

Working environment

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

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



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Foreword	2
Introduction	2
1 Scope	3
2 Normative and informative references	3
2.1 Normative references	3
2.2 Informative references	4
3 Terms, definitions and abbreviations	5
3.1 Terms and definitions	5
3.2 Abbreviations	6
4 Systematic management of working environment in design and fabrication	7
4.1 General	7
4.2 Management system	7
4.3 Working environment (WE) design basis	8
4.4 Working environment analyses	10
4.5 Verification and validation of design	15
5 Working environment requirements	16
5.1 Arrangements	16
5.2 Ergonomics	17
5.3 Technical appliances	20
5.4 Chemical substances and products	20
5.5 Noise and vibration	21
5.6 Illumination	24
5.7 Indoor climate	25
5.8 Outdoor operations	26
5.9 Electromagnetic fields	26
5.10 Radioactive sources - Ionising radiation	26
Annex A (normative) Working environment area limits	28
Annex B (normative) Vertical and horizontal clearances and distances	31
Annex C (normative) Detailed requirements related to installation areas	33
Annex D (normative) Vibration limit curves	37
Annex E (normative) Working environment area chart	39
Annex F (informative) Noise data sheet	41
Annex G (informative) Examples of methods for analysis of the working environment	42
Annex H (normative) Procedure for noise control	48

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 Subject to development and publication of international standards, the relevant NORSOK standard will be withdrawn.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

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.

- 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.

- 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.

- 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.

4.3 Working environment (WE) design basis

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.

- 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.

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

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:

- 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.

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

- 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. |
- 4.3.2.0-5 Implementation of the area limits shall be verified by appropriate measurement methods and documented in the WEACs. |
- 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. |
- 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. |
- 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 |
- 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. |
- 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. |
- 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 |
- 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.
- 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. |
- 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. |
- 4.3.5.0-3 Reference is made to the psychosocial analysis method in G.2. |

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, |
- 4.4.2.0-5 - storage and handling of hazardous substances, |
- 4.4.2.0-6 - storage of bulky equipment and materials, e.g. containers, scaffolding, |
- 4.4.2.0-7 - noise and vibration-emitting equipment and areas with noisy activities adjacent to quiet areas, see H.5.1, |
- 4.4.2.0-8 - solitary work in permanently manned areas. |
- 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. |
- 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. |
- 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: |
- 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, |
- 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, |
- 4.4.3.0-5 - causes and potential consequences shall be identified, and decisions on follow-up actions shall be made for identified hazards. |
- 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: |
- 4.4.3.0-7 - frequently repeated manual tasks, especially in material handling, |
- 4.4.3.0-8 - manual tasks in the risk zone of mechanical equipment, |
- 4.4.3.0-9 - manual tasks involving hazards with potentially severe consequences. |
- 4.4.3.0-10 For risk assessment of machinery, see NORSOK S-005. |
- 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. |
- 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. |
- 4.4.4.0-3 The analyses shall include, but not be limited to, evaluations of |
- 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. |

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: |
- 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 |
- 4.4.6.0-6 - major chemicals emitting sources are identified, |
- 4.4.6.0-7 - possible enclosure of sources is evaluated, |
- 4.4.6.0-8 - a review of the localisation of high emitting sources in relation to permanently manned work areas is performed, |
- 4.4.6.0-9 - need for storage areas is defined. |
- 4.4.6.0-10 During engineering, the activity shall ensure that |
- 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, |
- 4.4.6.0-12 - significant chemical emissions are identified and their effects evaluated, |
- 4.4.6.0-13 - elimination, or substitution of less hazardous chemicals are evaluated, |
- 4.4.6.0-14 - chemicals HRA is performed and documented, |
- 4.4.6.0-15 - need for exposure barriers is specified, including need for general and/or local ventilation, |
- 4.4.6.0-16 - need for emergency showers and eyewash stations is defined, |
- 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. |
- 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. |
- 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. |
- 4.4.7.0-2 During concept definition and optimisation/FEED, the activity shall ensure that: |
- 4.4.7.0-3 - major noise and vibration sources are identified, |
- 4.4.7.0-4 - possible use of low-noise equipment is evaluated, |
- 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, |
- 4.4.7.0-6 - area noise level limits (total and HVAC) are specified, |
- 4.4.7.0-7 - preliminary predictions of area noise levels and personnel exposure levels are performed, |
- 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. |
- 4.4.7.0-9 During engineering, the activity shall ensure that: |
- 4.4.7.0-10 - significant noise and vibration sources are identified and their influences evaluated, |
- 4.4.7.0-11 - sound absorption treatment for all enclosed work areas, sound insulation and vibration isolation for equipment and machinery are specified, |

- 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

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, |
- 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, |
- 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/m², |
- 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, |
- 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. |

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: |
- 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, |
- 4.4.10.0-3 - selection of materials and chemicals, |
- 4.4.10.0-4 - relevant experience related to health, safety and environmental pollution during construction. |
- 4.4.10.0-5 Reference is made to NORSOK S-012, Clause 7. |

4.5 Verification and validation of design

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. |
- 4.5.1.0-2 Design reviews shall be performed in the early phases of engineering, and shall be repeated prior to construction. |
- 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. |
- 4.5.1.0-4 In particular, design reviews shall be used for: |
- 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, |
- 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, |
- 4.5.1.0-7 - layout and physical work environment of control centres/CCR, |
- 4.5.1.0-8 - installation areas to verify illumination predictions and evaluations. |
- 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. |

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. |

- 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.