Refleksjoner rundt alvorlige hendelser i petroleumsindustrien i et risikostyringsperspektiv

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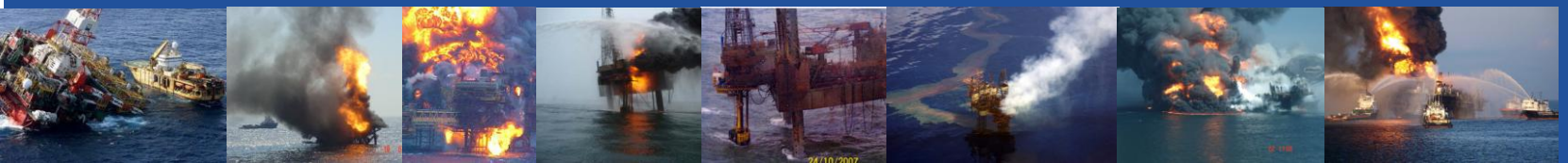
Overview

Major hazard focus

- Background and challenges
- Brief history
- Trends in accidents & incidents
- Trends in modelling of major accidents
- Goal-setting regime
- Main regulatory principles
- Could risk assessment have prevented Macondo or Gullfaks C?
- Barrier management
- Conclusions

Background

- Serious OO&G accidents since year 2000:
  - Capsize and sinking of Roncador P-36 (Brazil, 2001)
  - Burning blowout on Temsa field (Egypt, 2004)
  - Riser rupture and fire on Bombay High North (India, 2005)
  - Burning blowout on Usumacinta (Mexico, 2007)
  - Blowout on Montara field (Australia, 2009)
  - Burning blowout on Macondo field (US, 2010)
  - Pollution from well leak in Frade project, Campos Basin (Brazil, 2011)
  - Capsizing and sinking of Kolskaya jack-up during tow, (Russia, 2011)
  - Burning blowout on Endeavour jack-up platform (Nigeria, 12)
  - Uncontrolled well leak on Elgin platform in North Sea (UK, 12)
  - Fire on Black Elk Energy platform off Louisiana coast, 3 fat. (US, Nov 2012)
- Also several fatal helicopter accidents, during transit to offshore installations



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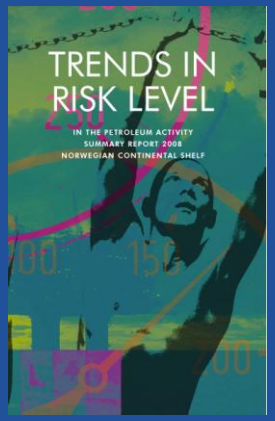
Recent trends worldwide – offshore

- 2001–10 compared to 1991–2000:
  - Notably fewer major accidents in earlier period
  - Most severe ever, the explosions and fire on Piper Alpha in the North Sea in July 1988 in previous decennium
- Is this total failure of risk management?
- Proof that risk based regulations do not function?
- Virtually all offshore regions are represented
  - Looking to the North Sea, North Atlantic, Norwegian Sea and Barents Sea
    - Most severe accidents occurred some 20 to 30 years ago
    - No severe accidents at all during the latest period
    - Very serious near-misses recently

Risk Level project, RNNP (N)

- Objective
  - Establishing a realistic and jointly agreed picture of trends in HES work
    - In order to support the efforts made by the PSA and the industry to improve the HES level within petroleum operations
- History
  - April 2001
    - 1. report issued, for period 1996-2000
  - January 2004
    - Responsibility for HES for offshore & onshore petroleum facilities taken over by Petroleum Safety Authority
  - April 2007
    - 1. report with 8 onshore plants included, based on 2006 data
  - 2010
    - Extension from risk to personnel to risk for spills to sea
  - Regular schedule
    - Annual reports (risk to personnel) issued in April
    - Separate spill report in September



www.ptil.no/rnnp

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Risk level project (RNNP)

- Major hazard risk one element of RNNP
  - Indicators suggest that major hazard risk has been reduced since year 2000
    - Precursor based indicators
    - Proactive ('leading') indicators based on barrier elements
  - On the other hand
    - Some installations are dramatically worse than average
    - Some are also exceptionally good
    - Large differences is a challenge for authorities
  - Modelling based on risk analysis R&D

Offshore risk management – success story?

- Impression
  - Norwegian & UK systems have been successful
    - Confirmed by Presidential Commission (US)
  - Large accidents have been avoided in NW Europe for long time
    - UK: after 1988
    - Norway: after 1985
- Is the situation so glorious as may be inferred from this?

Perspective: Alexander Kielland To Macondo

- Capsize and sinking of Alexander Kielland (Norway, 1980)
- Burning blowout on Macondo field (US, 2010)
- 30 years separation:
  - Capsize of the flotel Alexander L. Kielland in Norwegian North Sea
  - Burning blowout on Deep Water Horizon in US GoM
- Encompasses the development and use of risk assessments in risk management offshore

Brief history: Use of risk analysis (N)

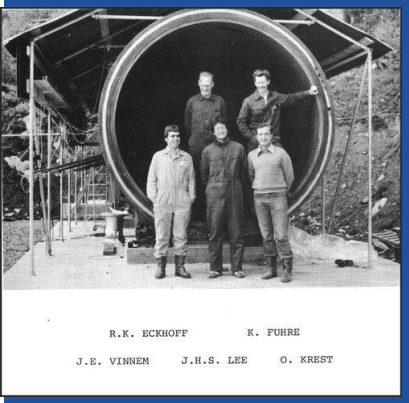
- Early start in late 1970s
- Regulatory requirement since 1981
- Approach initially based on practices in nuclear power plants
  - Usually no 3rd party personnel risk to consider offshore
- Development over time away from nuclear PSA approach
- QRA studies are not in the public domain
- Few cases where ethical controversies are known

- Offshore QRA
  - Focus on consequences (ignited HC leaks)
  - Limited focus on barrier failure probabilities
  - Causes of initiating events traditionally not covered

- NPP PSA
  - Focus on probability of defined scenarios
  - High focus on common mode & cause failures, etc
  - "Living PSA"

Brief history: Use of risk analysis

- Main application of risk assessments in the Norwegian industry in the 1980ties and 1990ties
  - Design tool, in order ensure that new installations had sufficient capabilities
    - To prevent major accidents and protect personnel in the case of such accidents
    - Significant investments in consequence modelling software tools, most well known is FLACS code



Brief history: Use of risk analysis

- Official inquiry by Lord Cullen in the UK, following Piper Alpha accident in 1988
  - Recommended that QRAs should be introduced into UK legislation
    - Corresponding to the way as in Norway nearly 10 years previously
  - Parallel focus on documentation through Safety Case documents

Brief history: Use of risk analysis

- Safety case
  - Primarily a tool for risk management in relation to existing installations
    - Main focus on consequences, layout and mitigation barriers
  - Similar approaches also adopted by several other countries (Denmark, Canada, Australia,..) & Shell on a worldwide scale ('HSE case')
- Many countries, most notably US, still have prescriptive regulations

Events that made marks on history

- Accidents that have had extensive impact for the offshore operations:
  - Capsize of Flotel Alexander L. Kielland, 1980
  - Capsize of Mobile Offshore Drilling Unit Ocean Ranger, ‘82
  - Explosion & fire on fixed production platform Piper A, ‘88
  - Burning blowout on Deep Water Horizon mobile drilling unit, 2010

Impacts on Standards and Practices

- Capsize of the flotel Alexander L Kielland
  - Basic safety training for personnel
  - Use of conventional lifeboats in severe weather
  - Construction safety
  - Barriers to prevent rapid capsizing following major structural damage

Impacts on Standards and Practices

- Capsize of drilling rig Ocean Ranger
  - Improvement of ballast system flexibility for stabilizing the unit in high inclination angles
  - Training of ballast operators
  - Evacuation during severe weather conditions
  - Rescue of survivors following evacuation in severe weather

Impacts on Standards and Practices

- Explosion and fire on Piper Alpha
  - Active fire protection
  - Passive fire protection
  - Protection of Temporary Refuge (shelter area)
  - Barriers against high inventories in pipelines
  - Compliance with procedures & documentation

Trends in offshore QRAs (10–15 years)

- Very limited further development
  - Some further development of consequence tools
  - Precursor data and barrier performance data through RNNP (N)
- Development of tools and methods for incorporation of
  - Causes of initiating events within HOF envelop
    - Collisions with offshore vessels
    - HC leaks

Overall purpose
FPSO Operational Safety Project

- Develop models and tools for predictive human reliability analysis
- Test out methodology on selected case studies
- Illustrate results that may be obtained

Tandem loading configuration

Objectives

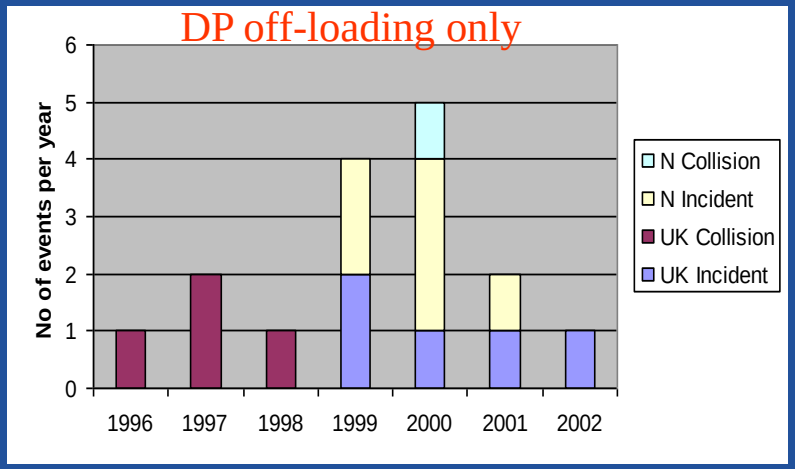
- Demonstrate importance of HOF collision risk
- Identify and evaluate the important HOF factors
- Propose potential risk reduction measures relating to HOF

Contractors:
NTNU
SINTEF

Sponsors:
ExxonMobil
HSE
Statoil
Navion

Importance

- Several incidents 1996–2001
- Low velocity impacts (high mass, up to 30 MJ)
- Cargo penetration unlikely
- Accident chain may imply very severe consequences
- After 2002, 2–3 minor accidents



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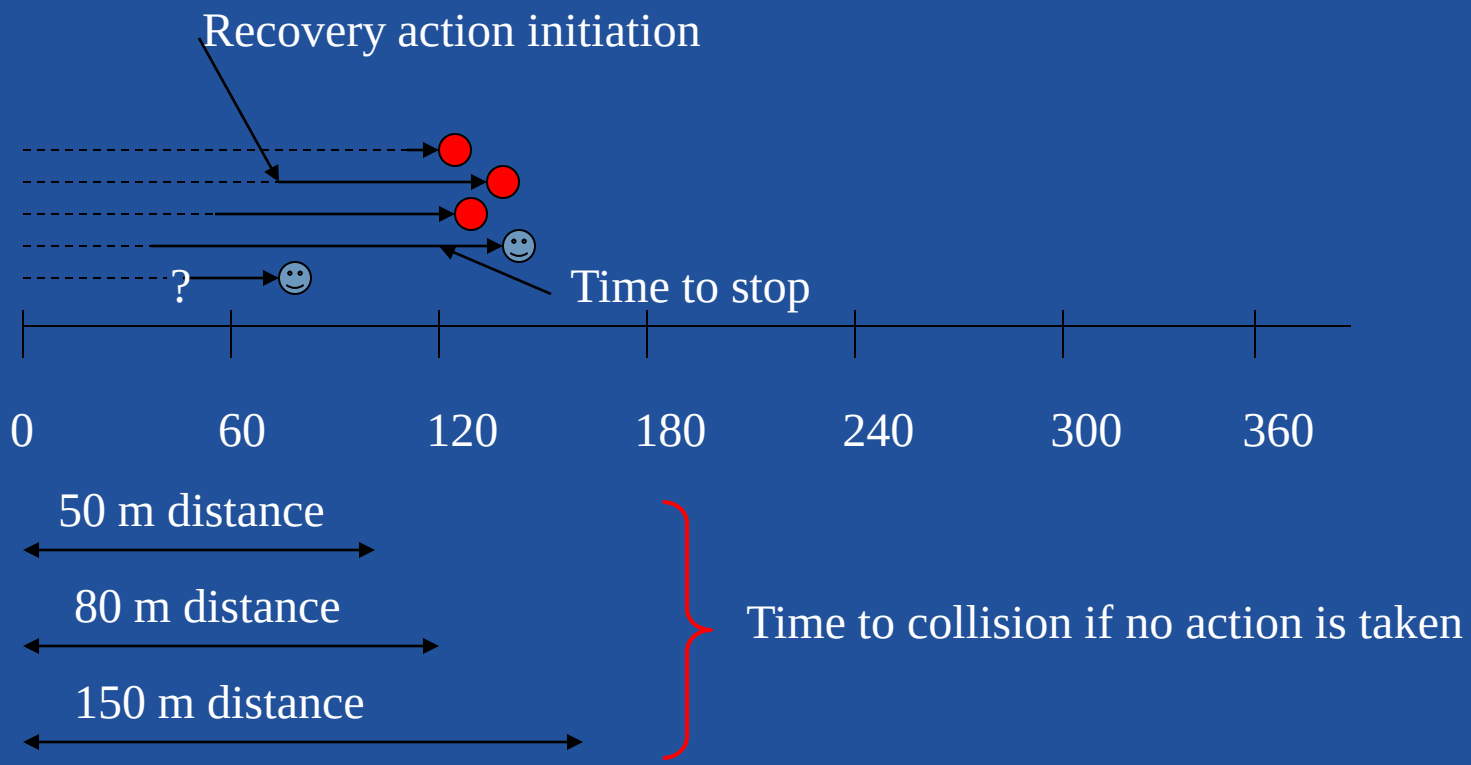
Comparison

Experienced times and maximum times available



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Risk Modelling, Integration of Organisational, Human and Technical factors (Risk_OMT)

- Ambitions for the Risk_OMT programme:
  - Extension of verification of barrier performance
    - From existing technical focus into a focus where operational barriers have similar weight
  - Provide sound quantitative basis
    - for analysis of operational risk reducing measures
  - Learn how the best managed installations
    - are achieving performance of operational barriers
  - Propose key performance indicators
    - enable identification proactively when operational conditions are deviating from a high standard

R&D PARTNERS:

•UiS, NTNU, SINTEF, IFE

•Statoil

Project sponsors (2007-11):

•Norwegian Research Council

•Statoil

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Dependencies

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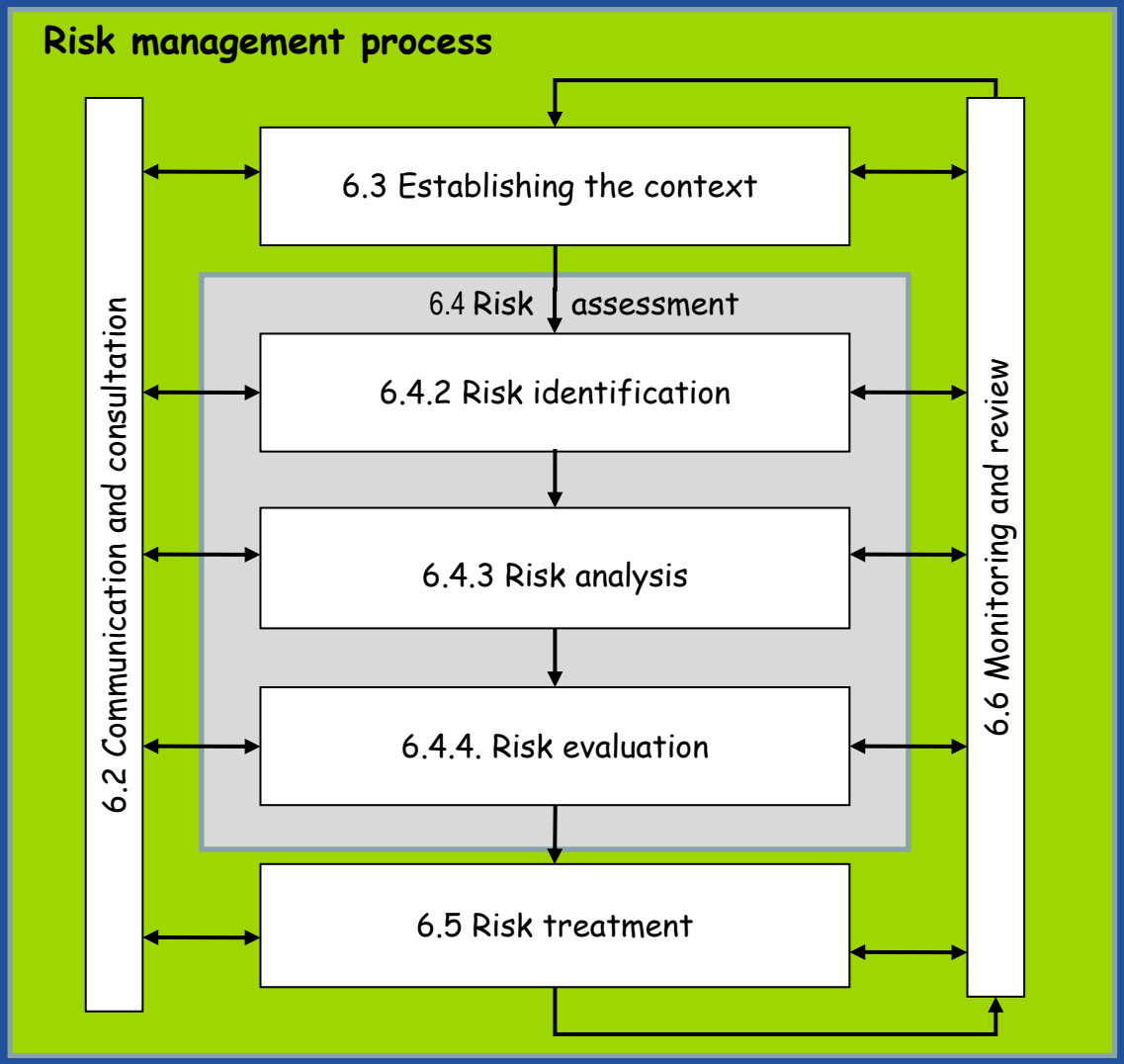
Goal-setting regime

- Implications of goal-setting approach:
  - Industry has more flexibility vis-à-vis fulfilling regulations & finding optimum solutions
  - Preventive and protective systems and actions may be tailored to relevant hazards
  - Models need to be available to distinguish between different levels of threats, and to tailor the solutions to the circumstances

ISO 31000 – Risk Management



- Also the basis for:
  - NORSOK Standard Z-013 Risk analysis and emergency preparedness assessment

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Misuse of risk analysis in petroleum sector

- PSA:
  - Risk analysis primary use to identify & assess risk reducing measures in ALARP context
  - Risk analysis shall not be used to 'prove' acceptability of deviation from laws, regulations, standards, common practice, etc.
- HSE [UK] has made similar remarks
- Misuse
  - Was an issue in 1980s, with limited QRA experience
  - Reiterated warning in 2007

Robust regulations?

- Combination of internal control and risk-informed regulations appear to be fragile and far from robust combination for
  - Industry
  - Authorities

- No apparent focus in research

- Committee appointed by Ministry of Labour to evaluate HES regulatory system

Could risk assessment prevented Macondo?

- Presidential Commission makes reference to North Sea legis-lation as possible model for US
  - ≈2½ years after the accident:
    - very limited change so far
  - Some are sceptical that anything will change

Could risk assessment prevented Macondo?

- Reflections on this question
  - PSA has confirmed that Macondo accident could have occurred in Norwegian sector
  - Several incidents/accidents during 2004–10
    - Full blown subsea gas blowout in Nov. '04 on Snorre A
      - Lack of compliance with procedures one root cause
      - Also one of success factors of the well killing operations

Could risk assessment prevented Macondo?

- One of the common factors in recent well associated incidents & accidents:
  - Lack of proper risk assessment to
    - Identify criticality of various factors and deviations from plans & procedures that have to be made
- Common factor with the Macondo accident
  - Failure to assess risk as basis for MOC one crucial failure
- Effective management of major accident risk is strongly dependent on
  - Adequate modelling (i.e. insight) of hazard mechanisms
  - Stringent management of barriers throughout field life
    - Crucial factor in Montara accident

Could risk assessment prevented Gullfaks C?

- Lack of risk assessment identified as root cause
  - PSA: why was risk assessments omitted?
- IRIS report identified significant management deficiencies
  - Limits Statoil's ability to learn from accidents & incidents
- Investigation practices are also counterproductive with respect to learning
- More important than risk assessment:
  - Significant improvements to management attitudes & supervision
- A-standard appears to have significant effect
  - Reduced frequency of HC leaks in 2012

Risk assessment of drilling and well operations

- PSA has repeatedly claimed that risk assessment tools used by the Norwegian petroleum industry are not suitable for operational decision-making
  - Survey (PSA, 2009–10) pointed to need for further development of risk analysis tools
    - Usable as input to day-to-day decisions on installations; minor modifications, maintenance and interventions
  - Same observation would be applicable also for drilling operations

- Large difference between the NPPs and offshore installations with respect to development of online risk monitoring

Risk assessment of drilling and well operations

- Online risk monitoring for management of operations, maintenance and modifications to facilitate decisions relating to:
  - When a leaking valve needs to be repaired (example)
    - Whether it needs to done immediately in order to control the major accident risk
    - Whether it can wait for some time for the next scheduled plant shutdown

- Online risk monitoring of drilling and well operations is altogether another league
  - Models are not available at all
  - Extensive research effort is needed to develop suitable models
    - Mainly in the HOF field!

Barrier management

- PSA in follow-up after the Macondo blowout proposed also development of a scheme for barrier management
- Barrier failures were also obvious on the Deep Water Horizon mobile drilling rig, such as failure of blowout preventer (BOP)
- Lack of proper management of barriers is also common in the Norwegian industry
  - Poor RNNP barrier data year after year
  - HOF improvement in LOC data

Barrier management

- Management of barriers (ref. PSA) dependent on proper modelling in planning phase
  - Implies that inadequacy of risk models for drilling and well operations will also prevent the basis for barrier management to be established
- Lack of proper risk models will also limit how well risk indicators could be developed

Conclusions

- Prevention of major accidents most effectively through risk-informed decision-making
  - US & others should follow after UK & Norway

- Probably not a coincidence that severe accidents and incidents
  - Have occurred worldwide during the last ten years
  - Not in NW Europe

Conclusions

- Threat from EU to 'throw out' all the good experience in UK and Norway
  - Directive proposal apparently mainly aimed at environmental spill protection
- Step back from risk-informed to compliance basis
- Industry is probably partly to blame
  - No focus for many years to develop suitable risk based tools, especially for drilling and well operations

Conclusions

- Modelling of barrier performance is area where substantial improvement is needed
  - Grossly inadequate, especially for drilling
  - Operational barriers extra challenge
- Improvement of risk-informed management of major hazard risk in day-to-day decision-making
- Operational barrier elements the main challenge

Conclusions

- Can major accidents be eliminated?
  - No, one can occur tomorrow even if the probability is very low
- Risk-informed decision-making more advanced for process plant operation
  - Even in this area we have identified significant development needs
  - Drilling and well operations less well developed