

NORSOK STANDARD

COMMON REQUIREMENTS
CRITICALITY CLASSIFICATION METHOD

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1 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 (The 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 Subject to implementation into international standards, this NORSOK standard will be withdrawn.

Annex A is informative.

2 SCOPE

This document has been developed to give a systematic approach to determine a sufficient accurate functional criticality level for production facilities and associated systems.

The standard should form part of the basis for selection of redundancies, development of Maintenance program, Spare parts evaluations and Life cycle cost evaluations/calculations.

The products from this work are:

- Hierarchical breakdown of systems into main functions, sub-functions and items (tag).
- Documented and auditable criticality classification of systems, main functions and sub-functions.
- Degree of redundancy in main functions and sub-functions.

Criticality classification should be an activity in the Conceptual phase.

3 NORMATIVE REFERENCES

NORSOK O-DP-001	Operational principles.
NORSOK O-CR-001	Life cycle cost for systems and equipment
NORSOK O-CR-002	Life cycle cost for production facility
NORSOK S-CR-002	Health, safety and environment during construction.
NORSOK Z-DP-002	Coding system.

4 DEFINITIONS AND ABBREVIATIONS

4.1 Definitions

Normative references	Shall mean normative in the application of NORSOK standards.
Informative references	Shall mean informative in the application of NORSOK standards.

Shall	Shall is an absolute requirement which shall be followed strictly in order to conform with the standard.
Should	Should is a recommendation. Alternative solutions having the same functionality and quality are acceptable.
May	May indicates a course of action that is permissible within the limits of the standard (a permission).
Can	Can-requirements are conditional and indicates a possibility open to the user of the standard.

In this document Criticality means the effect of functional failure with respect to Health, safety and environment, Production regularity and Costs.

4.2 Abbreviations

None.

5 CRITICALITY CLASSIFICATION METHOD

5.1 Hierarchical breakdown of the installation

We are seeking both a functional and a technical hierarchy. The hierarchies are based on a systematic breakdown of the systems and the difference between technical and functional hierarchy is shown in figure 1. The functional hierarchy shows how equipment units carrying out the same function are grouped in the criticality assessment, thus ensuring a consistent treatment of the units within each function. The technical hierarchy shows how the equipment units are built up technically and is used in the preparation of maintenance programmes, planning of preventive/corrective maintenance and for defining requirements for reporting historical data etc., during operations.

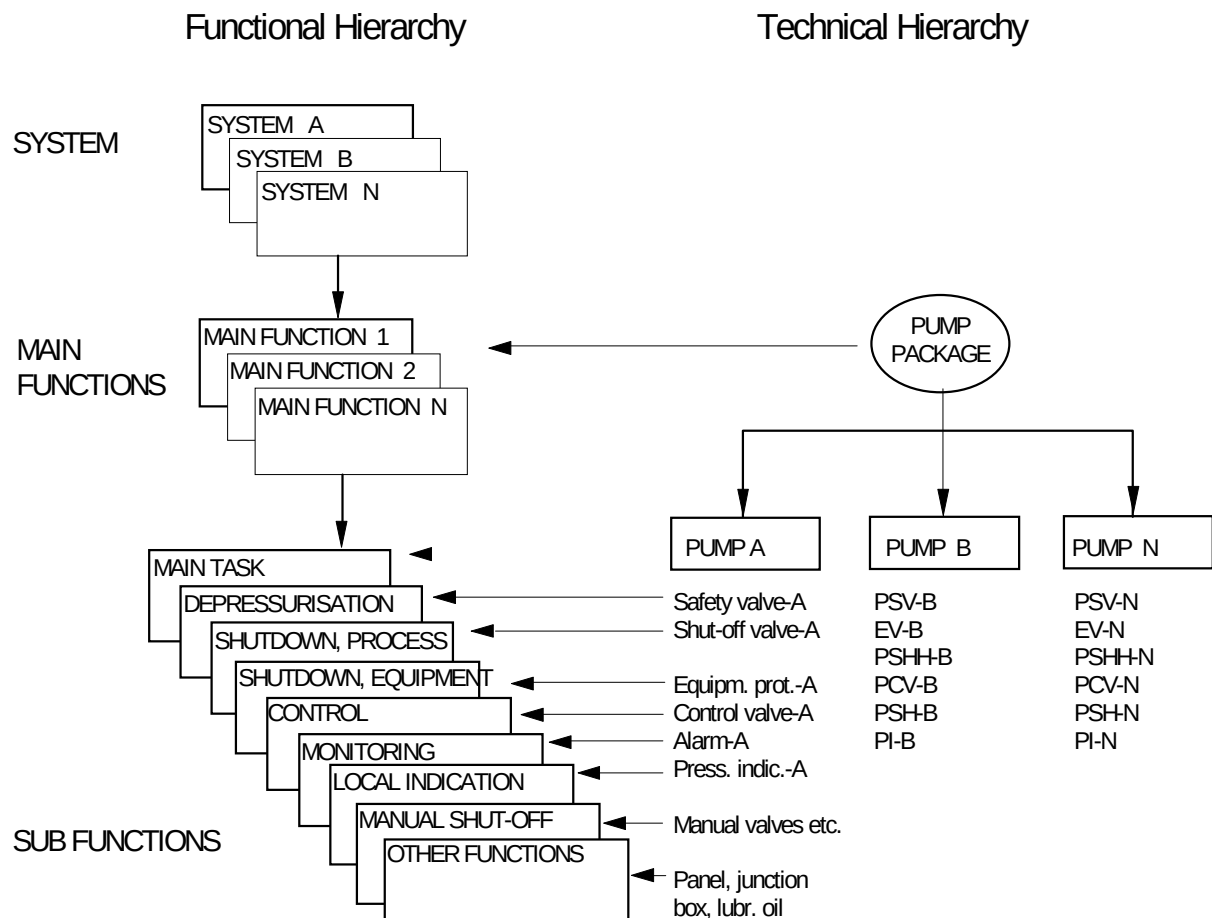


Figure 1 Functional and technical hierarchy

5.1.1 Functional hierarchy

A system is divided into main functions (covering the entire system).

Main functions are divided into sub-functions (covering the entire main function).

All tags which take part in implementing a sub-function are placed in that sub-function.

In principle, this breakdown can continue right down to the very smallest equipment component. However it is not practicable to continue beyond tag level.

5.1.1.1 Identifying the main functions

Each system is divided into a number of main functions (typical 3 to 10) and they are characterised by performing principal tasks within the system (for instance, heat exchanging, pumping, separation or power generation).

The main functions are each to be given unique designations consisting of a number (a tag number if appropriate) and a name describing the task.

5.1.1.2 Identifying the sub-functions

The sub-functions carry out more subordinate tasks which are necessary for the satisfactory implementation of the main function. In order to simplify the criticality assessment enabling work to be carried out with sufficient accuracy with the use of minimum resources, the function level has been "standardised" with pre-defined terms to cover all requirements. These functions are:

- Main task (term describing the task).
- Pressure relief.
- Shutdown, process.
- Shutdown, equipment.
- Control.
- Monitoring.
- Local indication.
- Manual shut-off.
- Other functions.

5.1.2 *Technical hierarchy*

The technical hierarchy identifies which units (tags) a system consist of and their positions in the technical hierarchy, as a consequence of their function in the system. The system forms the highest level in the hierarchy. The system's main-/subfunctions are identified in flow charts and P&ID's. The technical hierarchy consist of the following levels:

- System.
- Subsystem (sub-subsystem).
- Unit.
- Sub unit.
- Item function.

The technical hierarchy is identical to system breakdown in NORSOK Z-DP-002, Coding system, clause 7.

It is not mandatory to use the hierarchy structure described in the NORSOK standard when performing the criticality assessment, but it might require less effort as the hierarchies are already well defined.

5.2 **Criticality assessment**

This assessment is to be carried out by personnel with experience of criticality assessment (facilitator) in collaboration with personnel experienced in operations and maintenance and with sound understanding of processes and systems. The criticality is assessed based on the effect of errors/faults and on the time from the occurrence (of the error/fault) until the effect occurs on the installation - and is quantified with 1, 2 and 3 for the following areas:

- **Health/Safety/Environment (S)**
 1. No potential for:
 - Injury.
 - Pollution.
 - Fire.
 - Effect on safety systems.
 2. No effect on safety systems controlling hydrocarbons.
No potential for:

- Fatalities.
 - Moderate or large pollution.
 - Fire in classified areas.
 - 3. Potential for fatalities, moderate or large pollution and fire in classified areas. May render safety systems inoperable.
- **Production regularity (P)**
 1. No effect on production within a defined period of time.
 2. Brief stop in production or reduced rate of production within a defined period of time.
 3. Production shutdown within a defined period of time.
 - **Costs (C)** (Exclusive deferred production.)
 1. Insignificant consequential costs.
 2. Moderate consequential costs.
 3. Substantial consequential costs.

Quantification of the different levels of effect and time until effect occurs, are subject to project definition or definitions in NORSOK S-CR-002, Health, safety and environment during construction

5.2.1 Assessment of the main function's criticality

The entire main function is assessed as a "black box" in terms of the effect of its failure to operate - or of operating incorrectly. In this assessment any redundancy within the function is thus disregarded. (Redundancy will be treated separately).

The following question is to be asked:

What is the effect on the system/installation if this function does not work or works incorrectly?

The most serious (although realistic) effect of errors/faults is to be described and a percentage reduction in the main function's performance is to be quantified if possible. If the error/fault affects more than one of the areas being assessed, this is also to be described so that it is evident from the text how the effect takes place. In addition, the time from the error/fault occurs until it affects the system/installation should be estimated.

5.2.2 Assessment of the sub-function's criticality

Assessing the criticality of the installation's many sub-functions is the most demanding part of the criticality classification. This work must therefore be done as effective as possible while ensuring that the result is sufficiently accurate for further use. As for the main functions criticality assessment (clause 5.2.1), the effect on system or installation has to be evaluated.

5.2.3 Item (tag) criticality

All items (tag) shall be assigned the same criticality as the sub-function they are a part of.

5.3 Redundancy

If there is redundancy within a main function or sub-function, the number of parallel units and capacity per unit shall be stipulated. The equipment's function redundancy shall be classified using the following codes:

A = No unit can fail without functional effect.

B = One unit can fail without functional effect.

C = Two or more units can fail without functional effect.

5.4 Functional criticality and probability of failure

Although it is not a direct part of defining the functional criticality it is often useful to include the probability of failure as a further refinement to the criticality classification.

Probability of function loss may be rated and combined with the functional criticality based on the following matrix. The result is a rating displaying the importance of maintenance attention.

Table 1 Risk factor

3	M	H	X
2	L	M	H
1	L	L	M
Probability of functional failure	1	2	3
Criticality			

If the probability rating shall be performed, each project has to define the boundaries between the different probability classes. As an example, the quantification could be :

3 (High) = 0-1 year between each failure.

2 (Medium) = 1-10 years between each failure.

1 (Low) = >10 years between each failure.

6 APPLICATIONS OF CRITICALITY CLASSIFICATION RESULTS

There are several areas where the functional criticality classification is utilised. A few examples of how criticality classification results can be used are described below.

6.1 Design evaluation

The functional criticality, combined with the probability of failure will highlight equipment or design solutions which may need further attention - such as FMECA-analysis or engineering judgement.

Table 2 The risk factor used in the design phase

Risk factor	Design phase
X	Design evaluation. FMECA-analysis recommended
H	Possible improvement, engineering judgement
M	Acceptable
L	Preferable

6.2 Maintenance strategy

If the function's criticality and degree of redundancy are considered when establishing the maintenance strategy the appropriate attention with respect to maintenance will be ensured.

Table 3 The risk factor used to evaluate the need for maintenance activities

Risk factor	Maintenance in the operational phase
X	Maximum maintenance attention or compensating measures
H	Comprehensive maintenance attention
M	General maintenance
L	Minor maintenance

6.3 Establishing maintenance and inspection programmes

In order to ensure consistence through out the complete installation, the maintenance and inspection programmes should be established based on each item's (tag) criticality and degree of redundancy - as well as the operators / authorities requirements.

6.4 Spare parts evaluation

Functional criticality and degree of redundancy are two essential parameters for deciding how fast spare parts are required when needed on the installation, hence they are vital for the spare part evaluation and the selection between storing alternatives.

7 DOCUMENTATION OF THE END PRODUCT

The functional breakdown shall be done for each system/main function to an extent that covers all sub-functions in the system, i.e. loss of one or more sub-functions results in loss of the system functionality.

The functional breakdown and the determination of criticality shall be documented in an auditable manner. The documentation should be delivered on an electronic format.

ANNEX A EXAMPLES (INFORMATIVE)

A1 FUNCTIONAL BREAKDOWN AND CRITICALITY CLASSIFICATION

This is an example of a functional breakdown and a criticality classification. It must be stressed, however, that this is a subjective technique and several solutions would be feasible.

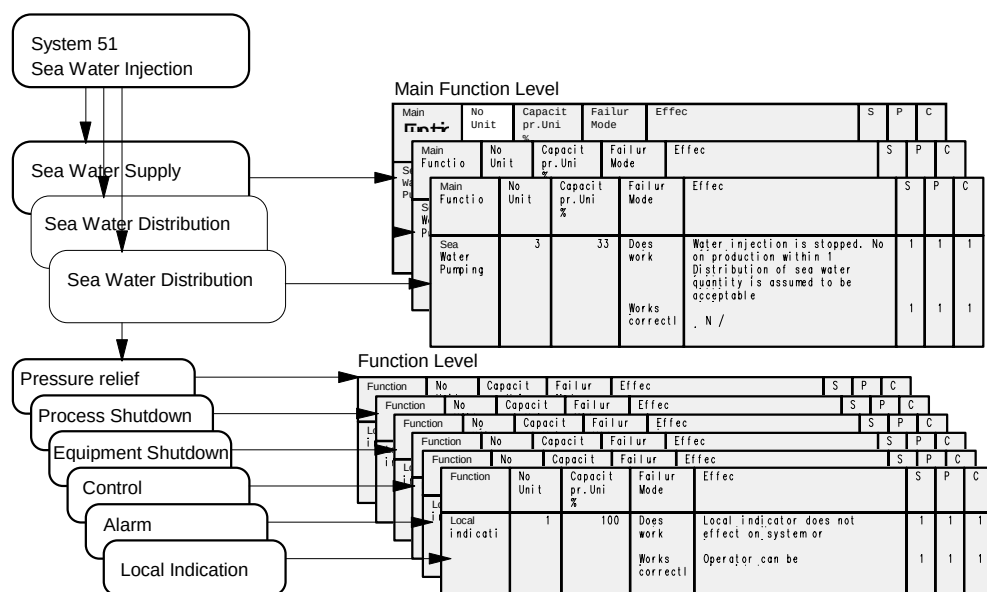


Figure 2 Example of functional breakdown and criticality evaluation

A2 BREAKDOWN OF A TECHNICAL HIERARCHY

It may be necessary to divide a system into several part-systems with the same function, but with different goals. For example, ventilation systems for different areas. A single "administrative" tag can be allocated to identify the part system and can be used as the highest level where all main functions can be connected.

A2.1 Main functions

It can occasionally be necessary to establish new tags to identify main functions. For example, main functions that are composed of parallel items (redundant equipment). In such cases, a new package tag that can be established to identify parallel items in a common package. If such a package tag number has previously been allocated, it shall be used.

Example:

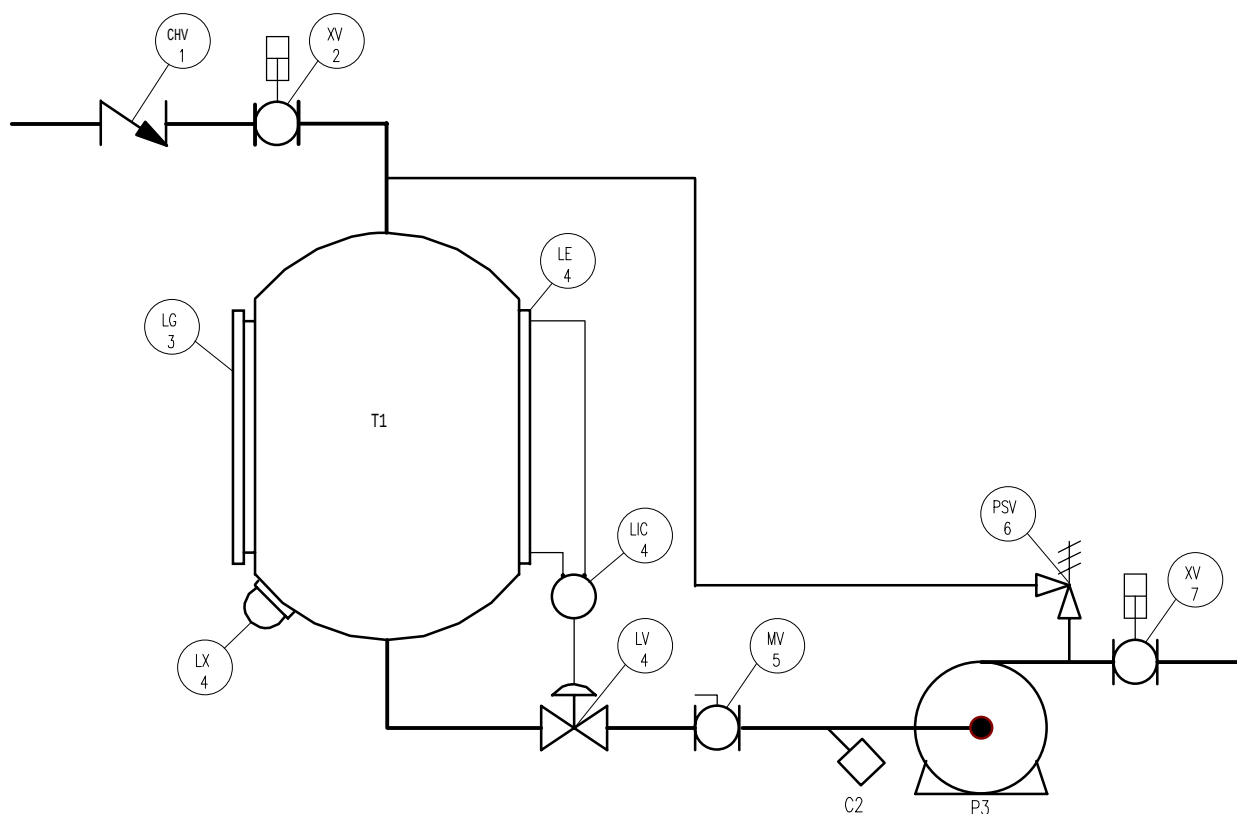


Figure 3 A simplified P&ID for system X

The system consists of two main functions; storing and pumping. The border between the two main functions is set at the outlet flange on the LV-valve. The chosen tag to identify the main function 'Storing' is T1, and the tag identifying the main function 'Pumping' is P3.

A complete technical hierarchy for system X would then be:

Hierarchical level						Service description
1	2	3	4	5	6	
T1						Storage tank
	CHV1					Storage tank inlet check valve
	LG3					Storage tank level gauge
	LV4					Storage tank level valve
		LE4				Storage tank level element
		LIC4				Storage tank level indicator/controller
		LX4				Storage tank level radioactive source
	XV2					Storage tank inlet valve
P3						Pump
	C2					Pump inlet filter
		PDI8				Inlet filter diff. pressure indicator
	MV5					Pump inlet valve
	PSV6					Pump pressure safety valve
	XV7					Pump outlet valve

Complete technical hierarchy presented in a figure:

