

NORSOK STANDARD

WORKING ENVIRONMENT

S-002
Rev. 3, November 1997

Please note that whilst every effort has been made to ensure the accuracy of the NORSOK standards neither OLF nor TBL or any of their members will assume liability for any use thereof.

CONTENTS

FOREWORD	3
INTRODUCTION	3
1 SCOPE	4
2 NORMATIVE REFERENCES	4
3 DEFINITIONS AND ABBREVIATIONS	5
3.1 Definitions	5
3.2 Abbreviations	7
4 CONTROL AND VERIFICATION ACTIVITIES	7
4.1 General	7
4.2 Procedures and work instructions	8
4.3 Experience report	9
4.4 Concept working environment analysis	9
4.5 Organisation and manning study	9
4.6 Risk analysis	10
4.7 Psycho-social analysis	10
4.8 Working environment area limits	10
4.9 Working environment analyses	11
4.10 Constructability analysis	13
4.11 Working environment inspections	13
4.12 Working environment status	13
5 WORKING ENVIRONMENT REQUIREMENTS	14
5.1 Arrangements	14
5.2 Ergonomics	14
5.3 Technical appliances	16
5.4 Chemical substances and products	16
5.5 Noise and vibration	17
5.6 Illumination	20
5.7 Indoor climate	20
5.8 Outdoor operations	21
5.9 Radiation	21
ANNEX A WORKING ENVIRONMENT AREA LIMITS (NORMATIVE)	22
ANNEX B VERTICAL AND HORIZONTAL CLEARANCES AND DISTANCES (NORMATIVE)	24
ANNEX C DETAILED REQUIREMENTS RELATED TO INSTALLATION AREAS (NORMATIVE)	27
ANNEX D TYPICAL HAZARDOUS SUBSTANCES (NORMATIVE)	28
ANNEX E VIBRATION LIMIT CURVES (NORMATIVE)	31
ANNEX F WORKING ENVIRONMENT AREA CHART (NORMATIVE)	33
ANNEX G LIST OF APPLICABLE ACTS, REGULATIONS, STANDARDS AND GUIDELINES FOR THE NORWEGIAN CONTINENTAL SHELF (INFORMATIVE)	35

ANNEX H NOISE DATA SHEET (INFORMATIVE)	36	
ANNEX I EXAMPLES OF METHODS FOR ANALYSIS OF THE WORKING ENVIRONMENT (INFORMATIVE)	38	
ANNEX J PROCEDURE FOR NOISE CONTROL (INFORMATIVE)	41	

FOREWORD

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

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

The purpose of this industry standard is to replace the individual oil company specifications for use in existing and future petroleum industry developments, subject to the individual company's review and application.

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

Annexes A, B, C, D, E, F are normative. Annexes G, H, I and J are informative.

INTRODUCTION

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

Revision 3 includes the following changes:

- Implementation of the parts of the guidelines to the Norwegian “Regulations relating to **systematic follow up of the working environment** in the petroleum activities” that affect design. Guidelines to the design of the living quarters and doors and stairs are found in NORSOK standards for the architectural discipline.
- Updating of the standard in view of new regulations and European standards.
- Implementation of experiences from Revision 2 in project work.

1 SCOPE

This NORSOK standard addresses design principles related to the working environment. It also covers requirements to the procedures for control and verification of design in order to ensure that these principles are implemented.

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

2 NORMATIVE REFERENCES

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

EN 292	Safety of machinery - Basic concepts, general principles for design, Part 1 and 2.
EN 294	Safety of machinery - Safety distances to prevent danger zones to be reached by upper limbs.
EN 349	Safety of machinery - Minimum gaps to avoid crushing of parts of the human body.
EN 547	Safety of machinery - Human body dimensions.
part 1	Principles for determining the dimensions required for openings for whole body access into machinery.
part 2	Principles for determining the dimensions required for access openings.
part 3	Anthropometric data.
EN 563	Safety of machinery - Temperature of touchable surfaces - Ergonomics data to establish temperature limit values for hot surfaces.
EN 614	Safety of machinery - Ergonomic design principles.
part 1	Terminology and general principles.
EN 626	Safety of machinery - Reduction of risks to health from hazardous substances emitted by machinery.
prEN 1005	Safety of machinery - Human physical performance.
part 2	Manual handling of objects associated to machinery.
part 3	Recommended force limits for machinery operations.
EN 1050	Safety of machinery - Risk assessment.
prEN 12437	Safety of machinery - Permanent means of access to machines and industrial plants
part 1	Choice of a fixed means of access between two levels
part 2	Working platforms and gangways
part 3	Stairways, stepladders and guard rails
part 4	Fixed ladders
DIN VDE 0848, Part 4	Safety at electro magnetic fields.

ISO 717/1	Acoustic rating of sound insulation in buildings and of building elements.
ISO 5349	Guidelines for the measurement and the assessment of human exposure to hand-transmitted vibration.
ISO 2631/1	Evaluation of human exposure to whole body vibration- Part 1: General requirements.
NORSOK C-001	Living quarters area.
NORSOK C-002	Architectural components and equipment.
NS 4815	Determination of occupational noise exposure.
NS 8172	Measurement of noise levels from technical installations.

See Annex G for a list of acts, regulations, standards and guidelines for the Norwegian continental shelf.

3 DEFINITIONS AND ABBREVIATIONS

3.1 Definitions

Can	Can-requirements are conditional and indicate a possibility open to the user of the standard.
Enclosed work area	Area that is fully protected against exposure to open air and ambient conditions.
Hazard	A source of possible injury or damage to health.
Informative references	Shall mean informative in the application of NORSOK standards.
Manning	Three levels of manning of work areas and work places are defined: Permanently manned; Work area or work place manned at least 8 hours a day for at least 50 per cent of the installation's operation time. Intermittently manned; Work area or work place where inspection, maintenance or other work is planned to last at least two hours a day for at least 50 per cent of the installation's operation time. Normally not manned; Work area or work place that is not permanently or intermittently manned.
May	May indicates a course of action that is permissible within the limits of the standard (a permission).
Normative references	Shall mean normative in the application of NORSOK standards.
Open work area	Area with no substantial obstacles to the free. The area is completely exposed to ambient conditions.

Semi-open work area	Area that is weather protected e.g. with weather louvers, and partially exposed to the open air.
Shall	Shall is an absolute requirement which shall be followed strictly in order to conform to the standard.
Should	Should is a recommendation. Alternative solutions having the same functionality and quality are acceptable.
Work area	A work area is an area of the installation, where personnel stay or move in connection with work.
Work place	A work place is a volume within a work area, allocated to one or more persons to complete work tasks related to production, inspection or maintenance.
Working environment	The 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. The influences from lasting exposure may be positive and negative.
Working Environment Analysis	A systematic work process including: Definition, limitation and break down of the installation with respect to one or more parameters (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 of remedial actions. Development of recommendations on remedial actions and/or follow-up activities. Identification of nonconformities and problems in meeting specified requirements
Working Environment Program	A document covering: Working environment objective and goals and acceptance criteria for the risk of occupational injuries and possible work-related illnesses during operation.

References to working environment requirements.

References to applicable procedures for control and verification.

Responsibilities for implementation of working environment requirements in design and for control and verification activities, including means of ensuring that the employees and their elected representatives are given an opportunity of participating in matters of importance to the working environment.

Plans for control and verification activities, deliverables included.

Status concerning performed activities.

The Working environment program may be a separate document or integrated into a Health, safety and environment program.

3.2 Abbreviations

BOP	Blow-Out Preventer.
CRIOP	Crisis Intervention in Offshore Production
HVAC	Heating, Ventilation and Air Conditioning.
LQ	Living Quarters.
TLV	Threshold Limit Value.
WCI	Wind Chill Index

4 CONTROL AND VERIFICATION ACTIVITIES

4.1 General

This standard assumes that a Working environment program is established and maintained.

Table 1 lists the studies and analyses to be performed and documented for new installations in order to control and verify that the design principles in clause 5 are met. For modifications or upgrading of existing installations, new analyses shall be performed or existing analyses shall be updated for the working environment factors that are affected by the modification. Responsibility and schedule for the different control and verification activities shall be defined in the Working environment program considering needs of timely input to design and procurement and needs of documentation.

Table 1 Overview of studies and analyses.

TYPE	PURPOSE	PERFORMED BY
Experience report	To ensure experience transfer related to the working environment from installations in operation.	Company
Concept working environment analysis	To identify and evaluate potential problem areas as input to concept selection and verification of design.	To be specified in working environment program
Organisation and manning study	To provide input to the establishment of working environment area requirements and to working environment studies and analyses.	Company
Risk analysis	To verify compliance with company acceptance criteria for the risk of occupational injuries and to identify the necessary assumptions for concept selection and optimisation and for detail engineering.	To be specified in working environment Program
Psycho-social analysis	To analyse design and planned organisation and manning in order to make an overall evaluation of the working environment and to identify potential problem areas related to the psycho-social working environment in particular.	Company
Working environment area limits	To establish and implement area limits for illumination, temperature, concentration of chemical substances in the working atmosphere, ventilation and noise	To be specified in working environment program
Working environment analyses	To identify and evaluate potential problem areas for different working environment factors as input to concept definition and optimisation and design development.	To be specified in working environment program
Constructability analysis	To ensure that the design promotes a satisfactory health, safety and environment standard during construction.	To be specified in working environment program
Working environment inspections	To verify that the fabricated mechanical packages, modules and structures meet the working environment requirements.	To be specified in working environment program
Working environment status	To provide an updated overview of the status on the different working environment factors.	To be specified in working environment program

4.2 Procedures and work instructions

Procedures and work instructions for the defined studies and analyses according to clause 4.1 shall be developed and maintained. In general, they shall cover the following:

- Aim and scope.

- Definitions.
- Responsibilities for initiation, execution and follow-up of the results.
- Descriptions of:
 - Types of input to the analysis.
 - Organisation of the analysis, requirements to qualified personnel and employee participation.
 - Types of work to be done.
 - Scheduling in relation to the progress of the project.
 - Methods for estimations, calculations and measurements with reference to relevant national and international standards.
 - Priorities for selection of safety measures. EN 292-1, clause 4 is referred to.
 - Documentation and follow up of the results.
- References.

The procedures and work instructions shall ensure that the requirements according to clauses 4.3 to 4.12 are implemented in the execution of the analyses and final conclusions.

4.3 Experience report

Sources of experience may include:

- earlier modifications to improve the working environment
- good technical solutions and solutions/equipment to be avoided
- statistics on occupational accidents, near accidents and possible work-related diseases
- results of working environment mapping and surveys

4.4 Concept working environment analysis

The concept working environment analysis shall provide input to concept selection and verification of the selected concept including cost estimates.

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

- Risks of severe accidents and muscle-skeletal injuries in heavy material handling.
- Risks of severe accidents and muscle-skeletal injuries in handling of drilling equipment (if relevant).
- Exposure to wind chill in naturally ventilated areas.
- Storage and handling of hazardous substances.
- Storage of bulky materials, e.g. scaffolding.
- Noise and vibration emitting equipment and areas with noisy activities adjacent to quiet areas.
- Solitary work in permanently manned work areas.

4.5 Organisation and manning study

The study should specify the following for the different positions in the installation's organisation:

- tasks / responsibilities
- distribution of working hours by area

4.6 Risk analysis

The methods for risk analysis shall be adapted to the applicable acceptance criteria for the risk of occupational injuries, ref. Working environment program. Normally, the risk of accidents should be analysed:

- for all personnel on the installation,
- for especially exposed groups of personnel,
- for critical activities with risk potential of severe consequences.

For requirements to specific types of risk analyses, see clause 4.9.

4.7 Psycho-social analysis

The conditions for a safe, efficient and health-promoting interaction between the employee and the environment shall be determined by applying a systematic method. This should include an evaluation of job demands and provisions for social interaction and self-determination in the different positions on the installation. The analysis should also consider the provisions for coping with the work situation offered by the various leisure activities during the time off at the installation.

4.8 Working environment area limits

4.8.1 General

Detailed specifications of area limits for each room/work area that is readily accessible shall be established as input to engineering. Annex A shows applicable area limits for illuminance, temperature, noise and vibration for typical areas of an installation. In addition, the uniformity of the illuminance ($E_{\min} / E_{\text{mean}}$) shall be specified. In establishing noise area limits above 85dB(A), the individual employee's exposure time in noisy areas shall be considered. For concentrations of chemical substances in the working atmosphere, area limits shall be established when there is a possibility of exceeding 10% of the threshold limit value according to clause 5.4.3. For Norway, establishment of area limits for the number of air changes per hour shall be based on the recommended calculation method in Directorate of Labour Inspection, order no. 516. The area limits shall be documented on Working environment area charts as shown in Annex F.

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 on the Working environment area charts where relevant.

The quality of the illumination in the central control room should be evaluated in a special study.

The implementation of the requirements shall be verified by appropriate measurement methods and documented in the Working environment area charts.

4.8.2 Noise and vibration control

During concept definition and optimisation, it shall be ensured that:

- Major noise and vibration sources are localised.
- Possible use of low noise equipment is evaluated.

- A review of the localisation of noisy equipment and areas in relation to silent areas is performed.
- The use of “buffer” zones is evaluated.

During engineering, it shall be ensured that:

- Significant noise and vibration sources are identified and their influences evaluated.
- Sound absorption treatment for all enclosed areas, sound insulation and vibration isolation for equipment and machinery are specified.
- Maximum noise and vibration levels for significant noise and vibration sources are specified on the basis of area noise and vibration limits and the acoustic properties and the adequate sound insulation between areas. A safety margin of 3dB should be applied in the calculations. Additive effects of several sources in the same area shall be taken into account. Noise data sheets for all potential noisy equipment shall be prepared and included in the inquiries, see Annex H. Vendors shall be requested to propose noise reduction measures, if equipment does not meet the requirements. All noise data shall be guaranteed. Procedures for testing and control of the guaranteed levels shall be required in the contract.
- Requirements to acoustic pipe insulation are specified.
- Noise and vibration levels are predicted and documented for the different areas of the installation at a stage of the project where all requirements have been stated. The individual noise exposure shall be calculated for typical categories of employees working in areas with a noise level above 83dB(A). No use of ear protection shall be assumed for the calculations.
- In areas where whole body vibration limits may be exceeded, structural vibration analysis are performed.
- Noise and vibration predictions are updated, based on vendor guaranteed noise and vibration data and the detail design of the installation.

During fabrication, it shall be ensured that all “noisy” non-standard equipment are tested according to a defined test procedure during the Fabrication acceptance test. For standard equipment, data from earlier tests may be accepted. All important tests shall be executed or witnessed by a qualified noise control engineer.

It shall be ensured that, where feasible, a full noise mapping of the different areas of installation is done during commissioning.

A recommended procedure for noise control is presented in Annex J.

4.9 Working environment analyses

4.9.1 General

The types of analyses to be performed are presented here. It is not required to repeat earlier performed analyses or to evaluate design in cases where this represents a standard and previously accepted solution, provided that design and manning are unchanged. In these cases, earlier analyses or existing standard solutions and accompanying documentation shall be referred to. Where practicable, different analyses should be combined. Examples of methods for working environment analyses are presented in Annex I.

4.9.2 Coarse job safety analysis

This analysis shall be carried out for each work area on the installation. Operation/drilling, repair/maintenance, material handling and waste handling/house keeping activities and walking shall be covered at a coarse level. Risks of severe injury or fatality due to moving parts of machinery, trapping/entanglement, falling to a lower level, sliding/stumbling/hitting against, ejected materials, fire/explosions, hazardous substances shall be identified and evaluated. Causes and potential consequences shall be identified and decisions on follow-up actions shall be made for identified hazards.

4.9.3 Detailed job safety analysis

This analysis shall be carried out for critical work places, which involve tasks with a high risk of accidents. Each task shall be broken down into steps and analysed by a method similar to that for coarse job safety analysis. Also less severe accident risks shall be covered. Criteria for the selection of work places for the analyses include:

- Frequently repeated manual tasks, especially in material handling.
- Manual tasks in the risk zone of mechanised equipment.
- Manual tasks involving hazards with potentially severe consequences.

For safety analyses of machines, EN 1050 is referred to.

4.9.4 Ergonomic job analysis

This analysis shall be performed for all workplaces, which involve tasks in operation or maintenance with a significant risk of muscle-skeletal injuries. The aim is to identify potential problem areas in design of workplaces in order to ensure that the requirements to maximum workload are possible to meet. Input concerning manning, work sequences, frequency of operation, inspection and maintenance tasks, necessary equipment for performance of the tasks, personnel selection and earlier experience in similar tasks should be ensured prior to the analyses. The analyses shall include but not be limited to evaluations of layout, clearances for performance of tasks, location of work functions (displays, control actuators, manually operated valves etc.), needs of stairs and access platforms, and lifting and transportation aids.

4.9.5 Man-machine interface analysis

This analysis shall include a job/task analysis and shall be performed for control room and control cabin tasks, where human errors may cause accidents with severe consequences to personnel, environment or property. The evaluations shall cover normal operation including start-up and shutdown, emergency operations and maintenance/revision. The analyses shall cover personnel and system safety aspects, including the possibility to control process disturbances in a safe manner. The CRIOP-method, see Annex I, is referred to for complex and critical control rooms.

4.9.6 Analysis of the handling of hazardous substances/chemicals

All chemical substances that are planned for use during operation and maintenance and may represent a health hazard shall be identified. Typical chemicals to be evaluated are process chemicals, drilling mud, paint, diesel, lube oil and crude oil. The activities where there is a risk of exposure to the chemicals during transportation, storage, use and disposal shall be identified and the needs of control measures to eliminate or reduce exposure shall be evaluated. Needs for safety showers or eye baths shall be evaluated.

4.9.7 Outdoor operations analysis

This analysis shall be carried out for work places in open and semi-open areas, considering the duration of stay and assuming normal work clothing. The aim is to identify and remedy potential problem areas related to the wind chill and hypothermia. During engineering, it shall be ensured that:

- Workplaces in open and semi-open areas, where there is frequent work with a duration of 10 minutes or more are identified.
- Primarily, the design and localisation of equipment representing such workplaces is reviewed in order to limit exposure to wind and rainfall. Secondly, the need for shelter to protect the workers is evaluated.
- The Wind chill index (WCI) is calculated and documented for the identified workplaces. When calculating the WCI, verified meteorological data for the past five years or more should be used.
- The acceptability of the exposure to high WCI's is determined, considering the work load and duration of stay in exposed areas, and assuming normal work clothing.

4.10 Constructability analysis

It shall be ensured that the design of the contract object promotes a satisfactory health, safety and environment standard during construction. The following shall be considered in particular:

- Accessibility (with respect to installation, lifting, cutting, welding, shot blasting and surface treatment) including selection of steel details and profiles.
- Selection of materials and chemicals.

Relevant experience related to health, safety and environmental pollution during construction shall be collected, compiled and used.

4.11 Working environment inspections

Working environment inspections shall be carried out during Construction and Mechanical Completion in order to verify that the physical installation meets the established requirements. Special checklists shall be prepared for this purpose.

4.12 Working environment status

Working environment area charts according to Annex F or equivalent shall be applied in documenting the working environment status. In principle, a Working environment area chart shall be prepared for each room and area on the installation. To maintain a manageable number of Area charts, several identical areas can be covered only by one typical chart, i.e. office, cabin, toilet/WC and escape/transport route.

The Working environment area charts shall be kept updated with the results of predictions, and measurements and problem areas and nonconformities identified in analyses and the status of decisions on remedial actions.

5 WORKING ENVIRONMENT REQUIREMENTS

5.1 Arrangements

5.1.1 General

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

Provisions shall be made for safe and efficient transportation of materials, both horizontally and vertically. Storage areas and lay down areas belonging to them should be located in the vicinity of each other and on the same level.

Offices, coffee bars and recreation rooms should preferably have access to daylight.

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

5.1.2 Means of access

All work areas shall have a layout that provides for safe access for operation and maintenance. Floors in work areas and walkways shall be designed in accordance with the following:

- Walkways for access to permanently and intermittently manned work places shall be arranged. These shall be shown on relevant drawings.
- Drips of oil and slippery liquid onto floor shall be avoided, e.g. by using drip trays.
- Protruding objects shall be avoided in walkways, access ways and transportation ways.
- Need for anti skid surfaces shall be evaluated in all work areas where spill of slippery liquid, dusts etc. may occur.

Stairs are preferred to ladders. Ladders may replace stairs where stairs are unfeasible or where daily access is not required. Stairs, ladders and platforms shall be designed in accordance with Annex B and recognised standards listed therein.

At the top of ladders, self-closing gates shall be arranged. Such gates shall not open towards the ladder.

Fixed stepladders shall be provided with handrail on both sides.

Access openings in vertical partitions into cofferdams, tanks etc. shall be equipped with hand grips on both sides above the opening.

5.2 Ergonomics

5.2.1 Prevention of muscle-skeletal injuries

Workplaces shall be designed such that the personnel is not exposed to excessive work loads with risks of muscle-skeletal injury. For determination of maximum work load and force limits, prEN 1005, part 2 and 3 are referred to. The requirements above entail that efforts should be made to avoid: