Goliat Barrier Management

ESRA Norge; March 25, 2015

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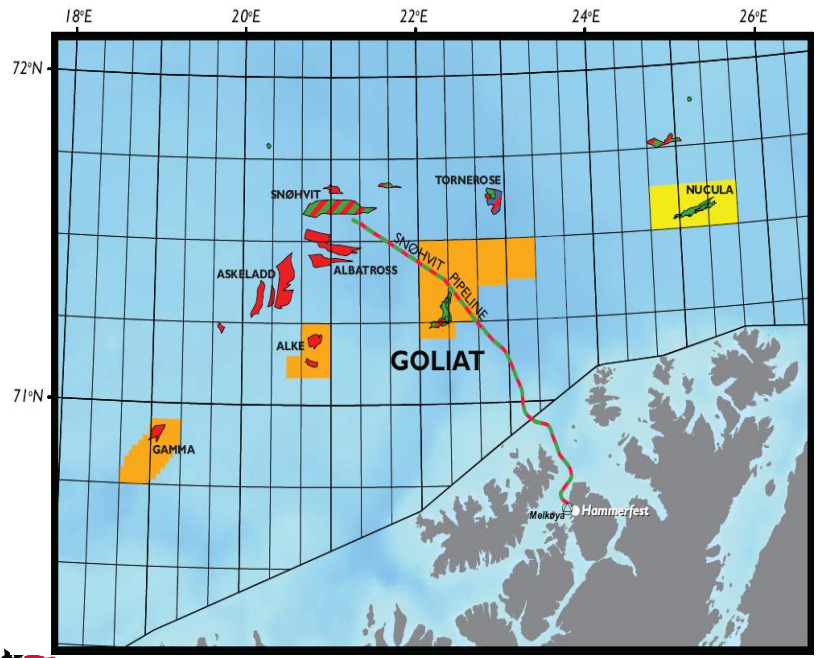
www.eninorge.com

PL 229 Goliat Location and Partnership

- License awarded in 1997
- Present licensees
  - •Eni Norge AS (op) 65%
  - •Statoil Petroleum AS 35%
- Production start-up Q3 2015



GOLIAT FIELD:

- Geostationary FPSO
- 8 subsea templates
- flow lines, risers and umbilical
- 22 wells 12 production
  7 water injectors
  3 gas injectors

- complete oil treatment
- power supply from shore
- underwater power cable integrated with on-board power generation
- stabilized oil exported by tanker
- associated gas re-injected

Fully PSA/NORSOK compliant
No class or flag state

Goliat FPSO

The PSA's Requirements and Expectations in relation to barriers (1/2)

The Operator shall:

- Establish strategies and principles which shall form the basis for design, operation and maintenance of barriers such that the barriers' functionality shall be maintained throughout the lifetime of the installation. These shall:
  - Give all involved parties an understanding of the basis of the requirements for the individual barriers
  - Show the connection between the risk and hazard assessments and the requirements for and regarding barriers

The PSA's requirements and expectations (2/2)

The Operator shall further:

- Establish barriers – and it shall be known:
  - Which function the barriers shall maintain
  - Which requirements for performance have been placed on the technical, operational or organisational elements that are necessary to ensure that the individual barrier is effective
  - Which barriers are non-functioning or weakened
  - Implement necessary compensating measures to restore or compensate for missing or weakened barriers

History/background

- Eni Norge's first major development project
- From license partner to 24/7 operation
- PSA's increased focus on major accident prevention and barrier management

Integrated Barrier Management Project

Purpose

- The purpose of the project is to establish the safety and barrier strategy and performance requirements to all barriers for the operation phase of Goliat based on the specific risk picture on the Goliat FPSO

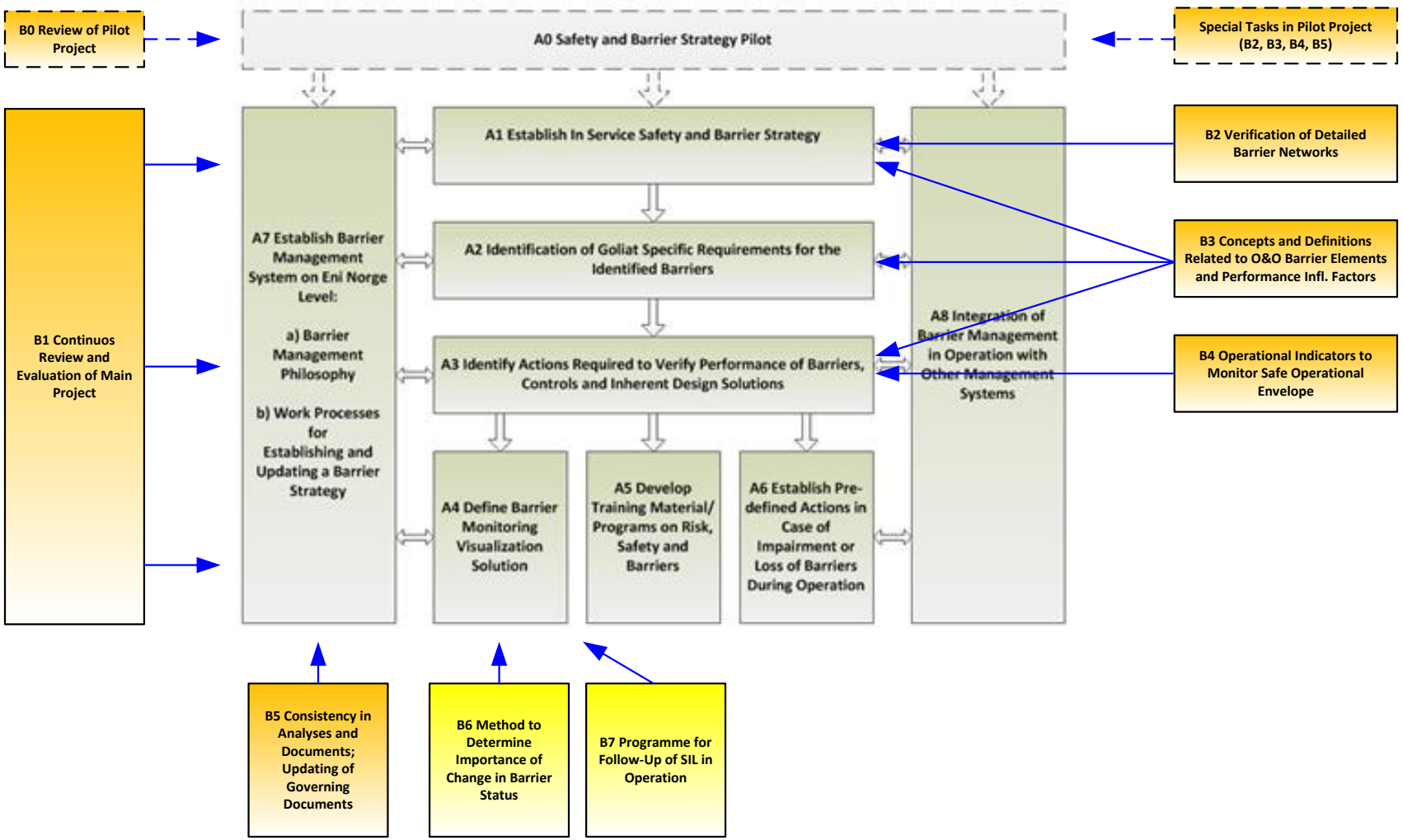
Participants

- Goliat Project
- Operations
- HSEQ Dept.
- D&T Dept.
- Professional support:
  - SINTEF
  - Safetec
  - ABB

The objective of the “In Service Safety and Barrier Strategy” is to provide an overview of all barriers in place to prevent and/or mitigate risk on Goliat FPSO, and thus be able to control risk through barrier management in daily operations.


Post ITT Phase
ITT Phase
Post FEED phase
HAZIDs
QRA, EER Assessment
DAL
Other Safety Evaluations
Experience feedback from previous projects/ Sevan Marine Units in operation
HSE Register
FEED phase Fire and Explosion Strategy Goliat
FEED phase Evacuation, Escape and Rescue Strategy
Safety Strategy
Layout drawings, 3-D model and documents available per November 2009
Petroleum Safety Authority Norway (PSA)
NORSOK Standards
ISO 13702:1999
Goliat Initial Safety Requirements for Systems and Barriers
Detail Eng. phase
Design Development
Safety Strategy Future revision(s)
Goliat Detailed Safety Requirements for Systems and Barriers
Design- and Layout Arrangement drawings - Future revision(s)
Design Development
Operation Phase
As-built
In Service Safety Strategy
Goliat In Service Safety Requirements for Systems and Barriers
As-built

Barrier Management Project – activity break down



Barrier Management Project - Methodology

From this:

Barrier Strategy based on PS (technical safety systems)

Requirements based on regulations & experience

Limited risk control and barrier mngt (no clear link to area risk)

To this:

Barrier Strategy based on identification of area hazards & corresponding required barrier functions

Requirements linked to barrier elements for each barrier function

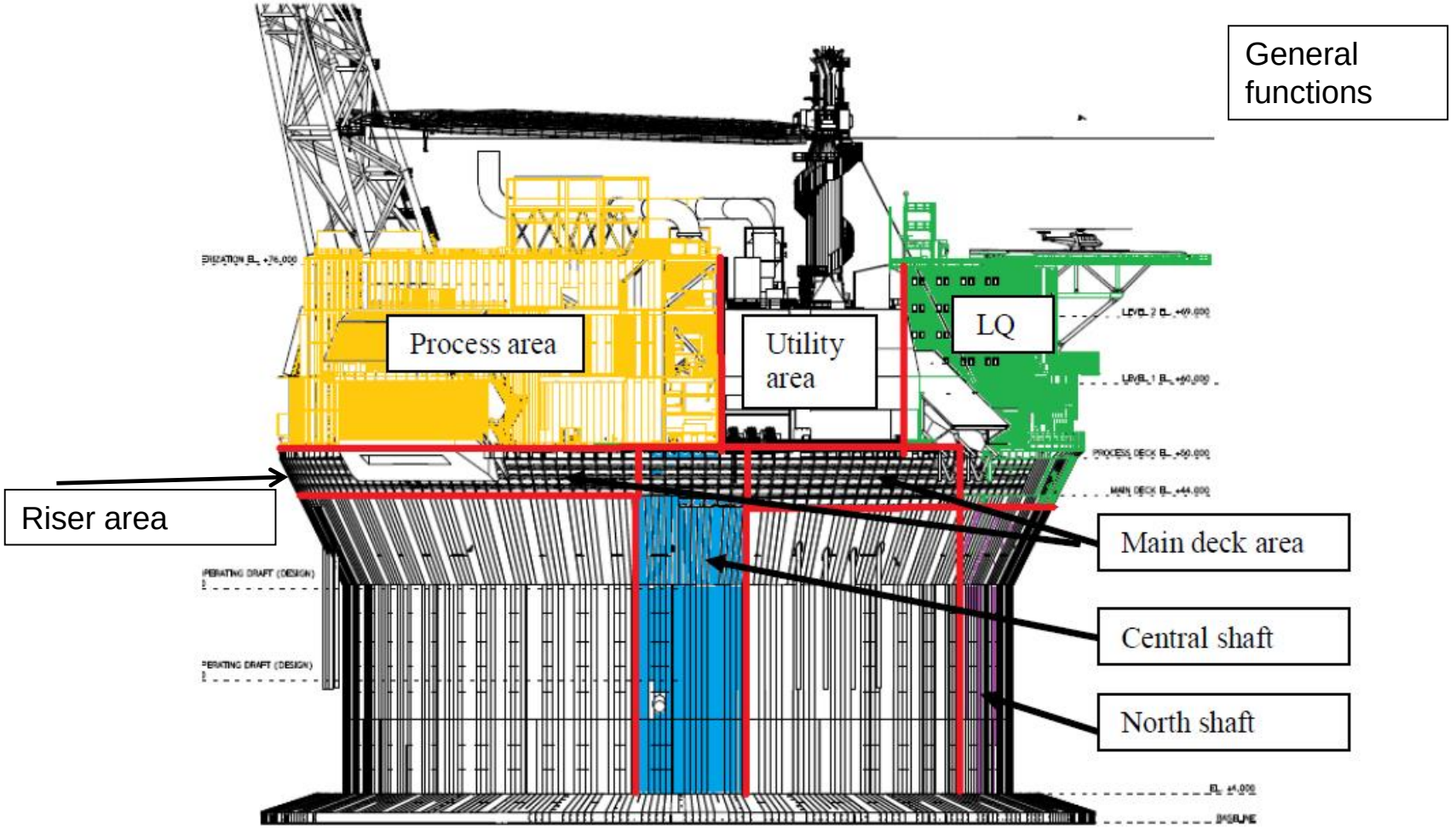
Increased risk control and barrier mngt (clearer link to area risk)

Barrier Management Project - Methodology

1. Agree on concepts & definitions
2. Establishing the context and an area division
3. Identifying major accident hazards
4. Identifying barrier functions (and sub-functions) to mitigate the risk identified in step 3
5. Identifying barrier elements for each barrier (sub)function
6. Identifying performance requirements for each barrier element
7. Identifying verification activities for the performance requirements of each barrier element

In service Safety and Barrier Strategy for Goliat

Main Areas on Goliat FPSO

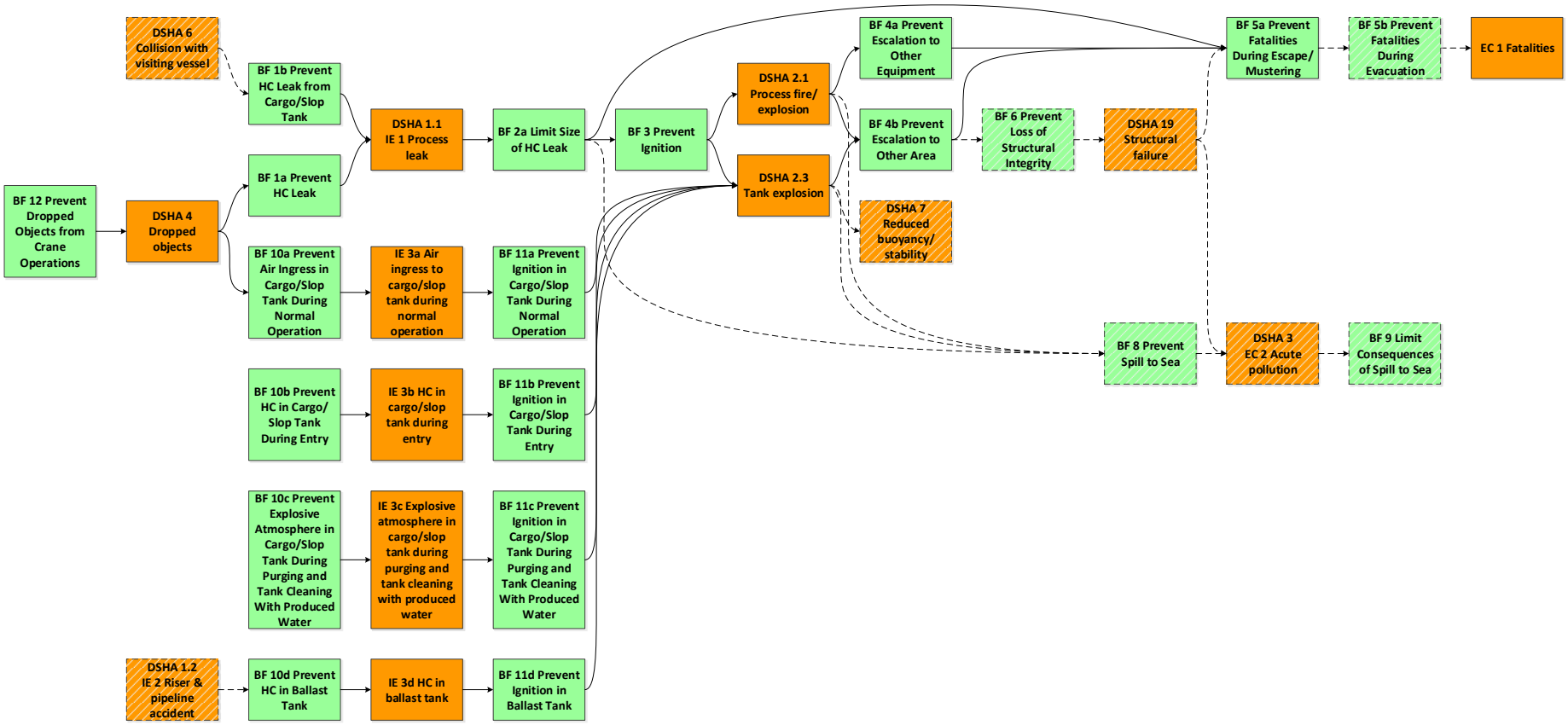


Barrier functions vs areas

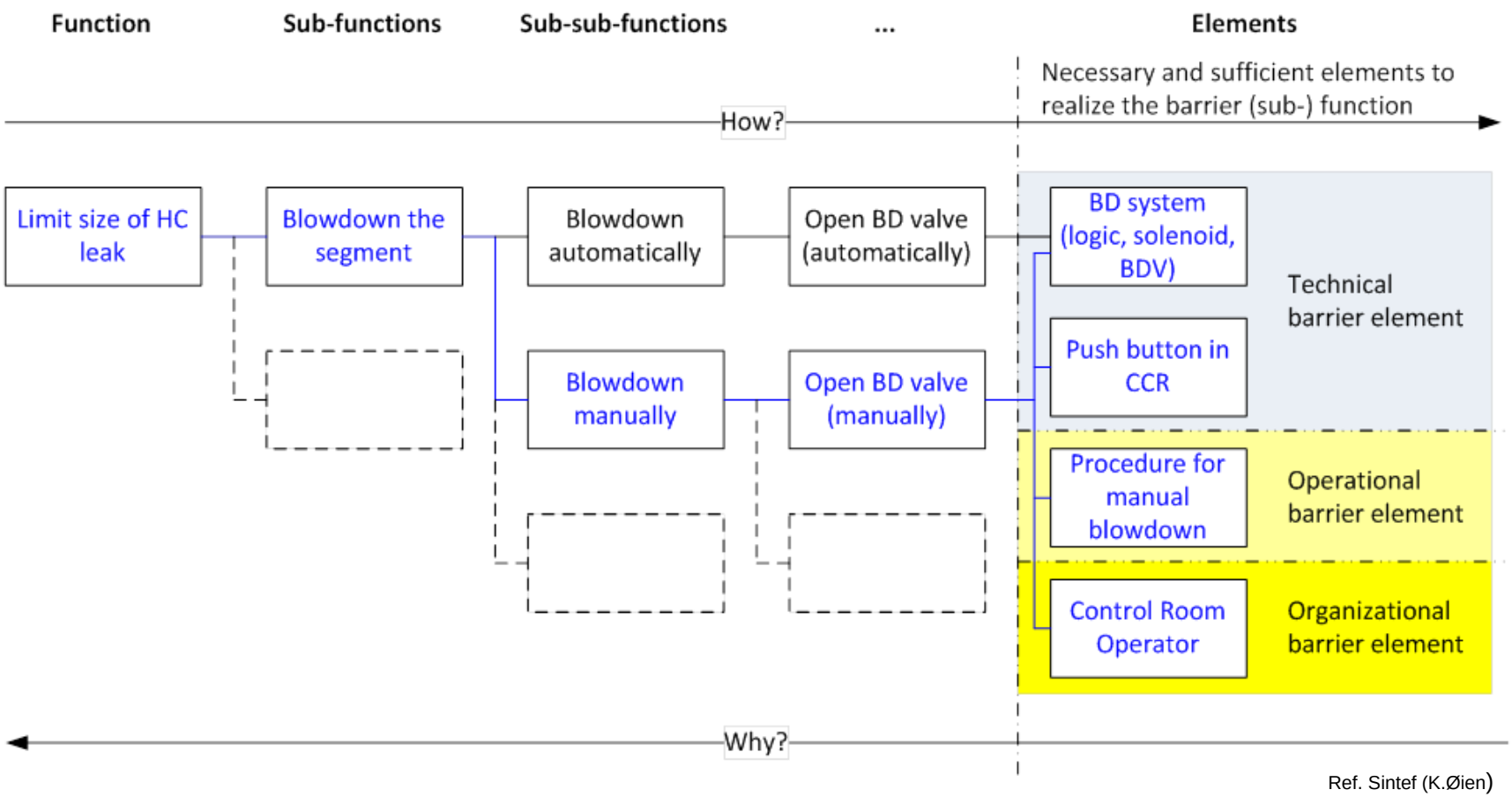
Barrier Functions		Main Deck Area	Process Area	Riser Area	Utility Area	Living Quarter	Central Shaft	North Shaft	Global
BF 1a	Prevent HC leak	x	x	x			x		
BF 1b	Prevent HC leak from cargo and slop tank	x							
BF 1c	Prevent HC leak from offloading operation		x						
BF 2a	Limit size of HC leak	x	x	x			x		
BF 2b	Limit size of HC leak from offloading operation		x						
BF 2c	Limit size of HC leak from riser/pipeline leaks			x					x
BF 3	Prevent ignition	x	x	x	x	x	x	x	
BF 4a	Prevent escalation to other equipment	x	x	x			x		
BF 4b	Prevent escalation to other area	x	x	x	x		x	x	
BF 5	Prevent fatalities during EER	x	x	x	x	x	x	x	x
BF 6	Prevent loss of structural integrity	x	x	x					x

.
.
.
Etc (37 in total)

Identify barrier functions by «barrier grid» technique



Barrier sub-functions and barrier elements identified and recorded in spread sheets

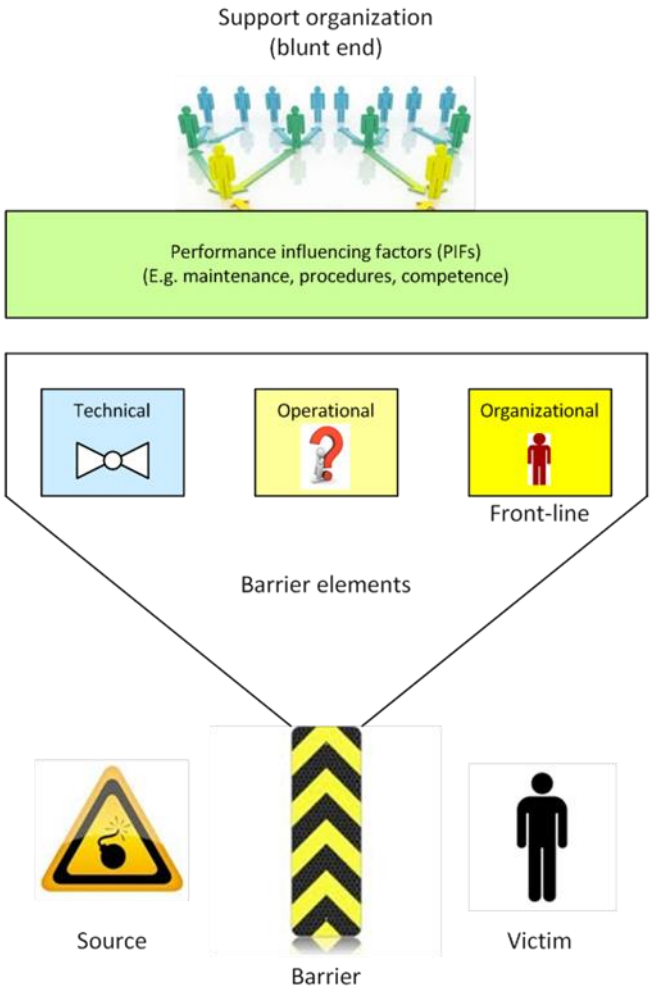


Ref. Sintef (K.Øien)

Barrier elements

- The barrier elements represent the solutions or "materialization" of the sub-functions necessary to realize a barrier function

- Technical barriers need to be made operational (e.g. how to operate the barrier systems) and organisational responsibility (e.g. who is going to operate the barrier systems; who is authorized to realise a barrier function) needs to be assigned



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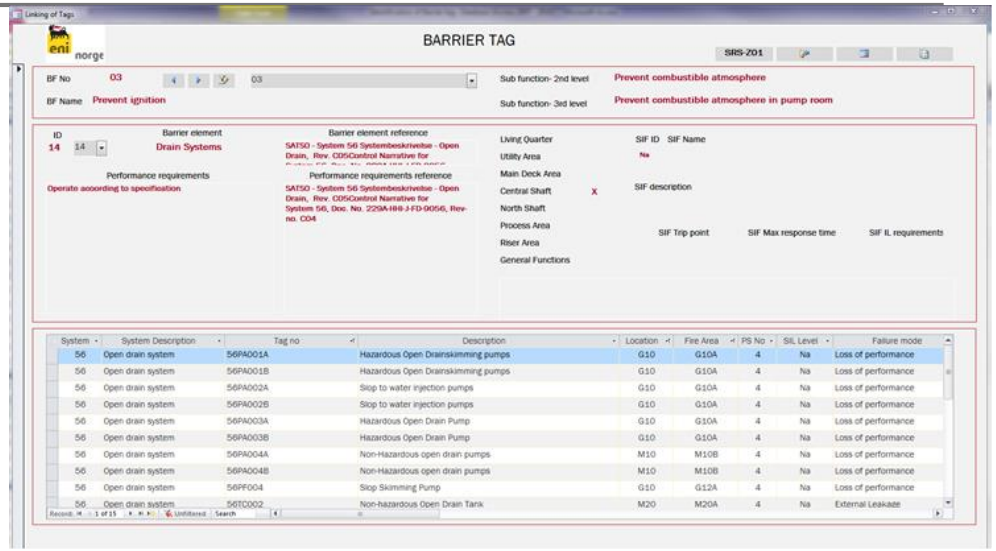
Barrier Status – Operational & Organizational elements

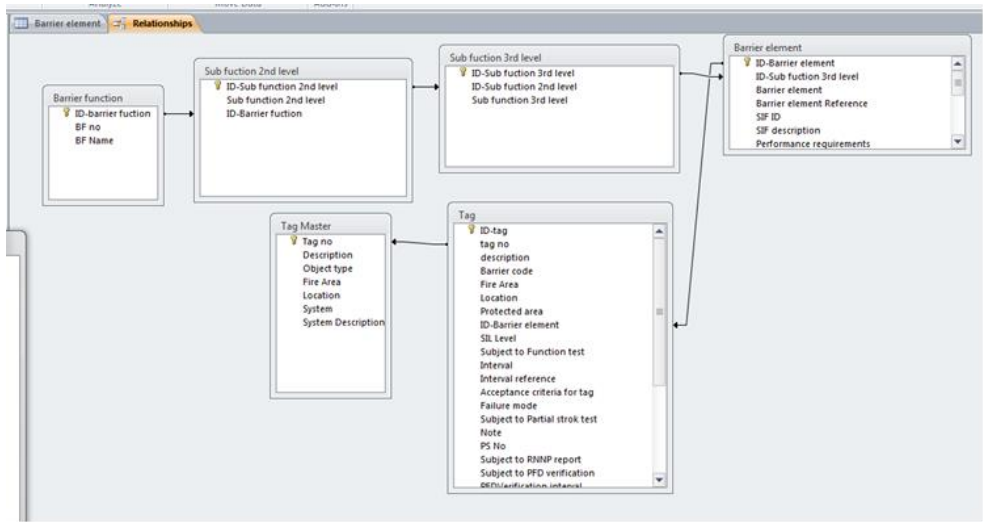
Indicators on op. & org. elements may be related to aspects such as:

- Competency, training and risk-awareness of the personnel performing the identified safety-critical tasks
  - Status (deviations) of required courses and training for personnel on-board (from competency matrix)
- Quality, availability and up-to-date-ness of the procedures, other documentation and routines describing the safety-critical tasks
- Frequency, quality and timeliness of training and drills
  - Overdue/backlog on the completion of all required trainings and drills according to plans
- Quality of the performed safety-critical tasks/work, e.g. in the form of adherence to procedures, reporting of deviations, etc.
  - Data from audits, both internal and external (e.g. PSA) audits
  - Reported deviations collected from SYNERGI, e.g. related to non-adherence to procedures, inadequate implementation of risk reducing measures, etc

Data management

- Barrier functions spread sheets (37 off) are imported into a database and combined with tag information from Tag Master List (SPF) and performance requirements in project documentation (SPS, SRS, etc.)
- When complete, database information is exported back to spread sheets and issued to ABB for programming of Barrier Status Panel
- Performance requirements for all barrier elements (tags) are also exported to a separate spread sheet

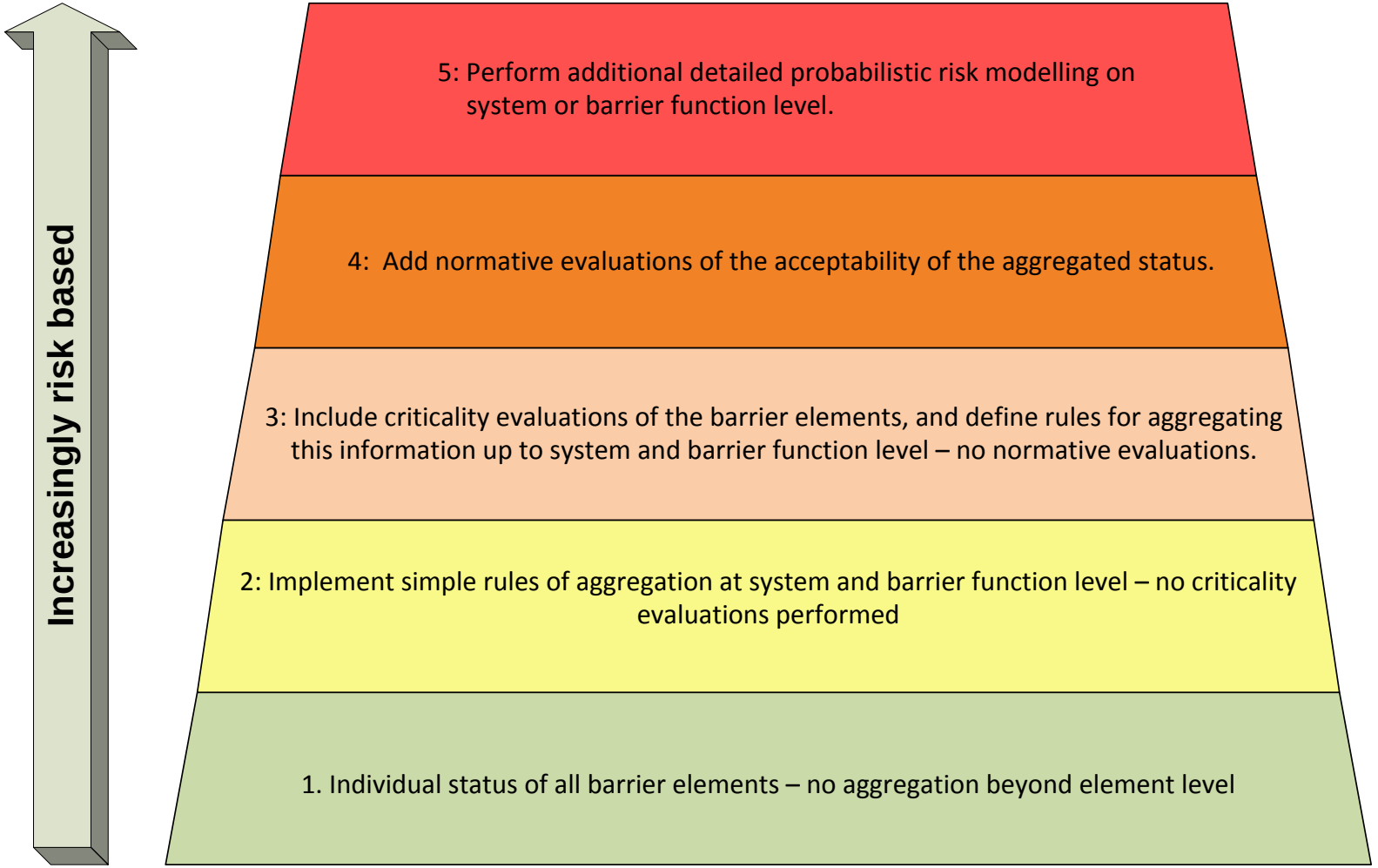




Barrier Status Panel - Visualisation tool

- The Barrier Status Panel it currently being developed by ABB (use of ACE)
- The Barrier Status Panel will show the status of the barrier functions (and hence, the barrier elements)
  - In the area they are meant to protect (protected area)
- Only the technical barrier elements will be included in the first phase
  - Barrier Management Project Phase II (2015-2017) will identify indicators for organisational and operational barrier elements and include these in the panel
- The Barrier Status Panel shall be a decision support tool
  - To be use during activity planning

6. Rules for aggregating barrier status information



Ref. Sintef

Aggregation rule set

Below, a rule set for allocating traffic lights on a barrier element/tag level is presented:

On a barrier element/tag level at least one of these observations will give a red light:

- IF PM overdue > 90 days, then red light [1)]
- IF CM notification open OR overdue, AND priority in SAP = high, then red light
- IF condition monitoring alarm = Failure (> 750), then red light
- IF safety fault alarm = failure, then red light
- IF tag manually blocked (i.e. inhibited) or suppressed[2)], then red light

On a barrier element/tag level at least one of these observations will give a yellow light:

- IF 28 days ≤ PM overdue ≤ 90 days , then yellow light [1)]
- IF CM notification overdue AND priority in SAP = medium, then yellow light
- IF fault alarm = degraded, then yellow light

IF none of the above conditions are present, then barrier element/tag has a green light:

Note 1): PM also includes functional testing (FT) of the barrier elements/tags
Note 2): Automatic suppression (e.g. of standby equipment) not to be included in barrier panel

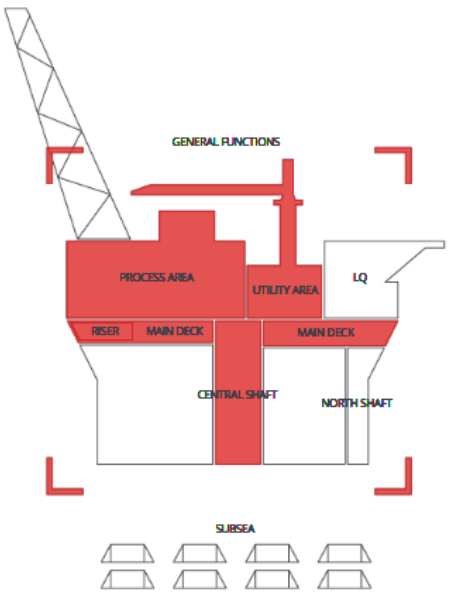
The above rule set is sufficient to set a traffic light on element level. Red takes preference to yellow which again takes preference to green. In this way all the individual barrier elements can be given a traffic light.

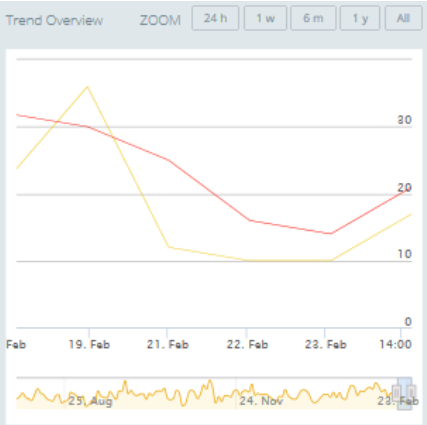
Goliat Barrier Status Panel – overview page

BARRIER STATUS

38	FPSO Goliat
15	Process Area
5	Main Deck Area
5	Riser Area
4	Central Shaft
3	Utility Area
0	Living Quarter
0	North Shaft
13	General Functions
0	Subsea

LAST TIME UPDATED	
800xA	2015-02-23 14:24
SAP	2015-02-23 14:24





MOST AFFECTED PERFORMANCE STANDARDS

8	18 MARINE SYSTEMS AND POSITION KEEPING last impaired: 6 days
4	02 STRUCTURAL INTEGRITY last impaired: 6 days
3	10 IGNITION SOURCE CONTROL last impaired: 6 days

MOST AFFECTED SYSTEMS

8	52 BALLAST WATER SYSTEM last impaired: 6 days
2	20 SEPARATION AND STABILIZATION SYSTEM last impaired: 6 days
2	43 FLARE AND VENT last impaired: 6 days

Goliat Barrier Status Panel – main page

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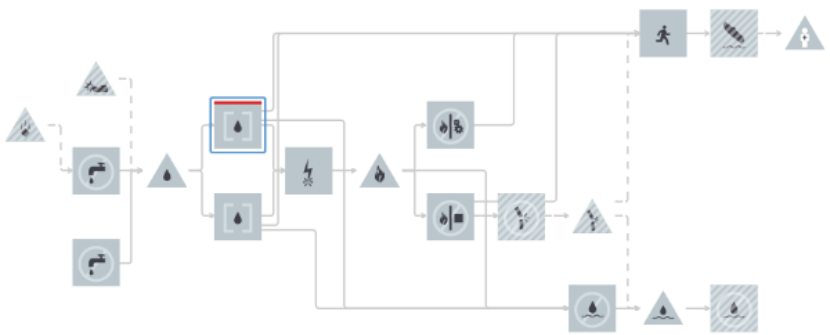
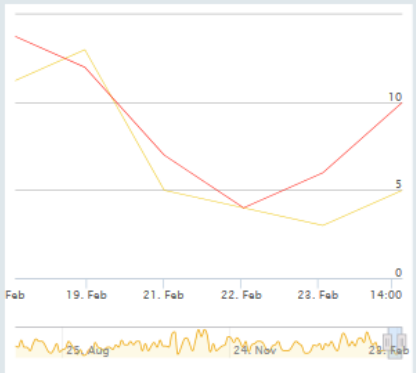
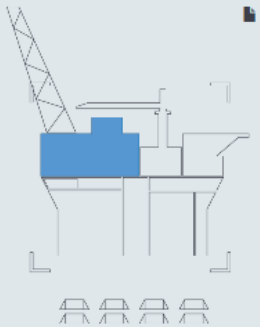
BARRIER FUNCTION | PERFORMANCE STANDARD | SYSTEM VIEW



BF 2a / Process Area ZOOM 24 h | 1 w | 6 m | 1 y | All





LAST TIME UPDATED

800xA	2015-02-23 14:24
SAP	2015-02-23 14:24

			800xA				SAP		
BARRIER FUNCTION - PROCESS AREA		LOCATION	COND	DU	FAULTS	BLOCK	CM	PM	IMPAIRED
2a Limit size of HC le...			1	2	5	3	0	0	23.02.2015
ESD initiation			1	1	3	1	0	0	23.02.2015
70GPP81B-...	IR Point Gas Detec...	P31		Demand					23.02.2015
70GPP82A-...	IR Point Gas Detec...	P22				Blocked			23.02.2015
70GPP81A-...	IR Point Gas Detec...	P21							23.02.2015
70GLP82A-...	Gas Detector LOS...	P12							23.02.2015
70GRP81B-...	Gas Detector LOS...	P31							23.02.2015
70GRP83B-...	Gas Detector LOS...	P33							23.02.2015
Detection of HC co...			1	0	0	0	0	0	21.02.2015
ESD sectioning			0	1	2	1	0	0	23.02.2015
Pressure relief			0	0	0	1	0	0	23.02.2015

Barrier Project – Barrier Status Panel

- Use of the Barrier Status Panel will lead to improved risk management and a joint risk awareness/understanding between the offshore and the onshore organisations:
  - Used offshore in daily activity planning
  - Used by the OSG (Onshore Support Group) in Hammerfest to prepare work packages and to monitor risk and barrier status
  - Used by TSG (Technical Support Group) in Hammerfest and Development & Technology at Forus to monitor and follow-up technical systems and performance standards
  - Used by onshore HSEQ to monitor and trend risk and barrier status
  - Used by onshore management to monitor high level risk and barrier status

- Training will be comprehensive. User groups identified and training packages are being developed:
  - E-learning: Introduction
  - Classroom, including use of scenarios
  - On the job training

Acknowledgements

- **PL229 Partnership**
  - **Eni Norge AS**
  - **Statoil Petroleum AS**