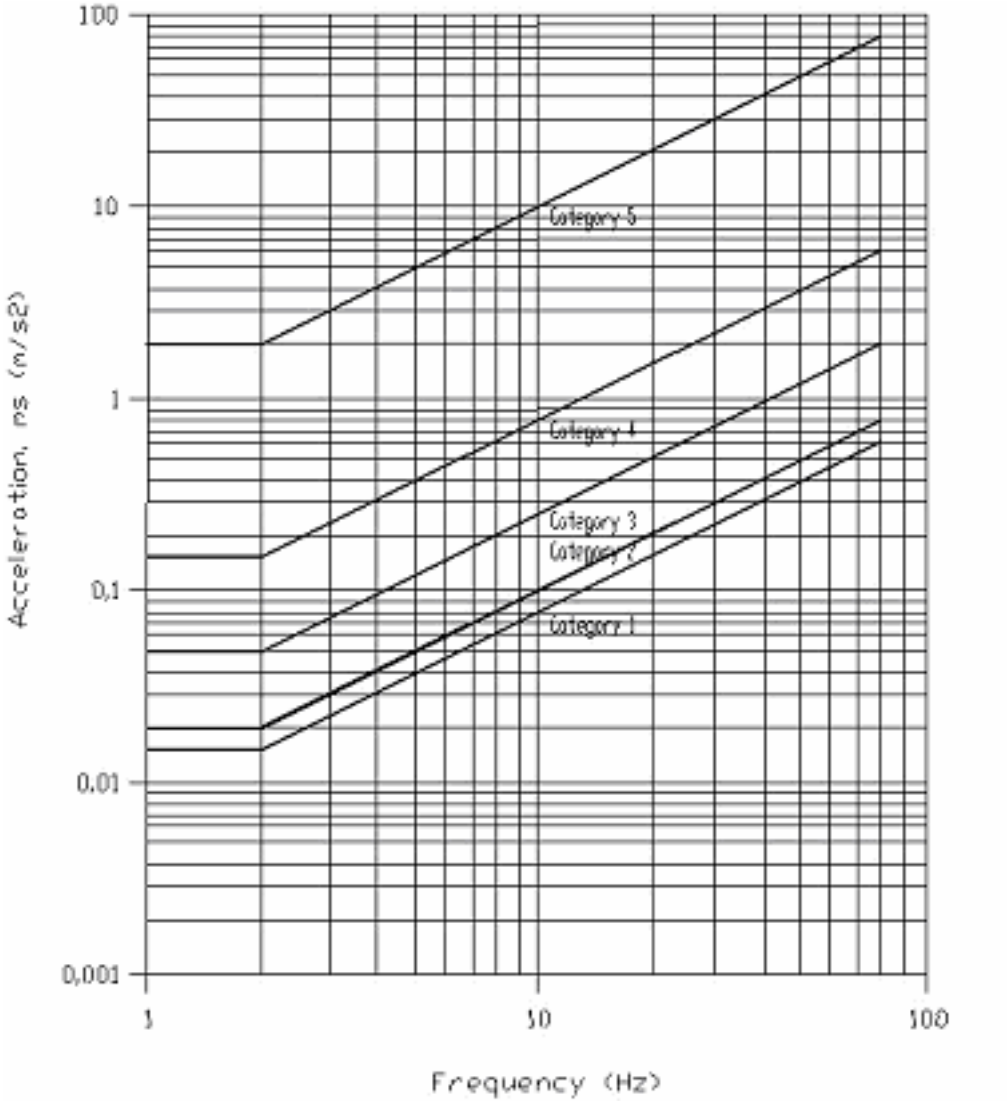


Figure D.2 – Vibration limit – Horizontal axis

Annex E
(normative)
Working environment area chart

11.0-1

WORKING ENVIRONMENT AREA CHART Doc. no. Rev. Date Page					
Installation:	Room/area name:		Module/level:	Area no.:	Manning:[a]
WORKING ENVIRONMENT AREA LIMITS					
Factor	Limit/level [b]	Preliminary prediction [c]	Predicted at issue for construction [c]	As built [d]	Status [e] /Notes [f]
Noise: Total HVAC					
Vibration					
Illumination [j]					
Temperature					
Air changes per hour					
Types of hazardous substances [g]:					
GENERAL					
Factor	Document id. no. [h]	Description of identified hazards/nonconformities/ comments		Decision	Status [e] /Notes [f]
Arrangements					
Ergonomics					
Human factors					
Technical appliances					
Chemical substances					
Permanent protective equipment					
Outdoor operations					
Radiation					
Notes [f]:					
PREPARED BY [i]:	CHECKED BY [i]:		APPROVED BY [i]:		

11.0-2

Notes:
[a] Level of manning, see Annex A: Permanently manned (M); Intermittently manned (I); Normally unmanned (U).
[b] To be established according to 4.3.
[c] Preliminary prediction and prediction at issue for construction shall be made for noise, see 4.4.7. The needs of two separate predictions shall be evaluated for other factors.
[d] Measured values during commissioning.
[e] Status: OK; Action required (AR); Nonconformity, action pending (NCP); Nonconformity, approved (NCA); Not identified (NI); Not applicable (NA).
[f] State references to underlying documentation, e.g. nonconformity reports.
[g] List all identified chemicals, that are planned for use and that may represent a health hazard, see 4.4.6.
[h] State document identification number for performed working environment analyses and design reviews.
[i] May be replaced by signatures on common front sheet.
[j] Emergency illumination in room/areas with personnel tasks during an emergency situation shall be analysed. For emergency illumination requirements, see NORSOK S-001 and NORSOK E-001.

Annex F
(informative)
Noise data sheet

13.0-1 SDS-050 Noise data sheet enclosed

13.0-2

NORSOK S-002	NOISE DATA SHEET	SDS-050 Rev. 3, Nov. 1997 Page 1 of 1

Package no.	Doc. no.	Rev.

Tag no. _____ Location/module _____
Unit _____ No. req'd _____
_____ _____
Service _____ Inquiry No. _____
Size & type _____ Quote No. _____
Supplier _____ P.o. No. _____
Manufacturer _____ Job No. _____
Model _____ Serial No. _____

EQUIPMENT DESIGN DATA

_____ Calculated Δ L=SWL - SPL _____ dB (Note 1)
_____ Efficiency _____ %
Equipment size (l x w x h) _____ m Driver type _____
Power _____ kW Driver speed _____ rpm
Capacity _____ Equipment speed _____ rpm
Pressure disch. _____ Gear tooth contact rate _____ Hz
Pressure suction _____ Blades/vanes pass frequency _____
Equipment weight _____ kg Number of stator/number of rotor blade ratio _____

COMPANY SPECIFIED DATA		Octave band centre frequency, Hz								
Noise Level Limits (Note 1)	dBA	31.5	63	125	250	500	1000	2000	4000	8000

Special requirement: _____

Noise test required: Yes O No O Optional O

SUPPLIER DATA		Octave band centre frequency, Hz								
Guaranteed Noise Levels (Note 1)	dBA	31.5	63	125	250	500	1000	2000	4000	8000

Narrow band component, Yes O No O Frequency/octave band: Hz _____
Method for Noise Level Test: _____

Description of implemented noise control measures / other information _____

AS BUILT NOISE DATA		Octave band centre frequency, Hz								
Measured noise levels (Note 1)	dBA	31.5	63	125	250	500	1000	2000	4000	8000

Special information _____

Note 1 SPL Sound pressure level in dB (re. 20 μ Pa) at 1 m distance free field conditions.
SWL Sound power level in dB (re. 1 pW).

Annex G
(informative)
Examples of methods for analysis of the working environment

14.0-1 The processes of implementing functional and specific WE requirements into design is outlined below in Figure G. 1 I

14.0-2 I

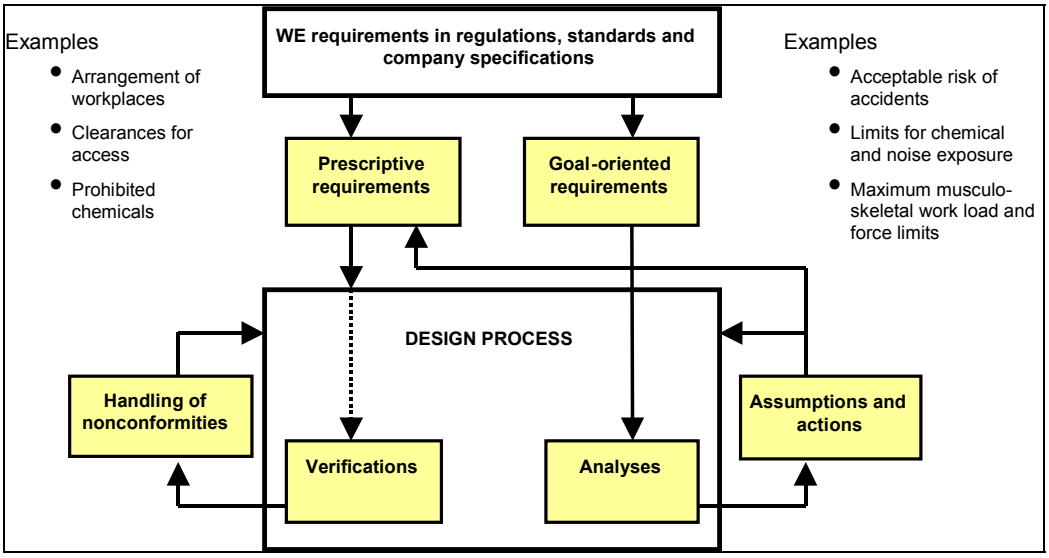


Figure G. 1 - Processes to implement prescriptive and goal-oriented WE requirements

14.0-3 Figure G. 2 shows a typical execution sequence of the WE analyses applicable on a large project (OLF standard project phase model). I

14.0-4 I

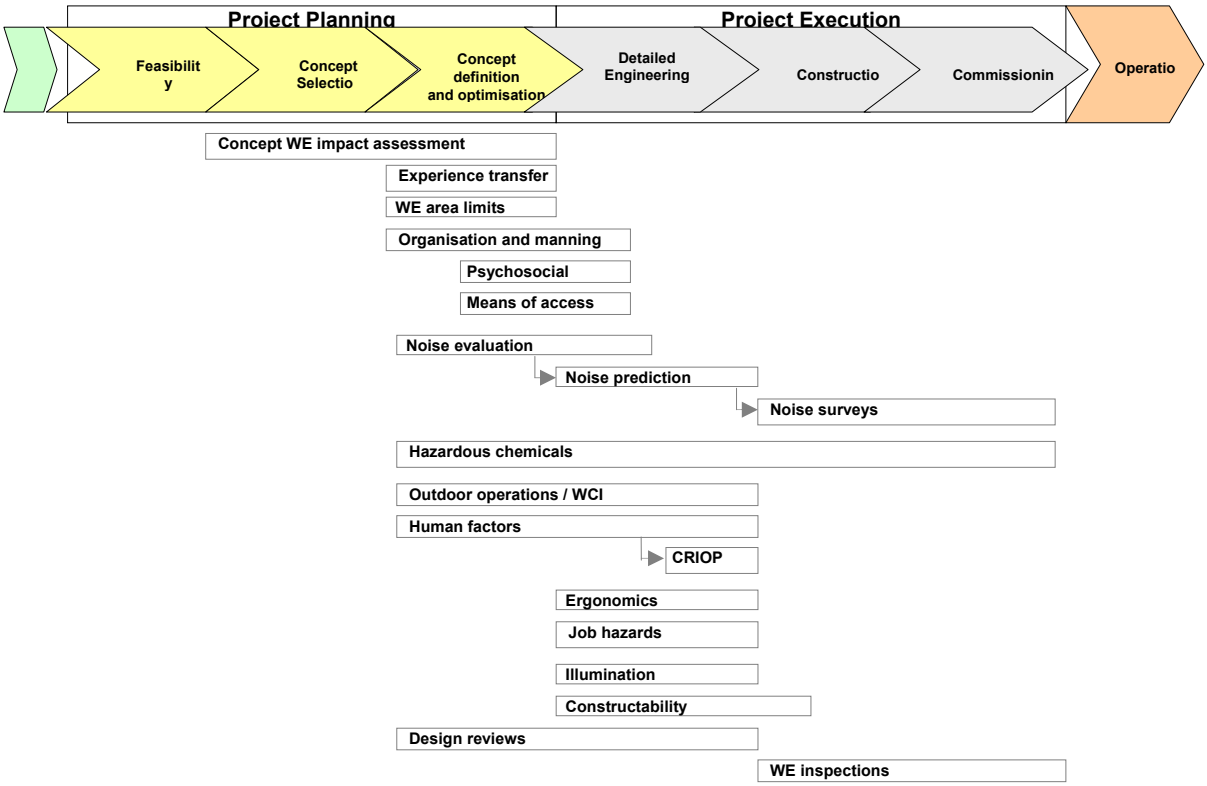


Figure G. 2 – Typical timing of WE activities relative to project phases

G.1 Working environment risk analyses

G.1.1 Job hazard analysis (JHA)

14.1.1.0-1 The aim of a JHA is to identify and evaluate the hazards to which employees are exposed when performing work activities. Coarse and detailed JHA differ in the level of detail by which the activities are broken down. A JHA is carried out in a JHA team consisting of project personnel and representatives of the user group. I

It follows a stepwise procedure:

1. Delimit the analysis to work activities within an area, in connection with a machine, etc.
2. Identify the activities of the area/machine. In detailed JHA, each activity is described, step-by-step.
3. Identify relevant hazards for each activity/sub-activity.
4. Estimate the expected frequency and consequences of accidents due to exposure to the identified hazards.
5. Evaluate need for remedial actions.
6. Checklists support steps 2, 3 and 4 of the analysis. The results are documented in a table, showing activity, hazards, causes, expected frequency and consequences, and actions.

G.1.2 Chemical health risk assessment

14.1.2.0-1 A recommended method for risk assessment, including risk estimation and evaluation, is outlined below. Any alternative method shall be documented to be of equivalent functionality and quality. I

1. Establish an inventory of all hazardous chemicals that are in use or are planned for use during operation or maintenance. For each chemical, determine and document the potential health effects of being exposed, i.e. the toxicity of the chemical and severity of the consequences. Reference is made to the safety data sheet and regulatory scheme for classification, labelling etc. of dangerous chemicals. Chemicals can be categorised based on inherent properties expressed

by risk phrases. Typical example of categorisation is given in Table G.1.

2. For each chemical classified as dangerous, list all associated activities where there is a potential for significant exposure through inhalation and/or skin contact. Include activities during handling/transportation, storage, use, maintenance, and waste disposal.

3. For each activity and chemical, estimate and categorise the degree of exposure through inhalation and/or skin contact. For long-term exposures through inhalation, the extent, frequency and duration of the exposure should be taken into consideration.

For estimation of exposure the following guidelines could be given:

A description of the technical solution will be sufficient when

- effective exposure barriers are established and all chemical exposure can be ruled out,
- unclassified chemicals are used under normal temperature and pressure, without aerosol formation,
- low hazardous chemicals are used, provided there is low risk of evaporation/dust formation, and aerosol formation can be ruled out.

When chemical exposure cannot be ruled out (estimated to be above 10 % of OEL/reference value) with the selected technical solution, numerical/semi-quantitative calculations shall be performed taking into consideration

- physical properties of the substances/chemical,
- volumes in use,
- typical work tasks,
- distance to the source,
- ventilation,
- effectiveness of barriers etc.

Measurements from similar situations can be used as part of the documentation.

If necessary, more advanced computer assisted models (e.g. dispersion or computational fluid dynamics models) or simulations shall be used, especially when evaluating exposure to very hazardous chemicals or complex problems, e.g. dispersion of exhaust.

For categorisation of exposure, the occupational exposure limits could be used as reference value. For skin exposures, the size of the affected area and the chemical's concentration are important factors. Typical example of exposure categories is given in Table G.2.

4. Estimate the risk to health and safety as high, medium or low, combining the health hazard category and the exposure category. A typical risk estimation matrix is shown in Table G.3. For any activities with potential for exposure to acute toxic/corrosive chemicals resulting in an accidental injury/illness, a JHA should also be used, see 4.4.3.

5. Evaluate the needs for, and the priorities of, risk-reducing measures to be implemented in design. In general, high risks are unacceptable, and medium risks should be reduced according to the ALARP principle.

14.1.2.0-2 **Table G.1 - Example of health hazard categories for chemicals**

Health hazard categories	Risk/safety phrases
Very serious	
Very toxic (T+)	
- Acute toxicity	R26, R27, R28
- Irreversible effects	R39
Toxic (T)	
- Carcinogens Cancer1 and Cancer2	R45, R49
- Mutagens Mut1 and Mut2	R46
- Toxic to reproduction/teratogen Rep1 and Rep2	R60, R61
Serious	
Toxic (T)	
- Acute toxicity	R23, R24, R25
- Chronic effects	R48
Corrosive (C)	R35
Harmful (Xn)	
- Cancer3	R40
- Mut3	R68
- Rep3	R62, R63
- Sensitising	R42, R43
Bioaccumulation	R33
Harmful to breast-fed babies	R64
Moderately serious	
Corrosive (C)	R34
Harmful (Xn)	
- Acute toxicity	R20, R21, R22, R65
Irritant (Xi)	R41
Less serious	
Irritant (Xi)	R36, R37, R38, R66, R67
Avoid inhalation	S22, S23
Avoid contact	S24, S25
Use personal protective equipment	S36, S37, S38, S39
Ventilation required	S51, S52
Insignificant	
Unclassified	

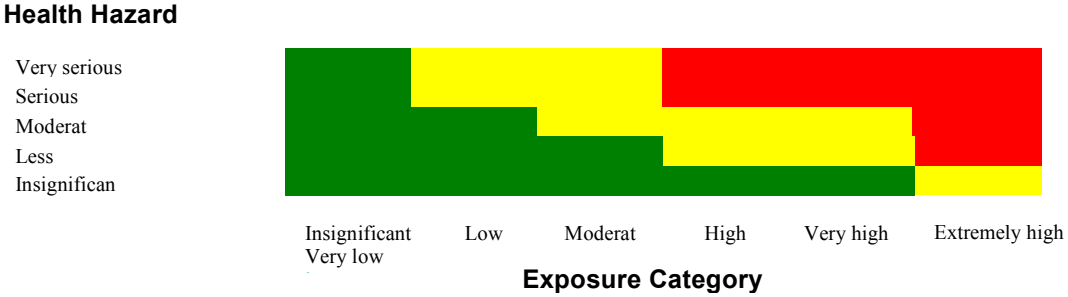
14.1.2.0-3

Table G.2 - Example of exposure categories

Exposure categories	
Qualitative	**Quantitative**
Extremely high	>> Reference value
Very high	≥ Reference value
High	50 % to 100 % of reference value
Moderate	10 % to 50 % of reference value
Low	< 10 % of reference value
Insignificant/very low	~ Background

14.1.2.0-4

Table G.3 - Typical risk estimation matrix for long-term/ average exposures



G.1.3 Comparison risk analysis

14.1.3.0-1 Comparison risk analysis results in an assessment of the expected increase/decrease in the accident frequency rate of the new installation, as compared to the historical accident frequency rate of existing "reference" installations. It involves the establishment of a database of accidents from the reference installations. This is manipulated in order to establish a simulated database of expected accidents on the new installation. The analysis is performed in the following four steps:

1. Selection of reference platforms and establishment of reference database.
2. Analysis of the accidents in the database by activity and hazard for each area of the installations.
3. Assessments of changes in exposure to hazards and probability of accidents for the new installation in relation to the reference installations, considering design, manning and operations programme of the new and the reference installations. This part of the analysis is documented in a table for each area of the platform. It shows the historical accident frequencies for the reference installations, the expected accident frequencies for the new installation, and the detailed assessments that have been made.
4. Calculation of accident frequency rates for different areas and occupations on the new installation and for the installation as a whole.

Reference: Kjellén, U.: Prevention of Accidents Through Experience Feedback. Taylor & Francis, London and New York, 2000.

G.2 Psychosocial analysis

14.2.0-1 DRA is a systematic method for evaluating the various psychosocial working environment aspects of a position on the installation. It focuses on the interactions between the employee in this position and the environment concerning: I

1. Psychological job demands, i.e. the non-physical demands imposed upon an employee from work
2. Social interaction/support at work, i.e. the help and the support an employee receives from people in his/her work environment.
3. Control at work, i.e. the amount of influence an employee has over the work tasks and the work situation.
4. Skill discretion, i.e. the amount of skill variety and the opportunity to learn new things on the job.
5. Information, i.e. the information an employee receives from others regarding work responsibilities and their fulfilment, as well as the prediction of workloads and events.
6. Preconditions for restitution, i.e. the recuperation of mental and physical energy that an individual needs by means of rest and leisure activity between work shifts.

The DRA is performed by a panel of operators and managers representing this position on an existing installation, project personnel, and working environment experts. They scrutinise design and planned organisation and manning by examining the interactions between the employees in the position and the environment. A profile showing the extent of positive and negative stresses for each area along with comments is compiled.
The DRA can also be expanded to include physical WE factors in order to make an overall evaluation of the working environment.

G.3 Ergonomic analyses

G.3.1 Task analysis

14.3.1.0-1 In a task analysis, functions allocated to operators are broken down into units of work, which are described and systemised to ensure necessary resources to support successful work performance. Both the requirements to the employees' capabilities (skills, knowledge, etc.) and to the working environment (controls, displays, procedures, etc.) are considered. I
There are many variations of task analysis. A simple method adapted for industrial use lists the sequence of tasks by purpose, action, needed information input, and problems related to controls, displays and working posture. Results are used in order to identify the requirements for a good design as input to the redesign of the workplace.

See EN 614-1 and EN 614-2.

Salvendy, G. (Ed.): Handbook of Human Factors. Whiley, 1986.

Kirwan, B., Ainsworth, L.K.: A guide to task analysis. Taylor and Francis, 1992.

G.3.2 Crisis intervention and operability analysis (CRIOP)

14.3.2.0-1 The objective of a CRIOP analysis is to evaluate the design, manning and procedures of a control centre in relation to its expected ability to handle disturbances that, if not properly handled, may cause major accidents. A CRIOP analysis consists of the following two parts: I

1. Review of the static characteristics of the control centre through use of a checklist.
2. Scenario analysis, including task analysis.

The static review includes arrangements, man-machine interfaces, physical working environment, control and safety systems, work organisation, procedures, and training programme. Part 2 can be used at different stages of design to validate chosen solution.

In the scenario analysis, step-diagrams of potential accident scenarios are established. A step-diagram shows the different "players" (humans, objects) along the y-axis. Time is shown on the x-axis. Actions are displayed in the diagram by player and point in time. In the next step, critical actions are identified where human errors may have severe consequences. For each critical action, design, manning and procedures are evaluated by considering the operators' possibilities to detect and diagnose hazards and to take proper action.

Reference: Stig Ole Johnsen et al: CRIOP - A scenario method for Crisis Intervention and Operability Analysis (Draft) SINTEF Report STF38 - ISBN 82-14-02723-3, Trondheim 27.01.2004.

G.3.3 Valves and instrument access and operability review

14.3.3.0-1 The aim of a valves and instrument access and operability review is to verify that the operators' access during their daily inspection rounds is safe and efficient. The review is carried out in a team consisting of project personnel and representatives of the user group.

It follows a stepwise procedure:

1. Identify the route through the process and utility areas that the operator takes during the daily inspection tour.
2. Identify on a process and instrumentation diagram the valves, instruments, etc. that are accessed during this tour.
3. Review the walkway and the access to the identified tag numbers in relation to the requirements to safe and easy access. This may be done on the basis of arrangement drawing or three-dimensional computer assisted design.

Annex H
(normative)
Procedure for noise control

H.1 Scope

15.1.0-1 This NORSOK standard describes the procedure for noise control of offshore installations and equipment. It describes the activities and studies, reports and documentation that shall be covered during design and fabrication of an installation in order to ensure that the requirements given in this NORSOK standard are implemented in the execution of the evaluations, analyses and final design.

The procedure defines the contractor's responsibility for acoustics, noise and vibration control and its documentation during the concept, engineering, fabrication, commissioning and early production phases. The same responsibilities apply to the contractor's subcontractors.

H.2 Aim

15.2.0-1 The aim of this NORSOK standard is to establish a satisfactory noise-control engineering working practice in order to limit the noise level and attain satisfactory sound insulation and acoustic conditions throughout all parts of the designed installation, e.g. accommodation, utility, drilling and production areas.
A good acoustic environment and controlled noise levels:

- reduce the risk of permanent hearing damage to an acceptable level and prevent accident risks and other health hazards,
- ensure that warning signals and emergency messages are clearly audible,
- allow adequate speech, telephone and radio communication, and audible oral perception,
- make possible a reasonable level of conversational privacy,
- maintain working efficiency and proficiency of personnel performing designated tasks,
- provide an acceptable sleeping and recreational environment in accommodation area (LQs).

The work philosophy shall be to obtain a satisfactory working environment with regard to acoustics, noise and vibration at the lowest possible cost without reducing quality and accessibility or increasing the maintenance and production costs. This shall be attained through:

- involvement of noise control engineers and co-operation with process, electrical, instrument, piping, layout and mechanical (drilling) disciplines throughout the project,
- involvement of experienced personnel from existing installations,
- acceptance of noise control as an integral part of the design (also on process optimisation) from the first stage of the project.

15.2.0-2 For workplaces containing machinery, reference is made to the recommended practice for the design of low-noise workplaces in ISO 11690 (all parts). I

H.3 Requirements

15.3.0-1 NORSOK S-002

15.3.0-2 In Norway, the following acts and regulations apply: I

- Act relating to Worker Protection and Working Environment;
- Petroleum Safety Authority (for further information see www.ptil.no)

15.3.0-3 Other references:
Concawe Report 87/59.

H.4 Organisation and responsibilities

15.4.0-1 The engineering team should be equipped with at least one experienced noise control engineer,who works with noise control as his main activity. The noise control engineer is responsible for noise control activities as defined by the noise control flow chart, see Figure H.1. This includes establishment of specific noise control requirements, noise evaluations and calculations, and documentation of results.

Table H.1 gives a summary of the different noise control related activities that the various disciplines in an engineering team are responsible for. This should be used as a checklist for ensuring that the necessary activities are included in the scope of work during the different phases of the design.

Table H.1 - Responsibilities and activities within an engineering project team

15.4.1.0-1

	Ensure that requisitions for all noise emitting equipment include necessary requirements for noise and vibration control.
Instrument	Ensure that requisition for control valves includes noise limit and a requirement for calculating noise levels from the valves. Ensure that requisition for orifice plates includes a requirement for calculation of generated noise.
Mechanical	Ensure that requisitions for all noise emitting equipment include necessary requirements for noise and vibration control. Evaluate requirements for noise control treatment. Ensure noise testing requirements are implemented in the package specification.
Piping/ Layout	Ensure layout has considered location of noisy sources with relation to noise-sensitive areas, both on a horizontal level and vertically. Ensure layout has considered implementation of corridors/buffer zones between noisy and noise-sensitive areas. Ensure that there is enough space for implementation of noise control measures (where required) around equipment.
Process	Ensure that noise control aspects are considered during line sizing and process design. Include requirements for acoustic insulation of piping on the process and instrumentation diagrams.
Safety	Ensure that requisitions for any noise emitting equipment include necessary acoustic requirements. Ensure that working environment area charts include requirements to total area noise levels and HVAC noise levels.
Structural	Ensure that structural design of supports and deck areas under main rotating items and similar equipment takes into account required stiffness to avoid vibration problems
Telecom.	Evaluate the conditions and intelligibility of the PA system.

H.5 Work procedure and instructions

H.5.1 General

15.5.0-1 This subclause provides a step-by-step procedure for the execution, management and documentation of acoustics, noise and vibration control during the different phases of a project. Project phase designations are indicative. The steps shall not necessarily be taken in the described order. For modification projects, the procedure stated herein may be simplified depending on the type of project. The applicable parts shall be considered.

The principal activities of the procedure are also shown on the FLOW CHART, see Figure H.1.

15.5.0-2 For guidelines on noise control, the following standards should be consulted: I

- ISO 11688 (all parts),
- ISO 14163,
- ISO 15667.

15.5.1.0-1

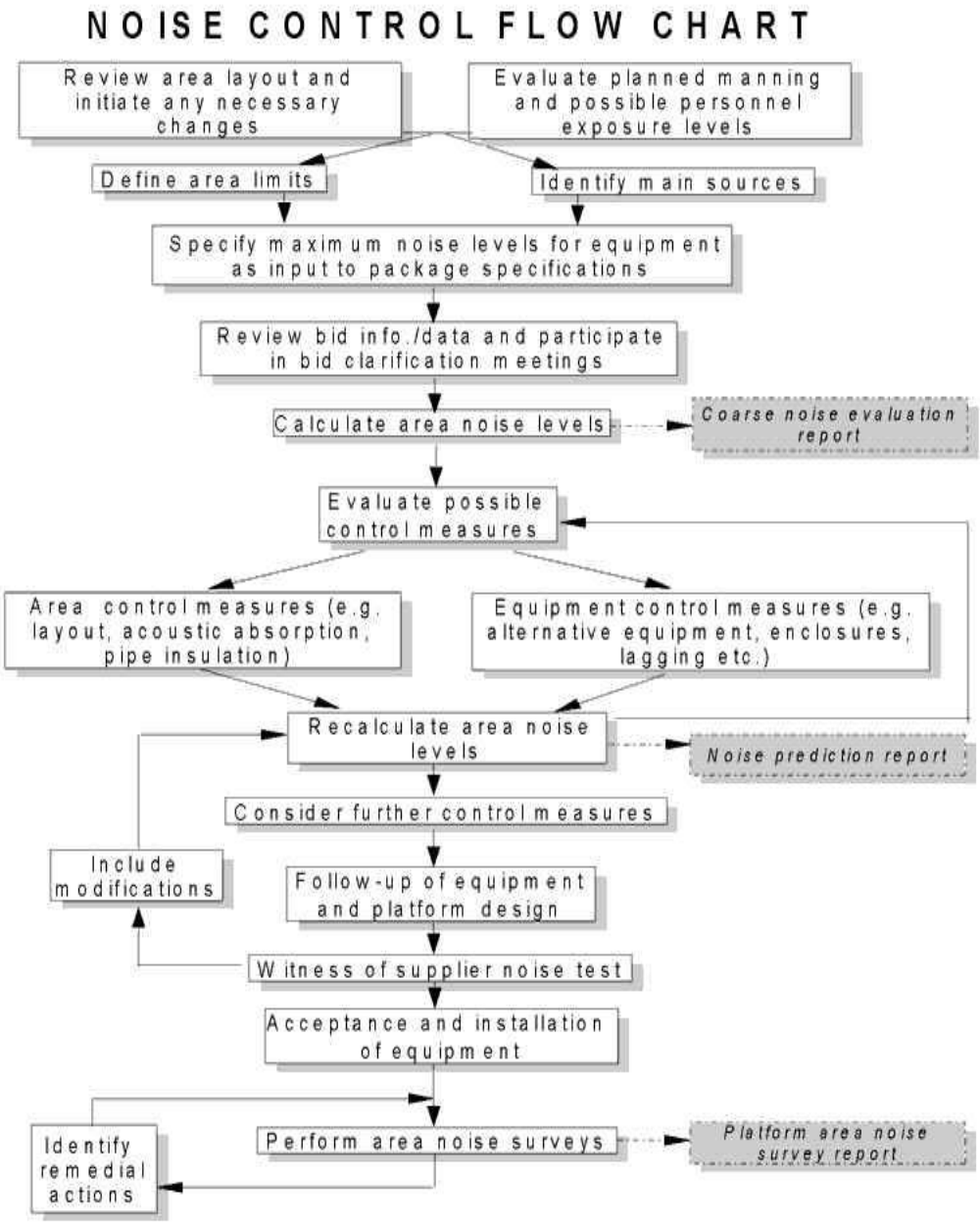


Figure H.1 - Noise control flow chart

H.5.2 Concept evaluations

Step 1

15.5.2.1.0-1 During concept selection and optimisation, the following principal noise and vibration control subjects shall be evaluated:

- the location of major noise and vibration emitting equipment and areas with noise generating activities with regard to quiet areas such as living quarters, offices, laboratories and control rooms,
- the use of low-noise equipment,
- acoustic modifications at source,
- identification of any items of equipment which should be isolated due to high noise levels and proximity to other items which will require regular maintenance,
- layout and arrangement changes, local or general (use of buffer zones),
- acoustic insulation and vibration isolation,
- valve and pipe noise control philosophy.

Decisions taken at this stage may have a major influence on the total cost of the installation as well as acoustics, noise and vibration control measures.

The acoustical evaluation shall therefore be an integral part of all relevant evaluations by all disciplines. The analyses of noise emissions and energy consumption should be co-ordinated.

15.5.2.1.0-2 The main items of mechanical equipment which shall be evaluated as early as possible include, as a minimum:

- gas compressors (motor and turbine driven),
- main generators (turbine driven),
- diesel engines (for emergency generators, firewater pumps, pedestal cranes, etc.),
- large pump sets (e.g. oil export, water injection, methanol injection),
- air compressors,
- drilling equipment (e.g. shale shakers, mud pumps, drawworks, top drive).

15.5.2.1.0-3 At an early stage in the project, factors concerning the noise exposure such as alternative layouts, remote control of units, maintenance requirements etc shall be evaluated. Even if it is too early to perform noise exposure calculations, solutions that will reduce the working time in noisy areas should be given priority.

H.5.3 Engineering evaluations

Step 2

15.5.3.1.0-1 Define preliminary noise level limits for each area/room on the installation, based on NORSOK S-002, Appendix A.
Identify noise sources and evaluate principal acoustic and noise control solutions.

Ensure input from operations concerning plan for manning levels on the platform, exposure periods for different categories of personnel on the installation, and the areas in which they may spend time. Based on this evaluation and using the first specification of area noise levels, derive preliminary predictions of personnel noise exposure levels and revise the area limits, or relocate equipment if necessary.

Noise and vibration sources that may contribute to the overall area noise level shall be identified and their characteristics predicted. Principal acoustics, noise and vibration control solutions shall be evaluated. Co-operation by all relevant disciplines is required, including layout, architectural, mechanical (drilling), electrical, instrument, piping, structure, HVAC, and safety.

Reports/Documentation: Specific area noise level limits for total and HVAC noise.

NOTE May also be input to working environment area limits (WEALs) report.

15.5.3.1.0-2 Personnel working categories shall be defined, and an estimate of working times in various areas should be established. The first calculation of noise exposure shall be performed using the preliminary area noise limits. If the calculation result, including an uncertainty factor of e.g. +5 dB(A) exceeds the 83 dB(A) limit, relevant actions shall be suggested.

NOTE The uncertainty factor accounts for the uncertainty in the early calculations and the experienced difference between predicted noise exposure and measured noise exposure.

Step 3

15.5.3.2.0-1 Calculate maximum noise level limits for equipment and machinery.
State requirements for sound absorption treatment, sound insulation solutions, and vibration isolation. (Normal and "extreme" conditions should be evaluated where possible).
Possible relocation of equipment should be evaluated if necessary.

The following procedure should be adopted when specifying maximum permissible noise emission from equipment:

- establish area noise level limits (see Step 2),

- calculate the acoustic properties of enclosed spaces,
- determine the total "permissible" sound power emission into the area (from step 1 and step 2),
- distribute the permissible sound power emission between the items in the area, including pipe and structure-borne noise, on the basis of their size, duty, operation cycle, typical (empirical) noise emission and the available noise control hardware,
- make allowance for additive effects of direct sound from adjacent sources,

NOTE A noise prediction model should be established.

- decide on the adequate form of specification (whether limits for sound pressure level, sound power level or both shall be stated).

Reports/Documentation: Coarse noise evaluation report

15.5.3.2.0-2 The noise exposure calculation shall be updated using the established area noise level limits. I
The calculated level + 5 dB(A) shall meet the 83 dB(A) exposure limit.
If problems occur in meeting the noise exposure limits, the area noise level limits may have to be reconsidered.
Administrative actions shall also be included as a remedy to noise exposure reduction.

Step 4

15.5.3.3.0-1 All inquiries for proposals for noisy or potentially noisy equipment shall be accompanied by:

a) a special technical specification which covers the requirements to vendor information and tests,
b) a noise data sheet on which the maximum noise level limits acceptable to the company shall be specified (several disciplines involved).

The special technical specification is normally a part of a master package specification, whereas the noise data sheet is usually included in the package specification/inquiry documentation.

Due to the uncertainties present in all noise measurements and calculation procedures, it is practical to design to noise levels 3 dB below the relevant area limits. This approach will also compensate for problems with increased noise in time. Such a safety margin, however, shall always be considered with respect to cost and technical basis.

The noise and vibration data, and noise and vibration control measures stated in the coarse noise evaluation report, shall form the basis for decisions and for a closer investigation in areas where noise level limits may be exceeded.

The requirements to sound insulation, sound absorption, and vibration isolation shall be specified and implemented in the design, both for equipment and structures.

Reports/Documentation: Noise data sheets

15.5.3.3.0-2 In establishing the equipment noise data sheet, extra attention shall be paid to the noise level at the operator's position or to inspection and maintenance points inside or on the surface of the equipment.

Step 5

15.5.3.4.0-1 Review bid information and noise data and ensure that the noise control engineer participates in bid clarification meetings for potentially noisy equipment.

A duly completed noise data sheet shall be returned from each of the prospective vendors for noise emitting equipment.
Vibration data shall be requested when adequate and required.
All bids shall be duly reviewed and incomplete data sheets returned to the vendor for completion.

All bids shall be reviewed with respect to:

- measured/estimated and guaranteed noise levels,
- noise and vibration control design,

- noise and vibration control cost increment.

If company requirements cannot be met by the vendor's standard acoustic design, the vendor shall present special design alternatives together with extra cost estimate.
Based on vendor information, possible revised noise limits for single and package equipment shall be entered in the noise data sheet for procurement.

All noise data shall be guaranteed in the contract. Preferably, documentation of the feasibility of the guaranteed values shall be provided.

Step 6

15.5.3.5.0-1 Further analysis and implementation of the requirements to sound insulation, sound absorption, and vibration isolation to be performed.
Based on experience and valve/pump/compressor noise estimations, requirements for piping acoustic insulation shall be implemented. The extent of the insulation will be revised as final supplier-data for equipment and valves becomes available, and as the process design develops.

A dedicated procedure for the calculation and evaluation of noise from piping systems is given below, where the steps do not need to be taken in sequential order:

1. Evaluate the process system and identify the noise sources, such as valves, pumps and compressors.
2. Collect adequate process data such as fluid type(s), pressure(s) and flow conditions.
3. Identify pump and compressor power, and rotational and vane tip speed(s).
4. Using supplier's estimate of valve noise levels and pump and compressor noise levels, evaluate level both to surroundings and in pipe.
5. Estimate maximum flow velocities in pipes and corresponding noise levels.
6. Contact supplier for proposals for low-noise valves and flow restriction orifices where found necessary.
7. Prepare requirements to valve trim (treatment), silencers, vibration isolation and acoustic insulation of pipes and equipment and/or maximum flow velocities.
8. Prepare and discuss alternative noise control measures with relevant persons in the project process, piping and mechanical disciplines.
9. Try to "distribute" pressure drops in the system and/or avoid unnecessary pressure build up by using variable pump and compressor speed.
10. Update estimations as necessary when adequate noise data are available.
11. If possible, prepare a "follow-up" measuring programme in order to collect "feedback" on noise and vibration in piping systems.

It is recommended to use Concawe Report 87/59 "The prediction of noise radiated from pipe systems - An engineering procedure for plant design" as a basis for the estimations of pipe noise.

15.5.3.5.0-2 For floating production storage and offloading vessels, and mobile offshore drilling units, an evaluation of pipe supporting and pipe penetration of bulkheads shall be carried out in order to identify any potential source of structure-borne noise. Hydraulic systems shall especially be addressed. I

15.5.3.5.0-3 The noise exposure calculation shall be updated using the best estimates of the area noise levels at this stage. This level shall be called the "installation noise exposure", and the result including an uncertainty of + 3 dB(A) shall meet the noise exposure limit of 83 dB(A).
For personnel categories known to have frequent use of hand held tools and/or perform other noisy operations, separate evaluations should be made. The evaluation in Step 6 concerning sound absorption, sound insulation etc. should also reflect the effect of such on the noise exposure.

Step 7

15.5.3.6.0-1 In specified areas where whole body vibration limits may be exceeded, a review of the structural discipline's evaluation of the structural vibration levels with respect to human exposure should be made.

Step 8

15.5.3.7.0-1 In cases where the main engineering contractor has the overall responsibility for noise control design of the installation, the need for carrying out full quality audits of subcontractors should be evaluated, e.g. contractors for living quarters, process ship hulls, other modules, etc. This may be required in order to verify conformity of requirements and interface items in the design.

Step 9

15.5.3.8.0-1 Based on guaranteed noise and vibration data for purchased equipment, layout, acoustic absorption treatment, sound insulation and vibration isolation, the acoustic and noise control status shall be documented in a noise prediction report. I
The predictions of personnel noise exposure shall be updated and included in the report. Predicted values for valve, pipe and ventilation noise shall also be included.
The predicted area noise levels should also be stated in the working environment area charts.

Reports/Documentation: Noise prediction report

15.5.3.8.0-2 The "installation noise exposure" shall be calculated and presented for all relevant personnel categories. I
If the calculated level + 3 dB exceeds the limit of 83 dB(A), actions to prevent hearing fatigue shall be discussed.

NOTE The final implementation in this case may be awaited pending the completion of the final noise exposure survey.

If the calculated level exceeds the limit of 83 dB(A), noise-reducing actions shall be included to reduce the noise exposure sufficiently.

H.5.4 Fabrication

Step 10

15.5.4.1.0-1 All noisy equipment shall be tested during the fabrication acceptance test.
All test results shall be documented.
The test should preferably be witnessed by the project noise control engineer, or alternatively, another member of the project team who is capable of evaluating the test results and determining the need for implementation of remedial actions while at the test site (in accordance with step 11).

Step 11

15.5.4.2.0-1 Test results shall be reviewed against noise data sheet performance values. Excessive noise and vibration shall be documented, and the vendor shall start remedial work to meet required levels. The company shall approve such remedial designs before being incorporated.

Improved equipment shall be subject to a re-test. If a factory re-test cannot be arranged, provisions shall be made for a test on site, preferably in connection with the commissioning testing. A re-test may be unnecessary if recommended remedial actions can be documented adequately in order to be able to guarantee the noise level that the equipment will emit when finally in operation on the installation.

Step 12

15.5.4.3.0-1 The contractor shall follow up delivery of materials, elements, equipment and machinery, and its installation on site with particular focus on acoustics, noise and vibration control. This is a part of the mechanical completion on acoustics, noise and vibration.

H.5.5 Commissioning

Step 13

15.5.5.1.0-1 Full noise level mapping of all areas shall be performed.
Where feasible, this shall be carried out during the commissioning phase. For other areas, this shall be done after start-up when all relevant noise sources are in operation.

A preliminary noise test is recommended during commissioning of equipment that represents noise

sources that may lead to exceeding the area limits.

The measurements shall be performed with equipment in normal operation.

15.5.5.1.0-2 A measuring programme shall be included in the commissioning procedure. Whole body vibration levels, sound insulation, and sound absorption shall be measured as applicable. Noise from the ventilation system should be measured prior to start-up of the other major noise sources on the installation.

The measurement results from all the different types of measurements shall be documented in the platform area noise survey report.

Reports/Documentation: Platform area noise survey report

15.5.5.1.0-3 Noise exposure measurements shall be performed using adequate measuring methods, for example the Nordtest methods:

Proposal 1566-01-1: NT ACOU 114
Proposal 1566-01-2: NT ACOU 115

H.6 Process and system calculations

15.6.0-1 A good and cost-effective design of an installation requires:

1. Inclusion of noise control requirements in all relevant package specifications.
2. Review of pipe sizing specifications and process specifications for coverage of noise control (this shall already be included as part of the NORSOK line sizing requirements).
   Calculation of noise from pipes at different fluid velocities.
3. Evaluation of equipment or item noise-reduction costs versus resultant noise levels in all areas, in order to optimise the technical/economical solutions.
4. Estimation of uncertainties in calculations - both due to calculation procedures/formulae and possible "off spec" operating conditions. Estimation of "overall" or resultant uncertainty.
5. Evaluation of the relation between costs and uncertainties of specific noise control measures (high uncertainty in a high-cost measure to be evaluated against low uncertainties in low-cost measures etc. - recommendations to be specified).
6. Adequate specification of retrofit noise control measures - related to uncertainties and costs of inclusion of these or other measures in primary design and fabrication.

H.7 Exchange of information

15.7.0-1 In order to obtain a satisfactory level of co-operation between the engineering contractor and the company, exchange of information is extremely important.

15.7.0-2 The following company data should be made available for the engineering contractor:

- experience data from earlier projects or present installations;
- preliminary manning plan for the installation;
- distribution of working hours by area for the different personnel positions in the platform's organisation;
- noise control requirements as stated in frame agreement contracts.

15.7.0-3 The information from the engineering contractor should cover the following material and documentation (reports):

- all studies and analyses which are documented in reports;
- noise data sheets for all types of equipment;
- special noise control measures for equipment and machinery.