EU Directive 2013/30, safety of offshore oil&gas operations

Politecnico di Torino
Energy Department

The Directive implementation

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Summary

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2. Risk Acceptability and ALARP concept
3. Critical Elements definition
4. List of Documents to be submitted for carrying out offshore oil&gas operations
5. Report on major hazards, scope and contents
6. International references about offshore risk assessment and safety management system
7. Conclusions and proposals for the future

About the RAMS Group of Politecnico di Torino

http://www.rams.polito.it/

- The RAMS group is involved in **Research and Training** activities in the field of **Reliability, Availability, Maintainability and Safety (RAMS), Risk Analysis** and **Environmental Impact Assessment** of complex technical systems
- The group is also involved in the support for the application of the **Seveso Directive**
- In this contexts, the activity is also addressed to support Industrial Companies and Authorities for the implementation of Techniques, Standards and Directives
- The Research aims to develop **new analysis techniques** and to **transfer traditional technologies**, born in nuclear engineering, to different industrial fields (oil&gas, power plants, chemical processes, transportation of people and/or dangerous materials)

Last Research activities:

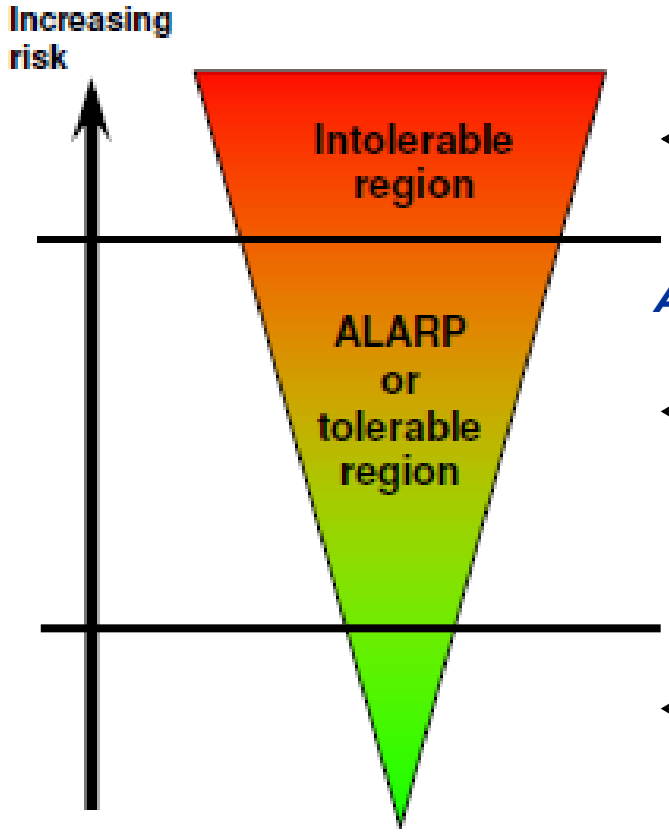
- ADDNANO: RAMS Analysis applied to Nanoparticle Industrial Plant (funded by EU)
- RISKNAT: Definition of a methodology for the multi-risk maps at regional level (funded by Reg. Piemonte)
- BIOH2POWER: RAMS Analysis applied to a biogas plant for hydrogen production (funded byReg. Piemonte)
- Other…

Last Training activities:

- Petroleum and Energetics Engineering, course on Risk Analysis
- Master of Petroleum, course on Industrial Safety
- Master on Reliability, Availability and Maintenance, courses on Industrial Safety and RAMS Analysis
- Other…

Risk acceptability and ALARP concept

Art 2 - Definitions (8):
'**acceptable**', in relation to a risk, means a level of risk for which the time, cost or effort of further reducing it would be grossly disproportionate to the benefits of such reduction. In assessing whether the time, cost or effort would be grossly disproportionate to the benefits, regard shall be had to best practice risk levels compatible with the undertaking;



Risk cannot be justified, reduction measures are essential

ALARP: As Low As Reasonably Practicable *(HSE UK 1974)*

Tolerable only if risk reduction is impracticable or if its cost is **grossly disproportionate** to improvement gained

Risk is acceptable, no further reduction measure isneeded. Necessary to maintain assurance that risk remains at this level (Safety Management System)
Usually in offshore activities risk levels are unlikely ever to be insignificant (DNV CMPT 1999)

ALARP implementation

Cost-Benefit Analysis (CBA) can be performed:

For a new measure the following values shall be estimated

The COST of implementing the measure:

- Costs of capital investment
- Operating expenditure
- Lost profits

The BENEFIT of the measure, in terms of the risk-factored cost of the accidents it would avert :

- The value of life of people killed (**VSL**)
- Human costs to people injured
- The cost of damage to property
- The business interruption costs, mainly lost production, but also including the damage to company reputation resulting from a major accident

- Risk Reduction = RISK without the new measure – RISK with the new measure **[damage / year]**
- COST and BENEFIT shall be expressed in common units: this can be **monetary units**

ALARP implementation

NET COST of new MEASURE
=
COST – BENEFIT

[€/year]

< 0 → the measure <u>should be implemented</u>

> 0 → the measure *should not be implemented*

What mean GROSSLY DISPROPORTIONATE ?!?

$$\frac{\textbf{NET COST per year}}{\textbf{REDUCTION of FATALITIES per year}}$$

[€/fatality]

< VSL → the measure is <u>reasonably practicable</u>

> VSL →the measure is <u>grossly disproportioned</u>

Example of risk acceptability criteria

QUALITATIVE RISK ANALYSIS

	Frequency rating	A	B	C	D
Severity Rating	People	Has occurred in oil&gas industry	Has occurred in operating company	Occurred several times per year in operating company	Occurred several times per year in location
1	Slight injury				
2	Minor injury				
3	Major injury				
4	Single fatality				
5	Multiple fatalities				

ALARP

QUANTITATIVE RISK ANALYSIS

IRPA (Individual Risk per Annum)

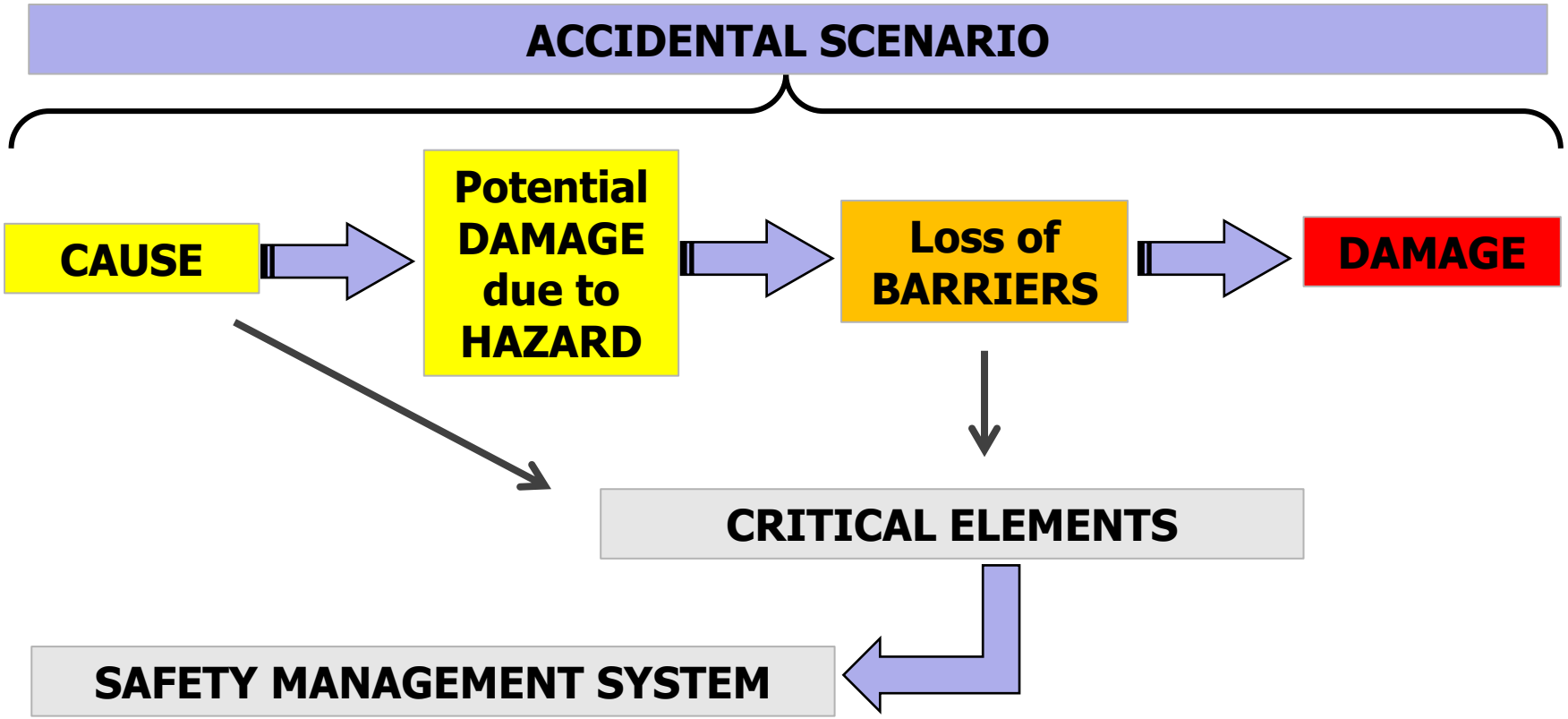
- ❑ HSE (1992): The Tolerability of Risk from Nuclear Power Stations, Health and Safety Executive, HMSO London
- ❑ Schofield, S.L. (1993): A Framework for Offshore Risk Criteria, Safety and Reliability, vol 13, no 2
- ✓ Maximum tolerable for installations
  10^{-3} per year
- ✓ Broadly acceptable for any installation
  10^{-6} per year

MAIN SAFETY FUNCTIONS

- ❑ Norsok Z-013: Risk and emergency preparedness assessment
- ✓ Maximum probability for the loss of safety functions due to accidental and environmental loads
  $5*10^{-4}$ per year

Critical element definition

Art 2 - Definitions (33):
'**safety and environmental critical elements**' means parts of an installation, including computer programmes, the purpose of which is to prevent or limit the consequences of a major accident, or the failure of which could cause or contribute substantially to a major accident



List of documents to be submitted for carrying out offshore oil and gas operations (art. 11)

(*)(a) the **corporate major accident prevention policy** (Article 19(1) and (5))

(*)(b) the **safety and environmental management system** (Article 19(3) and (5))

(c) in the case of a planned production installation, a **design notification** (Annex I,Part 1)

(*)(d) a description of the scheme of **independent verification** (Article 17)

(e) a **report on major hazards** (Articles 12 and 13)

(f) in the event of a material change or dismantling of an installation, an **amended report on major hazards** (Articles 12 and 13)

(*)(g) the **internal emergency response plan** (Articles 14 and 28)

(h) in the case of a well operation, a **notification of that well operation and information on that well operation** (Article 15)

(i) in the case of a combined operation, a **notification of combined operations** (Article 16)

(*) to be submitted within the report on major hazards

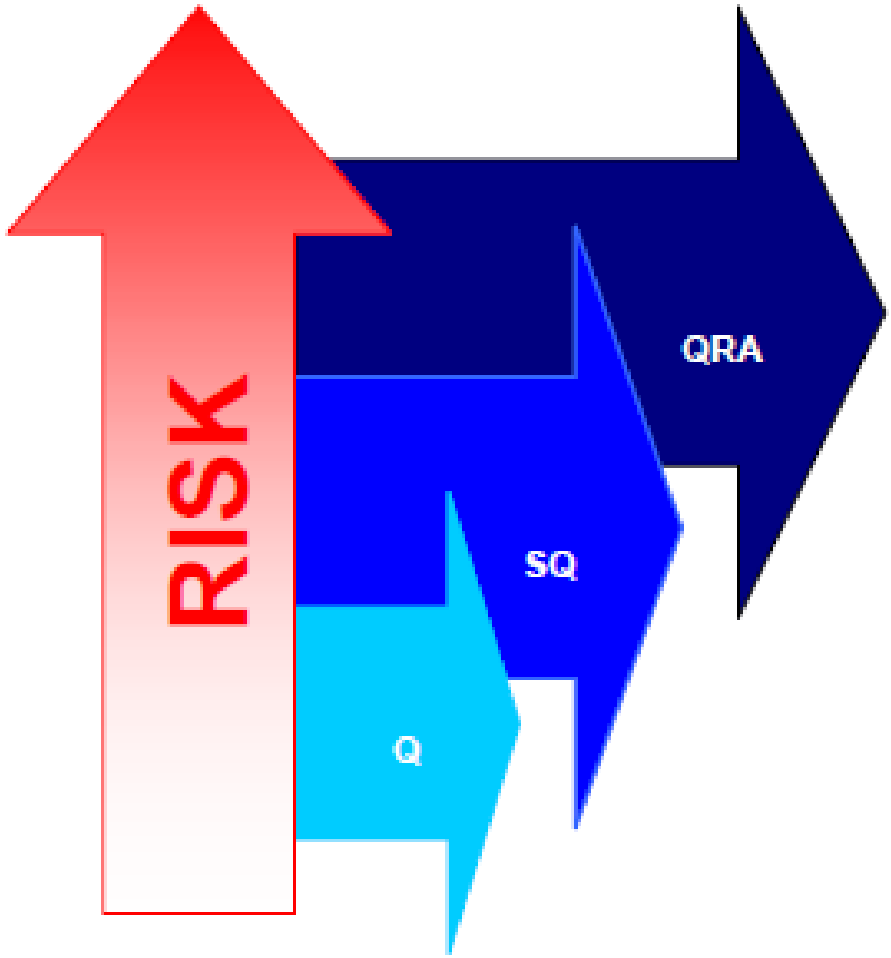
Report on Major Hazards, scope and contents (art. 12)

- Member States shall ensure that the planned modifications are not brought into use nor any dismantlement commenced until the **competent authority has accepted** the amended report on major hazards for the production installation
- The report on major hazards shall be subject to a thorough periodic **review** by the operator at least every **five years** or earlier when so required by the competent authority
- The Report shall contain at least the following information:

(1) …
(2) the name and address of the operator of the installation;
(3) …
(4) a description of the installation including wells;

(5) **demonstration** that all the **major hazards** have been identified, their **likelihood and consequences assessed**, … , and that their **control measures** including associated safety and environmental **critical elements** are suitable so as to reduce the risk of a major accident to an **acceptable level**

Report on Major Hazards, rigour of assessment



Exploration and production oil&gas installations

HSE UK, Guidance on Risk Assessment for Offshore Installations, 2006

Report on Major Hazards, methodology

QUALITATIVE RISK ANALYSIS

QUANTITATIVE RISK ANALYSIS

HAZID

FERA

HAZOP

QRA

SIL ALLOCATION

SIL VERIFICATION

SAFETY&ENVIRONMENTAL CRITICAL ELEMENTS

Standard Input Data:

- P&ID
- PFD and Material Balance
- Layout
- F&G Philosophy
- Cause/effect Matrix
- Maintenance Philosophy
- Process Description
- Others

Report on Major Hazards, qualitative analysis

- **HAZID (Hazard Identification)**
  - Identification of main hazards
  - Main issues to be analyzed: Natural hazards, seismic considerations, structural integrity, security, main process hazards
  - Qualitative analysis of each hazard by risk matrix

- **HAZOP (Hazard and Operability Analysis)**
  - Systematic analysis of all process hazards
  - Safety and Environmental Critical elements identification
  - Improvement of process
  - Use of qualitative risk acceptability criteria (Risk Matrix)

Report on Major Hazards, quantitative analysis

FERA

Fire and Explosion Risk Assessment

- Systematic approach to examine and estimate damage from **fire and explosion** scenarios
- **Scope:** estimating risk levels due to fire and explosion scenarios (decision-making tool)
- **Targets**: structures, buildings, equipment, escape routes
- **Results**: passive fire protection requirement, fire and blast wall rates, safe area protection, (preventing escalation and guaranteeing the evacuation)

QRA

Quantitative Risk Assessment

- Systematic approach to examine and estimate damage from **all major hazards**
- **Scope:** Estimating risk levels and assessing their significance. This helps to decide whether or not the risk need to be reduced (decision-making tool)
- **Targets**: personnel, environment, production, assets
- **Results**: further protection means and procedures

FERA supplies input to QRA

Report on Major Hazards, quantitative analysis

QRA

Strong points

- ✓ Identifying the main contributors to the risk
- ✓ Comparing design options
- ✓ Evaluating risk reduction measures
- ✓ Demonstrating acceptability to regulators and the workforce (ALARP demonstration)
- ✓ Identifying critical element

Limitations

- ✓ Uncertainties in input data and calculation
- ✓ Vulnerability criteria for damage estimation
- ✓ Need to develop several other studies in order to assessment risk due to dropped objects, helicopter and ship accident, structural accident, etc.
- ✓ Critical elements identification related to component failures (i.e. cause) leading to accidents cannot be performed

Report on Major Hazards, methodology

QUALITATIVE RISK ANALYSIS

QUANTITATIVE RISK ANALYSIS

HAZID

FERA

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QRA

SIL ALLOCATION

SIL VERIFICATION

SAFETY&ENVIRONMENTAL CRITICAL ELEMENTS

Standard Input Data:

- P&ID
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- Maintenance Philosophy
- Process Description
- Others

Report on Major Hazards, SIL study

- **SIL STUDY according to IEC 61508/61511**

- Need to define all Safety Functions to be implemented in the installation in order to control the risk (input from HAZOP study)
- Assessing the Safety Integrity Level for each Safety Functions according to qualitative or semi-quantitative risk acceptability criteria (**SIL ALLOCATION**)
- The Safety Integrity Level (SIL) defines the robustness of the Safety Control Loop suitable for the accidental scenario to be controlled (from 1 to 4)
- Verifying if the Safety Control Loop is suitable to achieve the SIL and defining maintenance requirements (**SIL VERIFICATION**)

International references about offshore risk assessment and safety management system

DNV CMPT 99/100a: A guide to Quantitative Risk Assessment for offshore installations

OGP 434: Risk assessment data directory

NORSOK Z-013: Risk and emergency preparedness assessment

NORSOK S-001: Technical Safety

HSE UK No. 3117: The offshore installation (safety case) regulations 2005

HSE UK No. 3/2006: Guidance on risk assessment for offshore installation

API 580/581: Risk-Based inspection

ISO 13702: Petroleum and natural gas industries – Control and mitigation of fires and explosions on offshore production installations

ISO 17776: Petroleum and natural gas industries – Guidelines on tools and techniques for hazard identification and risk assessment

IEC 61882: Hazard and operability studies (HAZOP)

IEC 61508/61511: Functional safety of electrical/electronic/programmable electronic safety-related systems/for process industry sector

OHSAS 18001/18002: Occupational health and safety management system / Guideline

ISO 14001/14002: Environmental management system / Guideline

UNI 10616/10617: Safety Management System, Fundamental criteria for the implementation

Conclusions (1/2)

- Seveso Directive 82/501/CEE, 96/82/CEE, 2003/105/CE about **control of major-accident hazards involving dangerous substances**
  - Any type of on-shore installations, not only oil&gas
  - The operator is obliged to analyze and take all measures necessary to prevent major accidents and to limit their consequences for man and the environment.

- The Directive 2013/30 establish minimum requirements for **preventing major accidents in offshore oil&gas operations and limiting the consequence of such accidents**
  - The Operator is obliged to analyze major hazards and submit documents to Competent Authority for approval
  - Member States shall cooperate in order to share knowledge, information and experience

- The Directive should not be considered just as «a law» to be complied with, but as an «**opportunity**» to:
  - Support the design and the operability since risk analysis is a **decision-making** tool
  - Improve **methodologies** of risk analysis taking advantages of the experience from nuclear and onshore plants, by adapting them to manage very congested spaces and several major hazards at the same time

Conclusions (2/2) – proposals for the future

- Investigating about the **fire and explosion scenario simulation** with simplified or CFD models (Computational Fluid Dynamics)
  - Simplified models give results in short time, but are not able to consider very complex geometry
  - CFD models are able to consider very complex geometry but give results in long time
- Members States shall cooperate to **external emergency plans and emergency preparedness** definition
  - Opportunity to investigate about the way to achieve this scope, by an European Project funded by EU
- **Training** about the Directive and improvement of the **safety culture**
  - From the Competent Authority to Operator personnel, by a Specializing Masters and Postgraduate programmes
  - Need to learn risk study is an opportunity to improve design and operability, not just a cost.
  - Not just how perform risk study, but especially How use results from risk study? How examine a risk study?
- **Safety and Environmental Critical Elements,** need to develop a technical standard in order to define the way to identify them, to be used in Europe

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THANK YOU SO MUCH FOR YOUR ATTENTION

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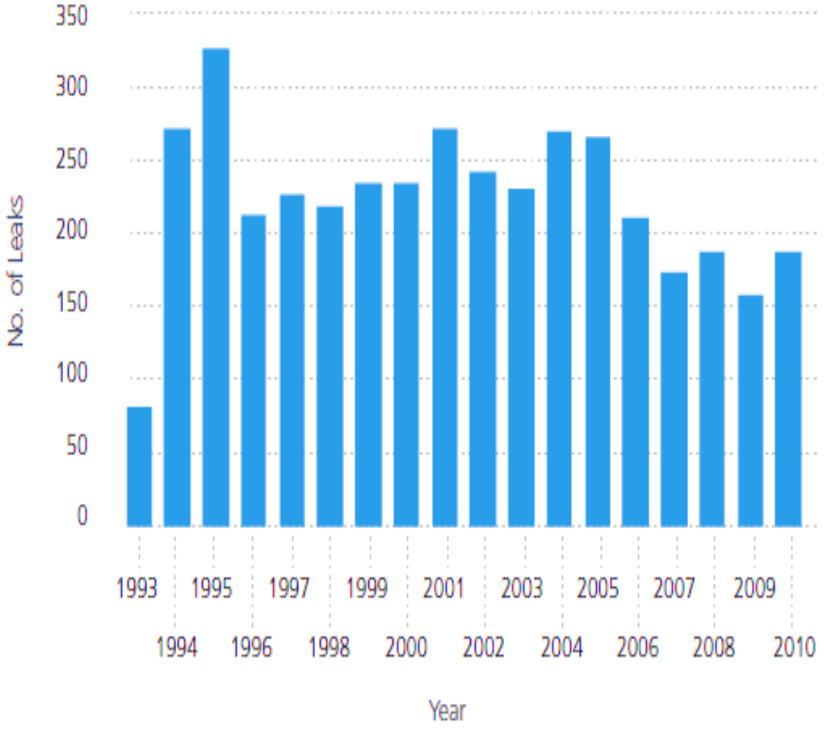
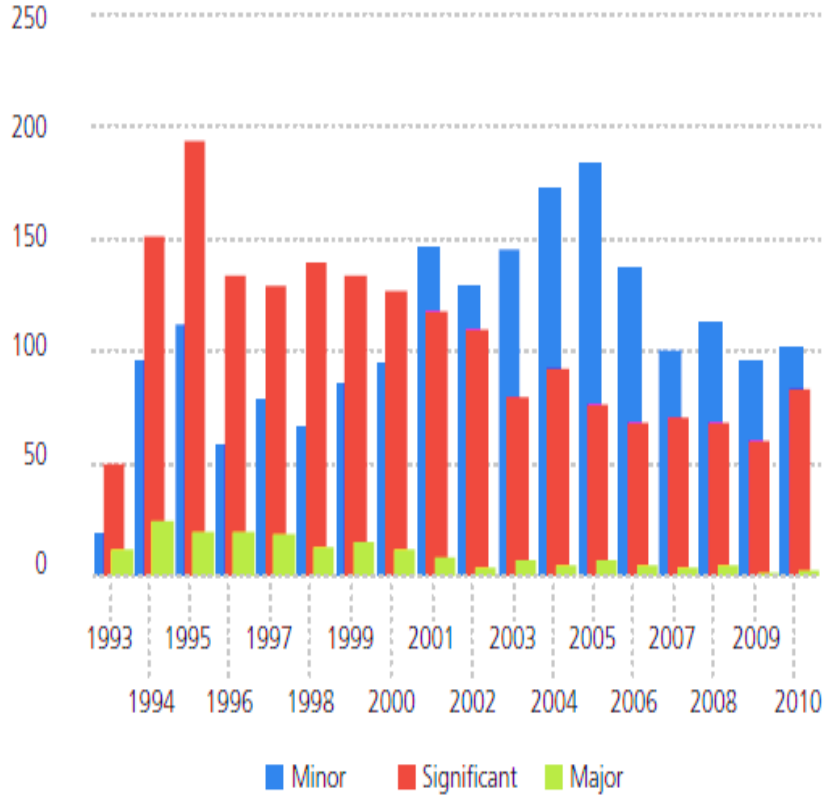
Historical Analysis for offshore oil&gas plant

Number of hydrocarbon leaks per year

(reference: HCRD, Hydrocarbon release reporting and statistics - HSE UK)

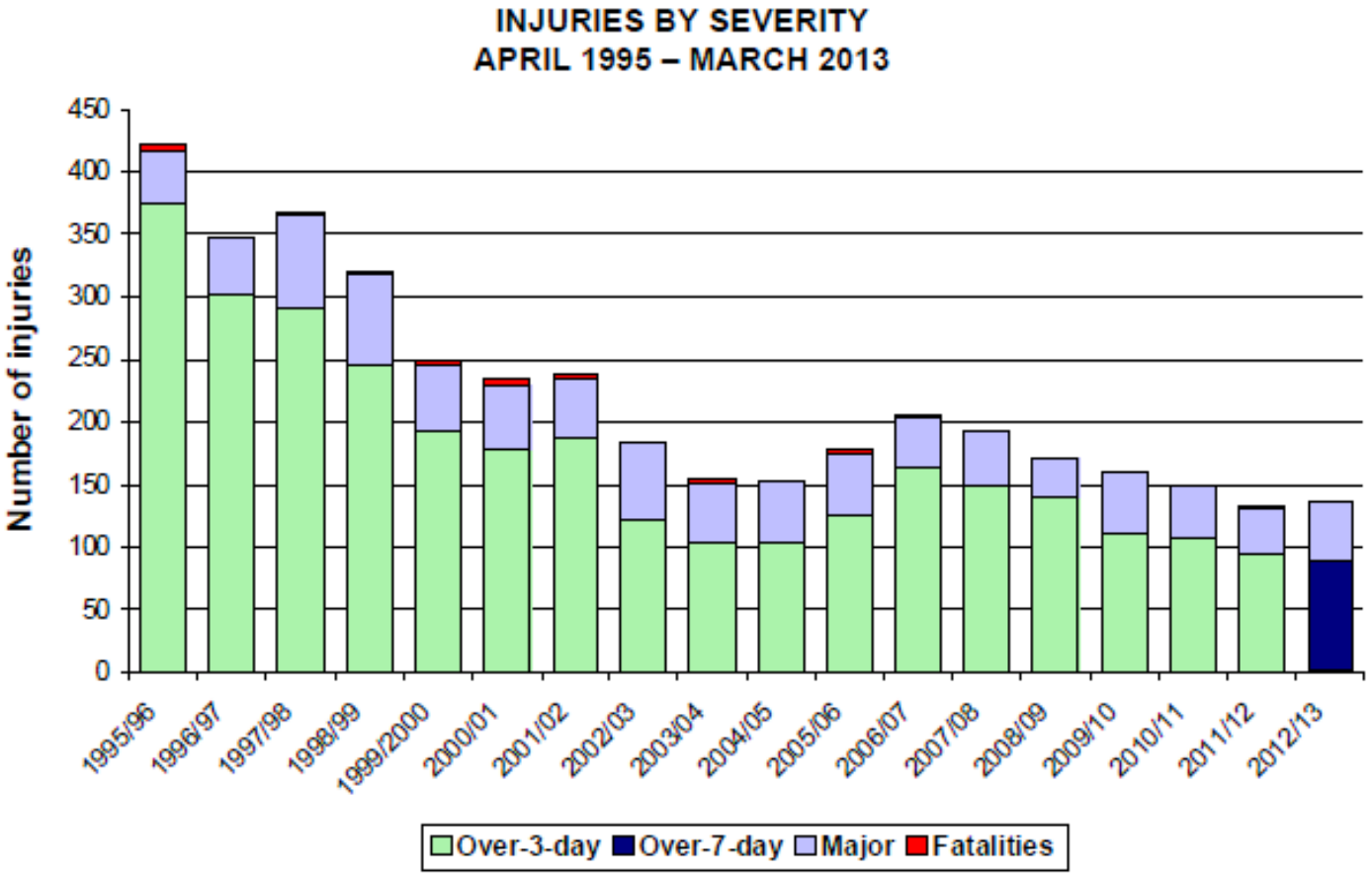




Historical Analysis for offshore oil&gas plant

Number of injuries by severity per year

(reference: Offshore Injury, Ill Health and Incident Statistics - HSE UK, 2014)



Historical Analysis for offshore oil&gas plant

Incidents/Spills per year

(reference: BSEE Bureau of Safety and Environmental Enforcement- US OCS)

OCS Incidents/Spills by Category: CY 2007 – 2013														
TYPE (Click for more info)	2007		2008		2009		2010		2011		2012		2013	
	GOM	PAC	GOM	PAC	GOM	PAC	GOM	PAC	GOM	PAC	GOM	PAC	GOM	PAC
FATALITIES	5	0	11	0	4	0	12	0	3	0	4	0	3	0
INJURIES *** #	423	17	318	14	285	16	273	12	213	18	253	34	226	21
LOSS OF WELL CONTROL ***	7	0	8	0	6	0	4	0	3	0	4	0	9	0
FIRES/EXPLOSIONS	110	8	139	12	133	12	126	4	103	2	134	6	97	6
COLLISIONS ***	20	1	22	0	29	0	8	0	14	0	9	1	19	0
SPILLS ≥ 50 bbls	4	0	33	0	11	0	5	0	3	0	8	0	^	^
OTHER ***	268	27	278	36	308	28	155	17	186	15	236	41	272	38
INCIDENT TOTAL FOR THE YEAR	837	53	809	62	776	56	583	33	525	35	648	82	626	65
COMBINED TOTAL FOR THE YEAR	890		871		832		616		560		730		691	
SOURCE: BSEE Database as of 14-Jan-2014													Incidents Archive	

Major Accident definition

Art 2 - Definitions (1):
'**major accident**' means:
(a) an incident involving an explosion, fire, loss of well control, or release of oil, gas or dangerous substances involving, or with a significant potential to cause, fatalities or serious personal injury;
(b) an incident leading to serious damage to the installation or connected infrastructure involving, or with a significant potential to cause, fatalities or serious personal injury;
(c) any other incident leading to fatalities or serious injury to five or more persons;
(d) any major environmental incident resulting from incidents referred to in points (a), (b) and (c).

List of Major Accidents:

Hydrocarbon accidents:
- process accidental release on each deck
- risers and pipelines release
- production wells blowout

Non-Hydrocarbon accidents:
- not-process leak (e.g. methanol, other chemicals)
- dropped objects
- helicopter transportation
- ship collision
- structural failure
- earthquake
- extreme weather
- occupational accidents

ALARP implementation

Valuation of Statistical Live (VSL)

Average VSL for several countries	
Country	**Million USD**
Australia	2,1
Austria	3,2
Canada	3,5
Danimarca	3,8
Francia	3,4
Giappone	8,3
Nuova Zelanda	1,6
Corea del Sud	0,6
Svezia	3,1
Svizzera	7,5
Taiwan	1,0
Gran Bretagna	2,3
Stati Uniti	3,5
Average value	**3,4**

HSE UK Study → 2M £ = 3.4M USD = 2.5M €

Critical element definition

Examples of Safety and Environmental Critical Elements:

- ✓ Pressure/temperature/level switches
- ✓ Control valves
- ✓ SDV and BDV (shutdown and blowdown valves)
- ✓ F&G system (Fire & Gas system)
- ✓ FFS system (Fire Fighting System)
- ✓ Flare system
- ✓ Crane and lifting systems
- ✓ Egress routes
- ✓ Means for evacuation and rescue
- ✓ Passive Fire protection
- ✓ UPS
- ✓ Etc.

Report on Major Hazards, scope and contents (art. 12)

(6) a description of the types of operations with major hazard potential to be carried out, and the maximum number of persons that can be on the installation at any time;
(7) a description of equipment and arrangements to ensure well control, process safety, containment of hazardous substances, prevention of fire and explosion, protection of the workers from hazardous substances, and protection of the environment from an incipient major accident;
(8) a description of the arrangements to protect persons on the installation from major hazards, and to ensure their safe escape, evacuation and rescue
(9) …
(10) information, regarding the operator's safety and environmental management system;
(11) an internal emergency response plan;
(12) a description of the independent verification scheme;
(13) …
(14) …
(15) …
(16) an assessment of the identified potential environmental effects resulting from the loss of containment of pollutants arising from a major accident, and a description of the technical and non-technical measures envisaged to prevent, reduce or offset them, including monitoring

Notification of Combined Operations (art. 16)

Art 2 - Definitions (25):
'**combined operation**' means an operation carried out from an installation with another installation … which thereby materially affects the risks to the safety of persons or the protection of the environment on any or all of the installations

Art 2 - Definitions (19):
'**installation**' means a stationary, fixed or mobile facility, …, used for offshore oil and gas operations … including mobile offshore drilling units only when they are stationed in offshore waters for drilling

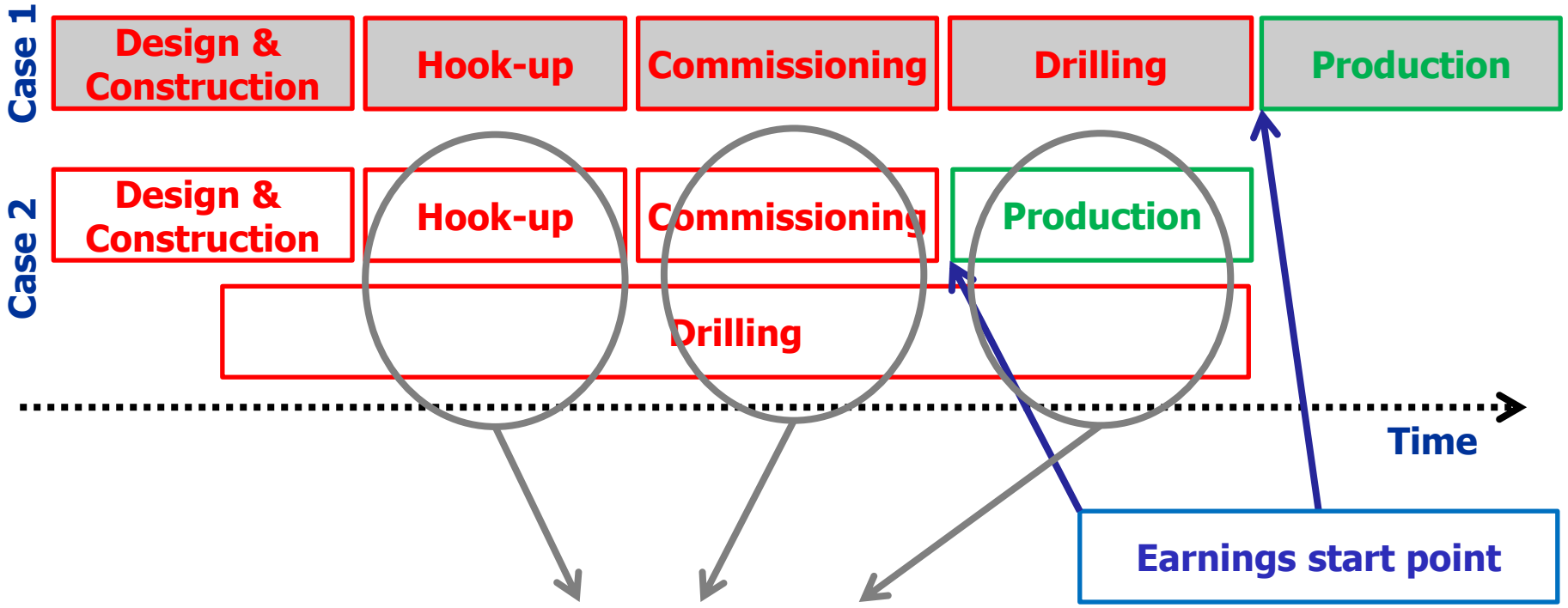
Art 16 – Notification of combined operations

- Member States shall ensure that operators and owners involved in a combined operation jointly prepare the notification to be submitted
- The notification shall contain at least the following information:

❑ a description of how the **management systems for the installations** will be coordinated so as to reduce the risk of a major accident to an acceptable level;

❑ a summary of the **risk assessment** carried out by all operators which shall include:
(a) a description of any operation during the combined operation which may involve hazards with the potential to cause a major accident on or in connection with an installation;
(b) **a description of any risk control measures introduced as a result of the risk assessment**;

Example of Combined Operations



SIMOPS – Simultaneous Operations

- Involvement of a larger number of personnel
- New risk due to the possible interference between simultaneous operations

Methodology to analyze and manage Combined Operations

Identification of all **operations** to be potentially performed simultaneously (SIMOPS)

Identification and **analysis** of hazards associated to each operation

Crossing of all operations and analysis of possible interferences and risks (**SIMOPS MATRIX**)

Integration in the **Safety Management System** of procedures for manage SIMOPS

ANALYSIS
and
RISK ASSESSMENT (QUALITATIVE)
and
CONTROL MEASURE DEFINITION

MANAGEMENT of COMBINED OPERATIONS
based on
RISK ANALYSIS