

NORSOK STANDARD

DESIGN PRINCIPLES **OPERATIONAL PRINCIPLES**

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1. FOREWORD

This standard has been developed by the NORSOK Standardisation Work Group.

Annex A is informative.

2. SCOPE

The scope of this document is to provide overall operational and maintenance guidelines and criteria to ensure design of and selection of equipment for process, process support and utility systems in accordance with operations objectives, including commissioning and start-up activities.

These operational requirements shall be part of the criteria basis for concept evaluation, system design, equipment selection and layout throughout all phases of the field development.

3. NORMATIVE REFERENCES

NORSOK Standard

S-DP-001

Technical Safety

4. DEFINITIONS AND ABBREVIATIONS

4.1 Definitions

Life Cycle Cost

Life Cycle Cost is the discounted sum after tax of investment, operating cost and cost of deferred (lost) production due to equipment failure and/or maintenance during the lifetime of the field.

Regularity

A measure of a system's capability to meet the demand for deliveries. In the context of this document the term has been used to represent the ratio of actual to planned delivery from a system.

4.2 Abbreviations

LCC	Life Cycle Cost
CCR	Central Control Room
LER	Local Equipment Room
OS	Operator Station
VDU	Visual Display Unit
CM	Corrective Maintenance
PM	Preventive Maintenance
SCSSSV	Surface Controlled Sub-Surface Safety Valve.

5. OPERATION CONCEPT

5.1 Operation Objectives

Operation main objectives are to produce, process and export reservoir recoverable oil and gas reserves as presumed in field development plans, including adequate reservoir management, at lowest LCC and accepted safety levels.

5.2 Operating Environment

Systems shall be designed to provide required performance, and to be operated and maintained when located in an open or sheltered area, on an offshore production facility. Special consideration shall be given to:

- safety
- working environment
- environmental conditions
- area hazard classification
- installation movement.

Equipment and functional areas shall be grouped together to facilitate efficient operation, handling and communication of activities and operations.

6. OPERATION PHILOSOPHY

6.1 General

The process and utility facilities shall provide capability and availability to produce and process the reservoir fluids with effective utilization of minimal resources. Systems design shall be established from a balanced cost optimization of the following elements:

- criticality
- complexity
- choice of technology
- training and sparing
- material selection
- manning level and personnel competence
- maintainability.

6.2 Criticality

Criticality analysis shall be one of the main principles for defining the design of systems and equipment. These analyses shall provide failure scenarios, consequences of failure, time to restore normal functionality, and requirements for spare parts and personnel.

6.3 Complexity

The complexity shall be kept low. System design shall be developed from a minimum requirements point of view. Deference of investment shall be considered if the system is not required from start of production. However, provisions for later installation shall be provided based on how this will affect production availability and LCC.

Instrumentation for control and monitoring of system performance shall be kept at a minimum and implemented based on defined operational needs for performance of regular production and maintenance activities or, directly or indirectly, resulting in increased productivity, cost savings or if improving a hazardous working environment.

6.4 Choice of Technology

The main principle shall be to accept suppliers standard equipment. Non-standard equipment and special solutions shall only be used if LCC benefits are demonstrated.

Proven technology shall be used if available. Use of new technology requires verification of functionality and performance against pre-defined acceptance criteria.

System design and layout should be standardized, especially the utility systems. The supplier shall demonstrate that the standardisation of system, equipment and parts within his scope of supply has been optimised related to inter-changeability and cost.

6.5 Training and Sparing

The main principle shall be to select a single train. Sparing shall be implemented based on criticality, availability and equipment capacity standardisation and constraints. Redundancy shall not be implemented unless proven required to maintain the target availability and sustain operational safety requirements.

6.6 Manning and Personnel Competence

The regular offshore manning level shall be kept low. To achieve this, the complexity and number of equipment units should be low. The systems must be designed and equipped for efficient handling of all normal production operations and maintenance work.

Personnel competence shall be as required to perform normal production and maintenance operations. Multi-skilled personnel shall be assumed.

7. PRODUCTION FUNCTION REQUIREMENTS

The main objective of the production function is to utilize available systems for optimal production, processing and export of hydrocarbons at lowest cost, while maintaining an acceptable safety level and causing minimal environmental impairment.

7.1 Control and Monitoring

In general, control and monitoring shall be done from the CCR. For systems that require local operation, or systems that are not critical for the production and require infrequent operation, control and monitoring shall be done locally adjacent to the equipment. LER's should contain necessary means for maintenance, but no operator control panels.

The number of alarms shall be kept at a minimum. Critical alarms and selected control and monitoring functions shall, based on a specific criticality assessment, be presented in the CCR. The alarm system shall be designed to suppress unnecessary information to the operator.

The CCR shall be designed and equipped to be operated normally by one operator.

The system for control and monitoring shall contain a report generator enabling system status reporting. Printout of alarms and trip signals shall be available at the operator's discretion.

Duplication of operation control functions in the CCR and in the field, shall not be employed unless required for specific operations or as described below.

7.2 Production Operations

7.2.1 General

The following modes of normal production operations shall form, as applicable, the basis for system design and equipment selection:

- steady state operation
- start-up
- shut-down
- isolation for maintenance
- well testing
- well intervention.

In addition, commissioning and start-up requirements shall be implemented.

It is emphasised that operating, start-up and commissioning instructions shall be developed in parallel with system design to ensure these operational requirements are optimized.

7.2.2 Start-Up

Start-up of systems shall be done with a minimum of overriding or inhibiting safety shutdown functions. Start-up from a planned and tripped shutdown shall require minimal interdependent interlocks.

7.2.3 Shut-Down

Planned shut-down shall leave the system in a ready for start-up mode. Tripped shutdown shall leave the system in a stable and safe condition.

The initial trip of a system shall be available on an OS in the CCR and be readably identifiable without ambiguity. All succeeding consequential trip signals shall be suppressed but still recorded.

Depressurization of systems shall be manually activated unless automatic depressurization is required to prevent damage to equipment.

During design, the consequences of a system trip shall be carefully analyzed and consequential shutdown escalation shall be minimized, e.g. a trip initiated in the gas processing systems should not cause shutdown of the oil processing systems.

Systems shall be designed such that automatic shutdown functions will not be activated as a result of normal operating transients.

7.2.4 *Isolation for maintenance*

Block valves shall be installed to provide efficient and safe isolation of equipment and components for maintenance. The requirement for valves shall be based on requirements for equipment testing, calibration, inspection, production consequences if equipment fails, regular production operations, and field experience in general.

In hydrocarbon systems or systems containing hazardous fluids, volumes being frequently isolated shall be equipped with permanent piping for draining to either the open or closed drain system as appropriate, and for depressuring and venting to the flare system.

Consideration shall be given to ensure that mixing of chemical drainage do not result in hazardous reaction products.

7.2.5 *Well Testing*

Well testing should be possible without interruption of current total production. Well testing can, based on a LCC evaluation, be manually activated or be activated and monitored from the CCR.

Sampling of well fluid streams of oil, gas and water shall be provided for.

Requirements for preparations for well testing shall be minimized. Information from well testing should be available directly on local or centralized data acquisition system.

7.2.6 *Well Intervention*

Well intervention shall be performed without interruption of current production except for the well to be entered and as required for heavy lifts when rigging up and down.

The intervention work will be done by a service contractor, who should bring with him all required equipment and tools. Provisions shall be provided for readily hook-up of equipment.

During intervention work the well should be controlled locally from the main wellhead control panel, including inhibition of closure of master valve and SCSSSV. The CCR operator shall be able to reset the inhibition and shut in the well in case of an emergency situation.

8. MAINTENANCE FUNCTION REQUIREMENTS

8.1 General

The main objective of the maintenance function is to sustain systems availability and preservation of the integrity of the physical assets.

Availability performance is a function of failure rate, repair time and waiting time for spares and manpower. Also included is unavailability due to planned maintenance. Equipment performance expressed in these functional terms shall be included when establishing system availability. Production unavailability shall be included as a cost element in all LCC evaluation and handled on the principle of deferred production rather than production loss.

8.2 Maintenance Strategy

The maintenance strategy shall be an important basis for technical design, organisation and maintenance programs.

Maintenance will be related to either preventing failure of equipment, PM, or to restore equipment to service after breakdown, CM.

PM and inspection programs shall be used for critical units. Non-critical equipment will be run to failure.

When PM is appropriate, emphasis shall be given to applying predictive techniques based on condition monitoring such as inspection, vibration monitoring, equipment efficiency, etc. Condition monitoring shall be based on supplier recommendations and own field experience.

Modification work and equipment repair should to a large extent be sub-contracted and performed by the equipment supplier.

8.3 Maintenance Engineering

8.3.1 Design

Equipment should be prepared for change-out when this is considered cost effective. Layout shall facilitate easy change-out.

Suppliers shall specify repair time for applicable failure modes including the time to change-out the whole unit.

Requirements to layout and material handling will depend on the repair level as follows:

Storage and laydown areas should be sized for the heaviest lift expected.

Main laydown areas shall be covered by at least one crane.

Heavier equipment shall be delivered or equipped with dedicated lifting beams and tackles for effective transportation to laydown areas.

Lifting lugs shall be installed where necessary.

8.3.2 Organisation

The maintenance function will be organised to perform regular PM and CM activities.

First line maintenance shall primarily be done by the production personell.

To achieve an effective team effort, the offices and workshops for maintenance should be gathered together, including areas for spare parts, centralized and located in an unclassified area. Dedicated workshops, including drilling requirements, should be provided for:

- Mechanical
- Welding
- TEAM (Telecom, Electro, Automation, and Metering).

In addition, areas shall be defined as required by other disciplines (insulation, scaffolding, etc) associated with planned maintenance shutdowns and modification work.

8.3.3 Programs

The original programs, procedures and spare lists from suppliers shall be used as a basis for maintenance programs.

The list of spare parts shall contain a schedule advising the reason for the spare part according to:

- component having limited operating life
- component having low mean time between failure
- component criticality
- component routinely replaced during maintenance

8.4 Inspection Strategy

The inspection strategy will consider the requirements for periodic condition control of structures, including surface protection, and static process equipment, i.e. pipes, valves and vessels.

The design of process, process support and utility systems should take due account of the need for shutdowns for inspection.

Inspection activities in the operation phase shall be optimised by design, planning and coordination in order to minimise operational shutdowns. Inspection requirements shall be established in parallel with detail engineering considering regulatory and maintenance requirements and the following factors:

- external corrosion because of insulation
- shutdown of critical functions
- duration and frequency of inspection

Effort should be made to keep the extent of insulation to a minimum in order to avoid corrosion, and in order to have better access for inspection and maintenance.

ANNEX A
INFORMATIVE REFERENCES

ANNEX A - Informative References

Norwegian Petroleum Directorate (NPD)

“Regulations relating to process and auxilliary facilities in the petroleum activities”
with guidelines.