Human factors in investigations and barrier management

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• Regulations
  - regarding HF and barrier management

• Barrier Management
  - technical, operational and organisational barrier elements

• RNNP qualitative studies
  - HC leaks
  - Well control
Important HF regulation requirements

Management
RF (FHSE) § 17 management system
SF (MR) § 4 Risk reduction

Analysis
SF (MR) § 18 Working environment analysis

Design of Plant and Equipment
IF (FR) § 69 Lifting appliances and lifting gear [incl. Remote operation of pipes]
IF (FR) § 55 Production plants
IF (FR) chapter XII maritime facilities
NORSOK S-001 Technical Safety
NORSOK Z-013 Risk and emergency preparedness analysis

Design of work and common areas
IF (FR) chapter III-IV

Function allocation
SF (MR) § 13 Work processes

Organisational framework
SF (MR) § 14 Manning and competence

Information
SF (MR) § 15 Information
IF (FR) § 17 Instrumentation for monitoring and recording
AF (AR) § 31 Monitoring and control

Organisation of Work
SF (MR) chapter IV Resources and processes

Barriers
SF (MR) § 5 Barriers

Human-Machine Interface
IF (FR) § 20 Ergonomic design
IF (FR) § 23 Human-machine interface and information presentation
IF (FR) § 34a Control and monitoring system

Work hours and Restitution
Working environment Act chapter 10
RF (FHSE) §§ 33-44
AF (AR) § 19 Accommodation and cabin sharing
AF (AR) § 33 Organisation of work [incl. rest and restitution]

Human Factors requirements in MR § 18 and AR § 33 (abbreviated)

Technical, operational and organisational solutions shall reduce risk for:
- a) mistakes that can result in hazard and accident situations,
- b) exposure and physical or psychological effects.

The employer shall ensure that the work is organised so as to avoid hazardous exposure and unfortunate physical and psychological strains for the individual employee, and to reduce the probability of mistakes that can lead to hazard and accident situations.
Management
Regulation section 5
Barriers (extract)

It shall be known what barriers have been established and which function they are intended to fulfill, as well as what performance requirements have been defined in respect of the technical, operational or organisational elements necessary for the individual barrier to be effective.

Many different interpretations of the concept “barrier”. Particular when it comes to operational and organisational barrier elements.

The necessary technical, operational and organizational barrier elements needed to ensure a specific barrier function must be identified.

Performance requirements must be specific and verifiable, also when it comes to operational and organisational requirements.

The PSA’s guideline related to barriers

• PSA have identified relatively substantial differences between the players understanding of the regulatory requirements related to barrier management.
• As a consequence of this, a number of nonconformities with significance for safety have been identified.
• That follow-up has highlighted a need to make the regulatory requirements related to barrier management more easily accessible.
• However, this document does not form part of the formal petroleum regulations.
Barrier Concept

- Barrier: Technical, operational and organisational elements which individually or together shall:
  a) reduce the possibility of occurrence of specific errors or hazards, or
  b) reduce or prevent damage if they occur.
- Barrier elements: Technical, operational or organizational measures or solutions necessary for realizing barrier functions
- Barrier function: the task or role of the barrier
Barrier element definitions

• **Organisational barrier elements** – personnel with defined roles or function which constitute a part of realising a barrier function

• **Operational barrier elements** – actions and activities the personnel have to perform constitute a part of realising a barrier function

• **Technical barrier elements** - equipment and systems which constitute a part of realising a barrier function

Some examples of performance influencing factors which is not organisational or operational barrier elements

• Procedures
  - but can describe equipment, personnel and actions which are incorporated in a barrier function, and how barrier elements shall be established, tested and maintained

• Safe Job Analyses (SJA)
  - but a tool for identifying risk which must be managed by technical, organisational and operational barrier elements

• Work permit (WP)
  - but can specify which barrier elements must be in place before a specific job begun

• Management in general
  - But can contribute to ensuring that routines and resources are in place for establishing and maintaining barriers

• Specific management roles and their functions at different levels however can be organisational and operational barrier elements
Barrier function

Barrier elements

Performance requirements

Performance influencing factors

Barrier

Technical

Operational

Organisational

Capacity, functionality, efficiency, integrity, reliability, availability, resistance to loads, resilience, specific qualifications, mobilisation time...

Management, experience, procedures, competence, human factors, MMI, exercise, safety culture, maintenance management, restitution...

DFU hydrocarbon leak

Barrier function

Barrier elements

Performance requirements

Performance influencing factors

Prevent leak (when opening hydrocarbon equipment)

Qualification requirements for each position: formal education, health certificate, familiarisation on board, training on the specific system/procedures, qualification requirements concerning relevant risk factors, availability of verifying personnel.

Operational:

- Inform COT
- Isolate
- Establish and leak test isolation + perform drain and purging
- Verify isolations
- Approve isolations
- Demonstrate zero energy check and proper interaction
- (Work on HC equipment without affecting isolation)

Reinstate
- Approve reinstatement
- Inform and leak test
- Remove isolations
- Verify removal of isolations and reinstatement of break points

Establish, verify and approve isolation plan according to company work processes, purging until no hydrocarbons are present in the isolated system, isolation shall be verified by another competent person.

Sufficient level of isolation - Possible to test barrier

Technical:
- Isolation: valves, blinds, Drain valve/line, Purging equipment

Organisational:
- Operation supervisor
- Area technician
- Executing skilled worker
- CCR operator

Inspection and maintenance according to planned frequency, quality and availability of isolation plan and other procedures, capacity and competence in the organisation, quality of the familiarisation program, quality of communication, team experience and training, security priorities and follow-up from leaders, workload and number of tasks to be performed, quality of man-machine interface, adequate restitutions, risk analysis and assessments, available information about current technical state (such as RNNP results), acknowledge test results and implement necessary follow-up actions.
Example: Ship collision

What is the task / purpose of these elements?

- Radar monitoring
- Structural strength
- Structural robustness
- Uomanning
- Warning the offshore instal.
- Shut down
- Standby vessel approach
- Automatic ship identification
- Radio contact with ship
- Hosing of bridge

What is the task / purpose of these elements?

- radar
- automatic ship identification and tracking
- alarms
- standby vessel

Organisational
- Personnel monitoring ship traffic
- Personnel responding to alerts
- Standby vessel crew

Operational:
- Monitor the system
- Respond to alarms
- Contact ship and installation
- Standby vessel operations

Performance requirements:
- Range of radar, requirements to automatic ship identification, presence of sound and visual alarms, presence and capacity (e.g. speed) of standby vessel.
- Training at the specific system, drills, back-up personnel.
- Criteria for when to alert, mobilisation time for back-up and standby vessel.

Performance influencing factors:
- Risk understanding, experience, maintenance, lighting, environment/weather, ship traffic extent and regulations, fatigue, noise, language, man machine interface...
Trends in risk level in the petroleum activity (RNNP) 
Qualitative Studies

Qualitative Study – (RNNP)

The Trends in Risk Level reports aims to:
• Identify areas which are critical for HSE
• Give priority to identifying causes in order to prevent unplanned events and accidents
  - In 2010 a qualitative study of hydrocarbon leaks, their causes and preventive measures – Sintef, Studio Apertura
  - In 2011 a qualitative study on casual relations and measures associated with well control incidents – Sintef
  - In 2013 a qualitative study causes and measures associated with structural and maritime incidents – Safetec, Preventor

Only some few results from these studies will be presented here
Qualitative study in 2010
Hydrocarbon releases – cause vs measures

This study's main object was to identify some challenges that the industry can make use of in its own preparation of measures to reduce risk of hydrocarbon leakages.

Problems addressed in this study:

• What human, technical and organizational causes can be put forward to explain the occurrence of hydrocarbon leaks on the Norwegian Continental Shelf?

• What risk reducing measures has been proposed after post-event investigations?

• Is there a good correspondence between identified causes and these measures?

Data

• 42 investigation reports (2002-2009)
• Reports from various research communities, consultancies and authorities
• 33 research articles
• Description of measures considered by the operator companies' own specialists to be the most important contribution to risk reduction
Identified causes (direct and underlying) and proposed measures from the company investigation reports

Study basis – Well Control Incidents

- 10 well control investigation reports
- 21 event reports
- 18 interviews - total of 33 persons
- A review of written evaluation on causes and suggested measures received from company experts on drilling from 18 companies
How do identified causes and measures correspond?

Spark arrestor silencer A
Air outlet engine room
Turbine exhaust
Ignited vent stack

Fire on Valhall PCP 13 July 2011
Figure 10. Crane driver in the cabin, with instruments for engine monitoring positioned to the right and partly behind him when the crane is being operated.

Figure 11. The fire and gas panel for local notification of the crane driver is placed behind him and above the floor. The audible signal is inoperative.
Detect and inform on overheating and fire in engine

Organisational
- Crane driver
- CCR operator
- Fire fighting team

Operational
- Monitor the system
- Respond to alarms
- Shut down engine
- Inform CCR
- Firefight activities
- Evacuation

Technical
- Engine temperature (measures)
- Fire detector
- Alarm panels

Performance requirements
- Light and sound alarm (temperature criteria – fire detection)
- Training and knowledge concerning the status of the alarm systems
- Immediately shut down engine, only perform firefighting activities if it is possible to extinguish the fire by hand held equipment, otherwise immediately evacuate.

Performance influencing factors
- Work place design, man-machine interface, noise, maintenance of alarm systems, management of change