Risk level in the Norwegian petroleum activities

Requirements for the companies' reporting on barrier performance

2008

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Contents

0. Summary

- The basis is that evaluation and reporting regarding barriers in the project shall not entail a lot of extra work for the companies.

Data from tests (drills in one case) shall be reported for the following selected barriers:

- Fire detection, availability
- Gas detection, availability
- Shutdown, availability
  - Riser ESDV
    - Closing test
    - Leak test
  - Wing and master valves, Xmas tree
    - Closing test
    - Leak test
  - Subsurface safety valve (DHSV)
- Isolation with BOP, availability
  - Drilling and well activities
  - Limited to production facilities
- Active fire protection
  - Deluge valves
- HIPPS
  - HIPPS/QSV valve including transmitter, pilot/solenoid and logic (for land facilities only)
- Emergency preparedness
  - Muster time, actual value
  - Ratio between actual value and VSKTB
- Watertight compartmentalization, hull
  - Closing watertight doors
- Ballast system
  - Ballast valves
- Mooring system
  - Number of situations with one brake not functioning
  - Number of situations when the other brake also fails

A selection of these barriers is used for land facilities.

1. Background and purpose

1.1 Earlier stages of the project

One of the focus areas from Phase 2 is empirical data for barriers. The scope has been undergoing development, and has been expanded somewhat over time.

Most of the players on the Norwegian Shelf have established systems for following up the performance of barriers, as required by the new HSE management regulations. The requirements for reporting empirical data for barriers is based on this work. Some of these systems are quite extensive as regards internal reporting of empirical data. The companies have both detailed and general indicators. The project has established its own indicators for barriers, based on the same raw data.

1.2 Purpose of the project

The purpose of the project has been nearly unchanged during the project's lifetime:

- The Petroleum Safety Authority Norway shall, in light of the established safety level in the petroleum activities, carry out an evaluation of status and trends (PSA, 2006).

Further development of the major accident risk model to more fully reflect barrier performance has been a consistent objective. Another intention is to make the reporting "broader".

The description in the document has been developed for facilities on the Shelf. For land facilities, at least in the initial phase of data collection, only a selection of these barriers will be used.

1.3 Purpose of the document

The document describes requirements for reporting experience gained with barriers for Phase 8 of the project, including reflecting the changes and expansions that have been made in previous stages as regards reporting of barrier data.

For reporting of reliability data, system boundaries and failure criteria are also presented (in Appendix 1). Exchange of experience with the OREDA project (an international cooperation project where nine oil companies participate, including most of the operators on the Norwegian Shelf) is also relevant. Guidelines for collecting and establishing reliability data for equipment are given in ISO 14224 and NORSOK Z-016, and the OREDA participants have experience with such acquisition of reliability data.

2. Reporting on barriers - background

2.1 Regulations

Barriers are a key concept in the new regulations, and reference is also made to them in OLF's guidelines (070) for implementing IEC 61508 and 61511, as well as in ISO standards 13702 and 17776.

The following is stated in the Management Regulations (Section 1, risk reduction, second subsection):

"….. In addition, barriers shall be established to
a) reduce the probability that any such failures and hazard and accident situations will develop further,
b) limit possible harm and nuisance."

The following references to the Management Regulations can be used related to the requirements for mapping of barriers:

- "It shall be known what barriers have been established and which function they are intended to fulfil, cf. Section 1 on risk reduction, second paragraph, and what performance requirements have been defined in respect of the technical, operational or organizational elements which are necessary for the individual barrier to be effective." (Second section, second subsection)
- "It shall be known which barriers are not functioning or have been impaired." (Second section, third subsection)
- The party responsible shall take necessary actions to correct or compensate for missing or impaired barriers." (Seventh section, second subsection)

These requirements have been used as a basis. The project does not stipulate any requirements beyond those stipulated by the regulations.

However, one cannot conclude that one automatically meets the regulatory requirements if the requirements for reporting of barriers in this project are met.

2.2 Definitions

2.2.1 Barrier

The term "barrier" is not defined in the strict sense used in the regulations. The term is used in a broader sense with somewhat differing meanings:

- Barrier is used synonymously with safety or emergency preparedness system or function
- In some cases, the barrier term refers to a larger function.

It has also been specified that barriers include organizational and administrative measures, not just technical measures as described in the examples here.

ISO 17776 has a definition of barriers, which can be expressed as follows when translated from English:

- Barrier – measure which reduces the probability of triggering a hazard's potential to cause damage or reduces the damage potential.

It emerges that this definition correlates with the description of barriers in Section 1 of the Management Regulations, see previous sub-chapter.

2.2.2 Safety function, safety system

In Section 1 of the Facilities Regulations, safety system and safety function have been defined as follows:

Safety system: A system which realises one or more active safety functions.

Safety functions: Physical measures which reduce the probability of a situation of hazard and accident occurring, or which limit the consequences of an accident.

The definition of safety function is practically identical with the definition of barrier (see 2.2.1sub-chapter with the limitation that the safety function consists of *physical* measures, whereas barriers include technical, organizational and administrative measures.

The guidelines to the Facilities Regulations give the following examples of safety functions:

a) sectioning of the process,
b) fire detection,
c) gas detection,
d) isolation of sources of ignition,
e) maintaining overpressure in unclassified spaces,
f) starting and stopping fire pumps, both manually and automatically,
g) active fire-fighting
h) active smoke control,
i) process safety,
j) well safety,
k) depressurization,
l) general alarm and evacuation alarm,
m) production and distribution of emergency power,
n) emergency lighting,
o) emergency drainage,
P) ballasting for mobile facilities,
Q) maintenance of correct pressure, humidity, temperature and gas composition in diving facilities.

2.2.3 The project's definition of barrier

The project uses the definition in ISO 17776 as its basis. This means that barrier can usually be used synonymously with safety or emergency response function including associated logic, or corresponding operational and organizational measures to reduce probability and/or consequences.

Barrier can in many cases be described as follows:

- Facility or measure which influences the progress of an accident in the intended direction, - reducing losses (or expected losses).

Barriers will often correspond to branching points in the incident trees in a QRA, and this applies to a great degree to the list in this sub-chapter.

The term barrier is, according to the definition used, somewhat broadly defined. In some contexts, it may be relevant to consider "parts of a barrier", and the term "barrier elements" is used in this context. The transition between barrier and barrier element is somewhat flexible.

2.2.4 Barrier performance

The guidelines to the Management Regulations explain the term performance as follows:

- "Performance as mentioned in the second subsection can include capacity, reliability, accessibility, efficiency, ability to resist loads, integrity and robustness." (Second section, Guidelines)

Performance can be considered to have the following three components, which can be described as follows:

- Functionality/efficiency: The effect the barrier has on the progress of the accident, given that it is present (functions) as assumed in the design.
- Availability/reliability: The barrier's ability to be available on demand
- The robustness (inverted vulnerability): the barriers' ability to function during relevant (specified) courses of events in accidents in connection with accidental loads.

2.3 Overall principles for prioritization of barriers

The following principles have been employed in the selection of barriers for reporting:

- Focus in the selection of barriers is set on the DFUs which the project has shown to have the largest risk contributions.
- Barriers which can stop a chain of events from developing at an early stage should be given priority.

In addition, the following aspects have been emphasised:

- The overall reporting of barriers must be such that they instil confidence from all parties.
- The barrier indicators should cover the broadest possible range, from barriers which prevent incidents from developing into accidents, to emergency preparedness systems and measures.
- Reporting of barriers is based on the requirements in the new regulations, and should as far as possible be given the same interpretation as in the regulations, including organizational and administrative measures.
- Experience from establishment of indicators suggests that this should start with technical barriers, as it is considerably more challenging to establish indicators for organizational and administrative barriers.

The barrier reporting requirements are based on these principles.

2.4 Prioritized barriers

On the basis of the overall principles in sub-chapter 2.3, the following DFUs can be identified as having the highest risk contribution:

- DFU1-2: Hydrocarbon leaks
- DFU3: Kick
- DFU5: Ships on collision course
- DFU8: Construction and marine incidents
- DFU12: Helicopter accident at/on facility/field

In the further identification of barriers, the primary emphasis is on the barriers which affect the development of these DFUs.

Based upon the overall principles in sub-chapter 2.3, the following technical barriers/barrier elements can be identified as having the highest priority:

- DFU1-2
  - Integrity of process facilities
  - Gas detection
  - Ignition source control
  - Emergency shut-down
  - Process control
  - Depressurization
  - Fire detection
  - Mustering and evacuation

- DFU3
  - Kick detection
  - BOP w/pressure control equipment
  - Valves for well shutdown
  - Mustering and evacuation

- DFU5
  - Detection of ships on collision course
  - Measures to alert ship to change course
  - Mustering and evacuation

- DFU8
  - Components in the ballast system
  - Components in the mooring system
  - Active elements in watertight compartmentalization
  - Mustering and evacuation

- DFU12
  - (Is currently being discussed with the authorities and helicopter operators)

The following barriers have, on the basis of assessments of the focus among the parties in the industry, been identified as having a correspondingly high priority:

- Firewater supply
- Deluge systems
- Means of evacuation
- MOB boat

The barriers which have been selected for pilot projects are shown in sub-chapter 4.2.1.

An overview of the barriers which have not been selected and the arguments for their deselection are shown below.

2.4.1 Comments to the barriers which have not been selected in the project

There are some barriers which are usually considered to be crucial but which have not been included in the pilot project, for various reasons. This is discussed briefly below.

• Loss of integrity in process facilities	Covered by reporting of DFU1.
• Ignition prevention	Often referred to as the most important barrier in the process area, second only to preventing leaks. Shutdown of electrical ignition sources and limitation of hot work are relevant measures to reduce the risk of ignition. However, there are presently few companies which record data related to this barrier. A decision has therefore been made not to include **this barrier in the** pilot project. This barrier is highly relevant for future expansions.
• Blowdown/depressurization • Process safety • Ventilation • Drain system • Foam facility	Few companies presently record data related to these barriers. As there are already several barriers related to the process area, a decision has been made to **not** include these barriers in the pilot project.
• Fire and explosion barriers	Few companies presently record data related to these barriers. As they are passive, it is not easy to identify representative data for collection.
• Sea monitoring (collision risk) • Measures to alert ship to need for changing course	Covered by the reporting of DFU5.
• Emergency power and lighting • Alarm and warning systems • Mobilization of response teams	Few companies presently record data related to these barriers. As limiting the number of barriers which are to be reported is a key issue, a decision has been made to **not** include these barriers in the pilot project.

3. Reporting of barriers

The following key premises have been used as a basis for the requirements for reporting and assessment of barrier performance in the project:

- Data collection and analysis should, insofar as possible, take place in the industry.
- The basis for making assessments is best in the companies, and this should primarily take place in the companies. Both these items reflect the fact that it is the companies which to a considerable degree will have the best insight, and will in this respect be able to make relevant and nuanced assessments.
- The companies have a duty to establish indicators in accordance with Section 7 of the Management Regulations (see sub-chapter 2.1). It is therefore natural to, insofar as possible, base the fulfilment of relevant requirements in the new regulations on the companies' own activities. It will therefore be an objective to limit the submitted volume to that which is necessary for the purpose. The plan is to facilitate a limited submission of data.

- The assessments and data collection are limited to the production facilities, with the exception of marine systems.

4. Requirements for barrier data reporting

4.1 What is the purpose of the barriers?

All companies test the barriers on the facilities. There has been come variation as regards the systematization of the test data, and thus the basis for indicating reliability and accessibility.

In this part of the project relating to barriers, the purpose is to achieve reporting of reliability and availability data from the companies to achieve a limited number of barriers. It is necessary to record data for some selected barriers to achieve participation from all parties.

4.2 Scope of the reporting

4.2.1 Selected barriers

The selected barriers which data will be reported for are as follows:

- Fire detection, accessibility
- Gas detection, accessibility
- Shut-down, accessibility
  - Riser ESDV
  - Pressure relief valve, BDV
  - Safety valve, PSV
  - Wing and master valves, Xmas tree
  - Subsurface safety valve (DHSV)
- Isolation with BOP, accessibility
  - Drilling and well activities
  - Limited to production facilities
- Active fire protection
  - Deluge valves
  - Firewater supply, start failure
- HIPPS
  - HIPPS/QSV valve including signalling device, pilot/solenoid and logic (only for land-based facilities)
- Emergency Preparedness
  - Muster time, actual value
  - Ratios between actual value and SEPRA

Data for all barriers, with the exception of emergency preparedness, should be based on test data, from planned and/or not planned tests. Muster time based on emergency preparedness exercises.

All these barriers are considered key barriers at the facilities. The first three are related to the process and well area, which are important areas in relation to the consideration of experienced risk. The authority regulations place considerable emphasis on these areas. For these barriers, the relevant barriers are based on the definitions in Appendix A of OLF guideline 070, for compliance with IEC 61508 and 61511.

As regards fire and gas detection, it is not necessary to separate between different types of detectors. For shutdown valves, the reporting has been limited to the most critical, those isolating against the reservoir and the pipelines.

Test data for BOP are related to drilling and well activities.

Active fire protection is a key barrier for both ignited hydrocarbon leaks and other fires. Here, there are also strict limitations concerning what is to be reported, test data for deluge valves and start-up failure for fire pumps.

Mustering at the lifeboat station/in safe area is a barrier which works for all major accident near misses.

There is in that regard a certain range in the types of included barriers, although the emphasis is on the process and well area. This corresponds with the authorities' regulations, the companies' own focus and assessments related to experienced risk.

Practically all the barriers are of the type which is presently tested on the facilities, the challenges will be related to data capture and systematization, for the companies to a varying degree.

Safety-related equipment (e.g. fire detectors, gas detectors, valves, firewater pumps) is included in the OREDA project. Before an implementation phase, it should be considered whether cooperate with this project, to assess the options provided by OREDA-24 Databank.

4.2.2 Barriers – marine systems

The following barrier data are reported for marine systems:

- Closing of watertight doors
- Valves in the ballast system
- Mooring system
    - Number of situations with one brake not functioning
    - Number of situations where the other brake also fails

4.3 Reporting from the companies

The companies report barrier data twice a year

4.4 System limits and failure definitions

Appendix 1 shows examples of system limits and failure definitions for the barriers which are included in the pilot project for barriers.

4.5 Summary of data

For the reporting of data, emphasis is placed on only receiving summary data, without underlying data, as shown in Table 1.

Table 1 Barrier data for submission

Barrier	Reported data	
	Number of tests	**Number of failures according to definition**
Fire detection, accessibility	Number of tests of detectors/logic throughout the year	Number of failures
Gas detection, accessibility	Number of tests of detectors/logic throughout the year	Number of errors
Shut-down, accessibility	Number of tests of riser ESDV throughout the year • Separated into number closing tests and leak tests	Number of errors • Separated into number of tests for closing test and leak test
	Number of tests of pressure relief valve, BDV	Number of errors
	Number of tests of safety valve, PSV	Number of errors
	Number of tests of wing and master valves (Xmas tree) throughout the year • Separated into number of tests for closing test and leak test	Number of errors • Separated into number of tests for closing test and leak test
	Number of tests of DHSV throughout the year	Number of errors
Isolation with BOP Separate test and field data for: • BOP for drilling activities • BOP for coiled tubing activities • BOP for cable activities • BOP for snubbing rig activities	Number of tests of BOP throughout the year	Number of errors
Active fire protection	Number of tests of deluge valves throughout the year	Number of errors
	Number of start tests with fire pumps throughout the year	Number of errors
Emergency preparedness	Muster times observed throughout the year for muster drills	Ratios between actual muster time and associated SEPRA
	The number of persons who participated in the individual mustering drills	
Watertight compartmentalization	Number of tests with closing of watertight doors	Number of errors
Ballast system	Number of tests of valves in the ballast system	Number of errors
Mooring system	Number of situations with one brake not functioning Number of situations where the other brake also fails	Number of errors

The definition of system limits for each of the barriers is shown in chapter 6.

4.6 The PSA's use of the companies' data

For each individual reported barrier, the PSA will estimate average values for accessibility and reliability for all companies. Over time, such calculations can show trends.

5. Reference

NPD, 2001. Development in risk levels - the Norwegian Shelf, Pilot project report 2000, Summary, the Norwegian Petroleum Directorate (http://www.npd.no) 19 April 2001

OLF, 2001. Recommended guidelines for the application of IEC 61508 and IEC 61511 in the petroleum activities on the Norwegian Continental Shelf, OLF guideline 070, February 2001

ISO, 1998. Petroleum and natural gas industries — Offshore production installations-Control and mitigation of fires and explosions — Requirements and guidelines, ISO 13702

ISO, 2000. Petroleum and natural gas industry — Offshore production installations — Guidelines on tools and techniques for identification and assessment of hazards, ISO 17776

NORSOK Z-016 "Regularity management & Reliability Technology", Rev.1, December 1998

ISO 14224 "Collection and exchange of reliability and maintenance data for equipment", July 1999

OREDA industry project (www.oreda.com)

6. Appendices: System limits and error definitions

This chapter describes system limits and failure definition for the barriers which are included in the description of data collection in Chapter 4. The definitions and limits follow OLF guideline 070 where relevant.

6.1 Fire detection

6.1.1 System limits

Figure 1 shows system limits for data collection for the fire detection barrier.

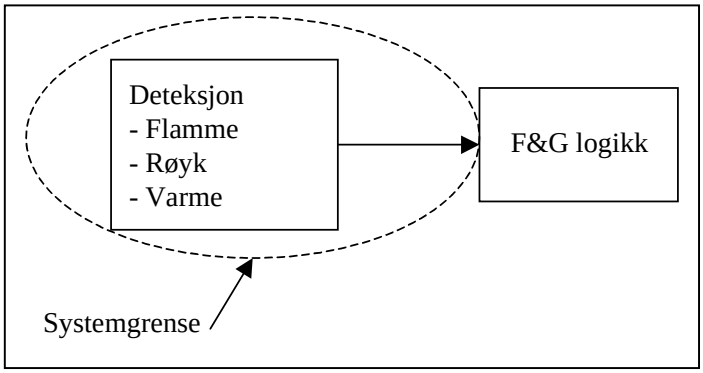

Figure 1 System limits for fire detection

6.1.2 Test procedure

All detectors are tested up to and including entry to fire function of F&G logic.

Restricted to automatic detection.

6.1.3 Failure definition

The following definition has been established for the definition of failures according to the system limits in Figure 1:

- F&G logic does not receive signals from detectors
- The indicator is counted per detector

' Signal' here refers to a signal which will activate an alarm in F&G panels.

6.2 Gas detection

6.2.1 System limits

Figure 2 shows system limits for data collection for the gas detection barrier.

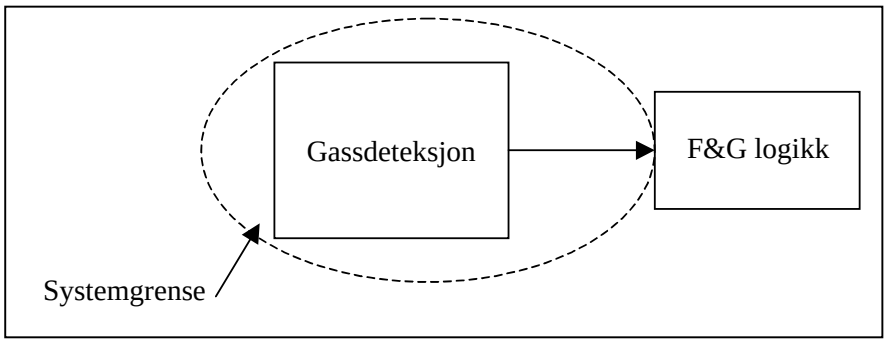

Figure 2 System limits for gas detection

6.2.2 Test procedure

All detectors are tested up to and including entry to gas function of F&G logic.

Restricted to automatic detection of hydrocarbon gas.

6.2.3 Error definition

For definition of failures according to the system limits in Figure 2, the following definition has been established:

- F&G logic does not receive any signal/wrong signal from detectors according to the functional requirements
- The indicator is counted per detector

Point detectors show the wrong signal when F&G logic does not receive a signal corresponding to the upper alarm limit when using prescribed test gas.

Line detectors have the wrong signal when F&G logic does not receive a signal corresponding to the upper alarm limit when using prescribed test filter.

6.3 Shut-down

The shutdown function includes riser ESD valves, pressure relief valve, BDV, and safety valve, PSV.

6.3.1 System limits – ESD valves

Figure 3 shows system limits for data collection for the shutdown barrier.

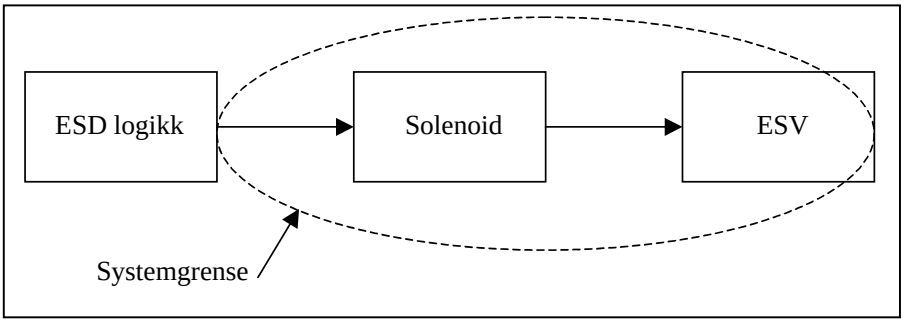

Figure 3 System limits for shut down with ESV

6.3.2 Test procedure - ESV

ESVs are tested from signal from ESD logic up to and including function of valve, including solenoid valve.

Restricted to ESVs against pipelines/risers (and against hydrocarbon reservoirs, see sub-chapter 6.4).

6.3.3 Failure definition - ESV

The following definition has been established for the definition of errors according to the system limits in Figure 3:

- ESV does not close within the safety critical timespan, or
- ESV has a higher internal leak rate than the specified value (safety critical rate for the relevant valve)
- The indicator is counted per ESV, including signal exchange from ESD logic and solenoid valve

The two failure modes closing failure and internal leak are reported separately.

Safety critical closing time is:

- Valve not closing within specified closing time when this has been established in connection with risk assessments.
- 2 seconds per inch (for example 12” valve = 24 seconds) where closing time is not specified.

6.3.4 System limits – pressure relief valves

Figure 4 shows system limits for data collection for the depressurization, BDV, barrier.

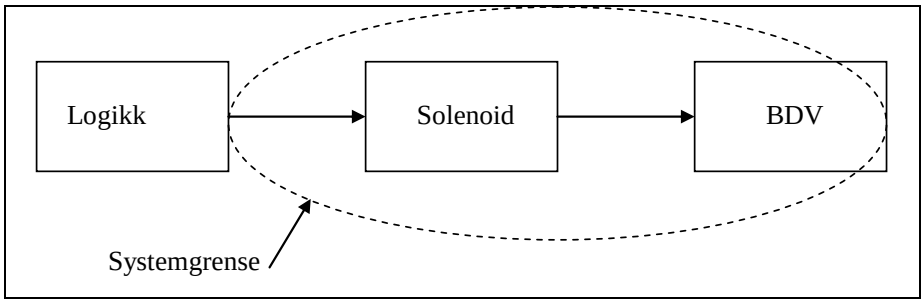

Figure 4 System limits for pressure relief valve

6.3.5 Test procedure – BDV valves

BDVs are tested from signal from logic and up to and including function of valve, including solenoid valve.

6.3.6 Failure definition – BDV valves

The following definition has been established for the definition of errors according to the system limits in Figure 3:

- BDV does not open within the specified time
- The indicator is counted per BDV, including signal exchange from logic and solenoid valve

6.3.7 System limits – PSV valves

Figure 5 shows system limits for data collection for the depressurization barrier.

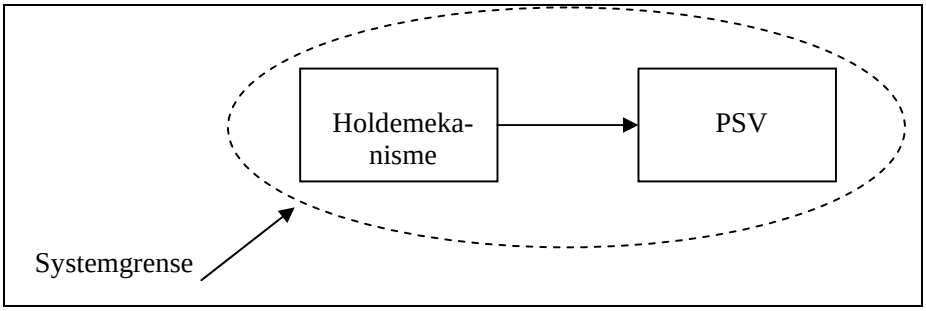

Figure 5 System limits for safety valve

6.3.8 Test procedure – PSV valves

PSVs are tested during pressurization (x% above set value) of valve, including holding mechanism.

6.3.9 Failure definition – PSV valves

For definition of errors according to the system limits in Figure 3, the following definition has been established:

- PSV does not open at the 120% of set point or over 50 bar, whichever is lower.
- The indicator is counted per PSV

6.4 Well isolation - production well

6.4.1 System limits

Figure 6 shows system limits for data collection for the isolation of production well barrier.

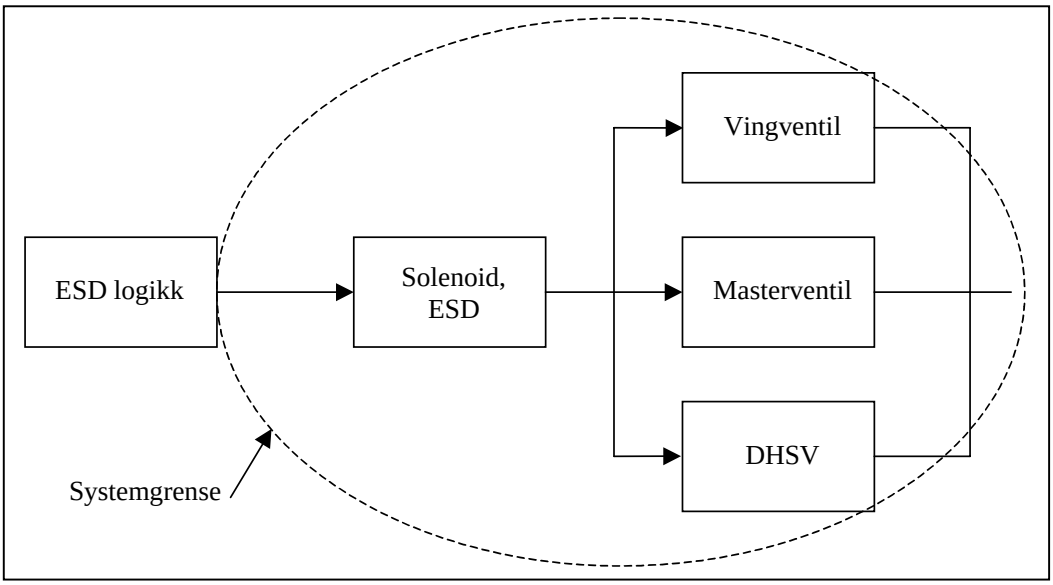

Figure 6 System limits for well isolation, production well

6.4.2 Test procedure

Wing, master and DHSV are tested from signal from ESD logic and up to and including valve function, including ESD solenoid valve.

Each valve is tested separately.

All production wells, at the facility and subsea production well.

6.4.3 Error definition

For definition of errors according to the system limits in Figure 6, the following definition has been established:

- The valve does not close according to function within the specified time (time requirement does not apply to DHSV)
- The valve has a higher internal leak rate (i.e. pressure build-up) than the specified value (in own procedure or according to API14B).
- The indicators is counted per valve (wing, master or DHSV), including solenoid and signal exchange from ESD logic

The two error modes closing error and internal leak are reported separately.

6.5 Well isolation with BOP

6.5.1 System limits

Figure 7 shows system limits for data collection for the isolation of well during drilling with BOP barrier (well intervention not included).

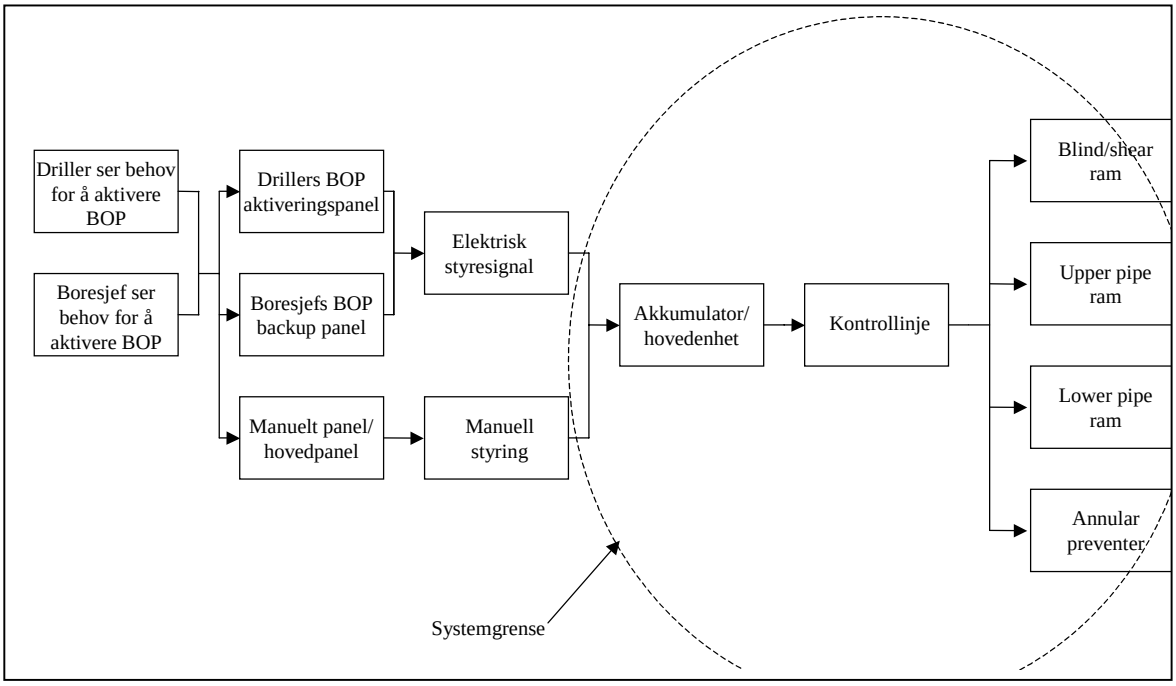

Figure 7 System limits for well isolation with BOP

6.5.2 Test procedure

The valves in BOP are leak tested separately, by observing the pressure drop above the valve.

Use of BOP at the facility is included.

6.5.3 Error definition

The following definition has been established for the definition of errors according to the system limits in Figure 7:

- The valve does not maintain constant pressure drop over a given period of time.
- The indicator is counted per valve in BOP

For pressure drop requirements, see NORSOK D010, Ch. 5.1.1.2 & 5.1.1.3, API 14B if relevant.

6.6 Fire protection

6.6.1 System limits

Figure 8 shows system limits for data collection for the barriers related to the fire protection function.

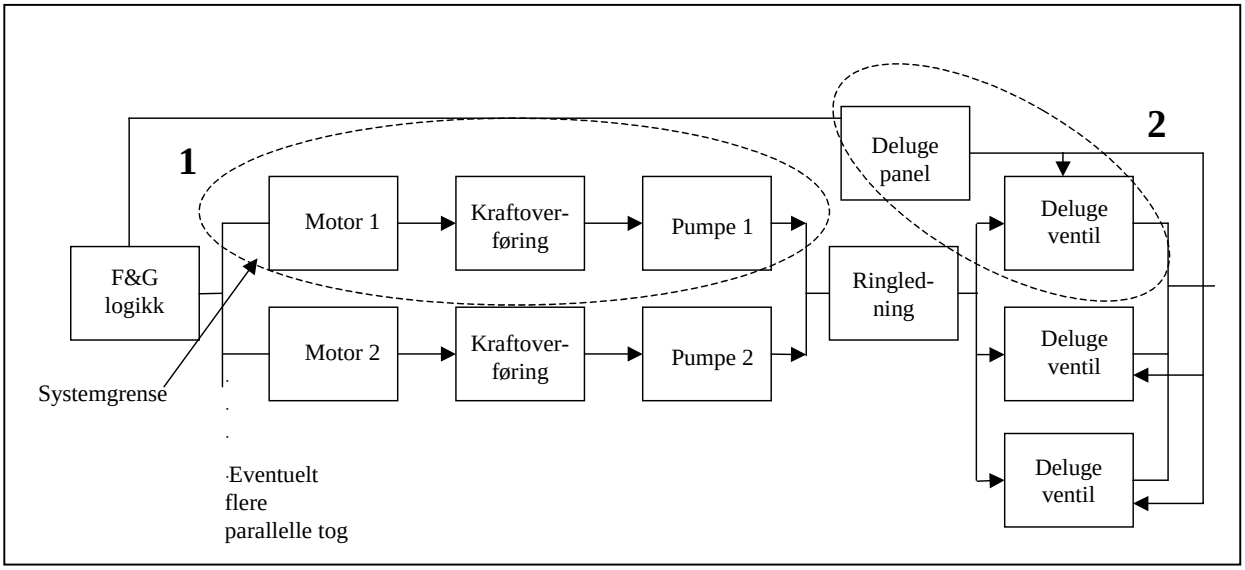

Figure 8 System limits for fire protection

There are two sets of system limits in Figure 8, for firewater supply (system 1, to ring main) and deluge valves for valves for loops in the process areas (system 2). These have their respective test procedures and failure definitions.

This means that there are two indicators which must be recorded for active fire protection.

6.6.2 Test procedure – deluge valves

Deluge panels and deluge valves are tested, including feedback to F&G/ESD.

Each valve is tested separately.

6.6.3 Failure definition – deluge valves

The following definition has been established for the definition of failures relating to deluge valves according to the system limits in Figure 8:

- Deluge valve does not open
- The indicator is counted per deluge control valve, including signal exchange from manual/automatic activation in the deluge panel

6.6.4 Test procedure – firewater supply

This is an indicator which must be reported:

- Start-up failure

Fire pumps and start sequence are tested, including continuous monitoring of the pump's status.

The indicator is counted per pump, regardless of the capacity of each pump compared with the defined need for firewater.

6.6.5 Failure definition – firewater supply

The following definition has been established for firewater supply according to the system limits in Figure 8:

- Start-up failure, firewater pump or engine (1 unit) i.e. does not start to pump water at the first attempt

6.7 Emergency Preparedness

6.7.1 System limits

Figure 9 shows system limits for data collection for the mustering barrier.

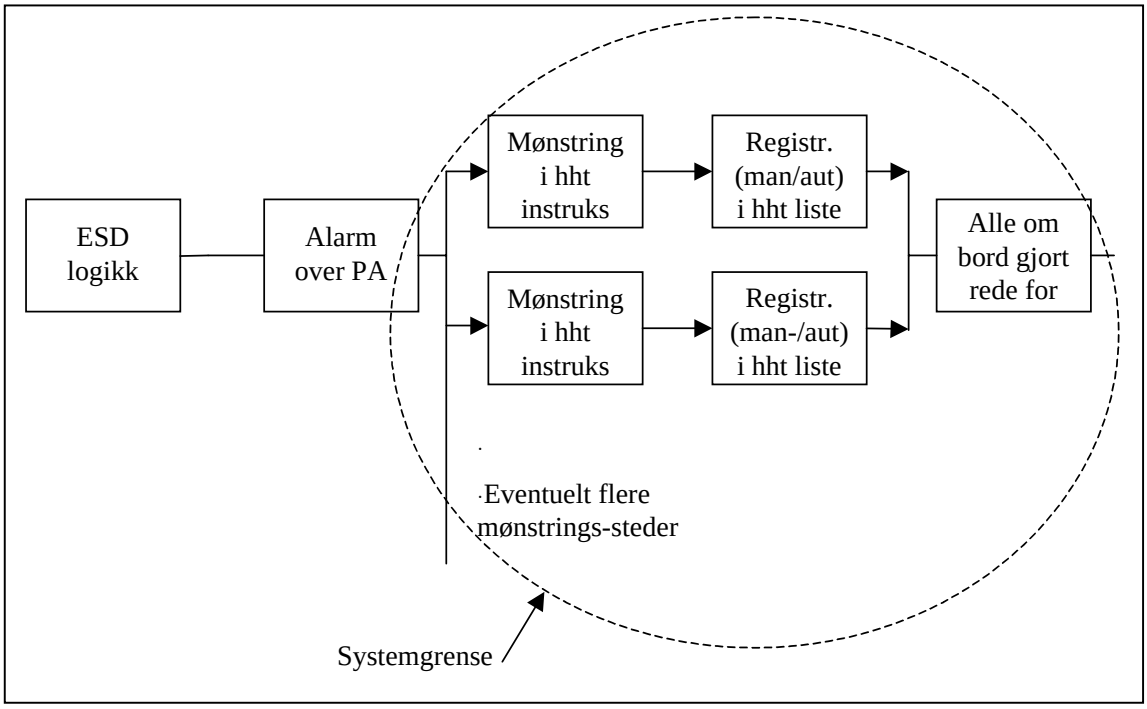

Figure 9 System limits for mustering

6.7.2 Test procedure

Mustering is carried out as drills according to the emergency instructions. Data can also be recorded during actual muster alarms situations. The system for registration of turnout at the muster points is also included, until everyone on board has been accounted for.

The indicator shall record the time elapsed until mustering is complete in relation to the facility's specific muster time requirements.

6.7.3 Definition of response

The following definition has been established for the definition of response according to the system limits in Figure 9:

- Turnout and reporting at all muster stations according to emergency procedures and any circumstances defined for the relevant scenario.
- Mustering shall not be considered completed before the location of all persons is known.

6.8 Watertight compartmentalization, hull

6.8.1 System limits

The system included consists of watertight doors which are part of the hull for floating facilities. The door itself, the closing mechanism and the signal transfer are included.

6.8.2 Test procedure

The closing mechanism and door are included in the test. Each door is tested separately.

The number of doors tested is recorded.

6.8.3 Error definition

Door not closing completely (locking) within the specified time.
Doors which are not completely closed during testing or which do not close within the time requirements stipulated by Sections 38 and 41 of the Norwegian Maritime Directorate's Regulations of 20 December 1991 No. 878 relating to stability, watertight compartmentalization and watertight/weatherproof closing mechanism at mobile installations.

6.9 Ballast system

6.9.1 System limits

The system included is limited to valves in the ballast system, including solenoids and signal transfer.

6.9.2 Test procedure

Signal transfer, solenoids and valves are included in the test. Each valve is tested separately.

The number of valves tested is recorded.

6.9.3 Error definition

Valve opens/does not close within the specified time when tested.

6.10 Mooring system

6.10.1 System limits

The brakes in the mooring line are included in the system.

6.10.2 Test procedure

No separate test shall be performed. A record must be made of the number of situations where one brake in the mooring system is not functioning during the use of the facility - regardless of cause.

Furthermore, the instances where the other brake has failed, partly or completely, when the first brake does not function.

6.10.3 Error definition

The reporting criterion for a brake which does not function is that the emergency stop was activated, or that the chain was discharged without control. If there are effective mechanical chain stoppers, the figure can be reported as zero.

The reporting criterion for instances where the other brake has failed, partly or completely, when the first brake does not function, is that the emergency stop had to be activated or that the chain was discharged without control. If there are effective mechanical chain stoppers, the figure can be reported as zero.

6.11 HIPPS

There are several versions of HIPPS. The most common are:

a) Valves / QSV which is activated by a dedicated pressure switch (PSHH) via a pilot or solenoid valve
b) Valve/ QSV which is activated by pressure transmitter(s) via logic and pilot or solenoid valve, if relevant.

The total HIPPS function can consist of one or more independent loops/valves in sequence and/or in parallel.

6.11.1 System limits – HIPPS

Figure 10 shows the system limit for data collection for the HIPPS barrier.

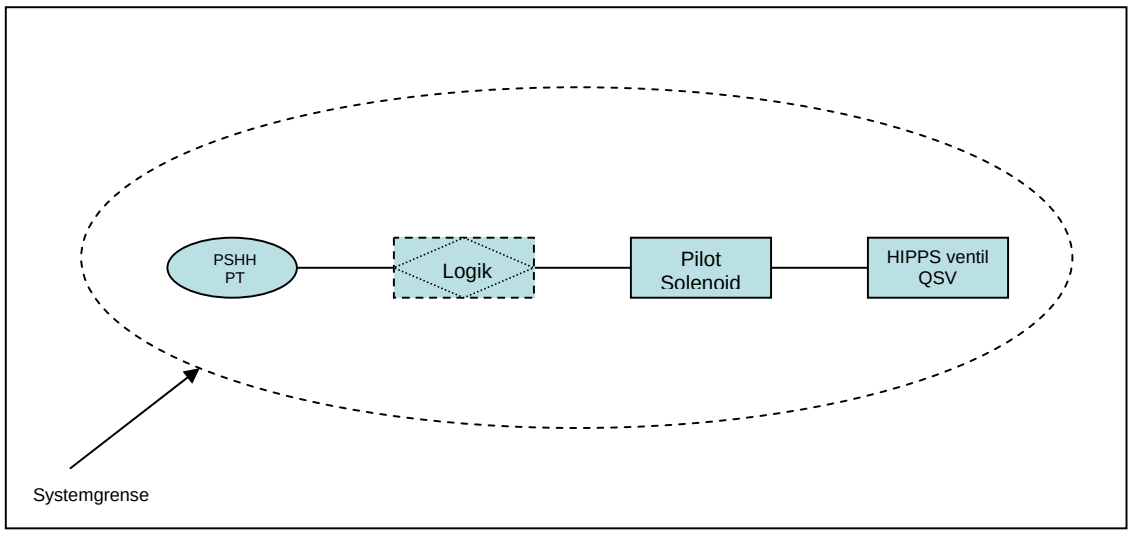

Figure 10 System limit for HIPPS

6.11.2 Test procedure

Each HIPPS valve/HIPPS loop is tested with signal from pressure switch/pressure transmitter including logic, pilot/solenoid up to and including function of valve.

Each valve is tested separately.

6.11.3 Failure definition

The following definition has been established for definition of failures according to the system limits in Figure 10:

- The valve does not close according to function within the specified time
- The indicator is counted per HIPPS/QSV valve including signalling device, pilot/solenoid and logic