QRA in Offshore Oil and Gas
A personal precis

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Overview

- History of QRA in Offshore O&G Regulation
- Methodology
- Underlying Assumptions
- Uses
- Abuses
- Taking it further?
- Summary
Potted History of QRA

- **1970s**
  - Earliest Offshore QRA (Norwegian Sector)

- **HSAW 1974**
  - 1980s
  - Piper Alpha

- **1990s**
  - Lord Cullen Report
  - OSC Regs
  - PFEER Regs

- **2000s**
  - OSC Regs
  - Outside UK
Offshore QRA History: 1970s
Offshore QRA History: 1970s
Robens concluded: there were severe limitations in the effectiveness of new regulation by external agencies. There was an attempt to keep pace with new laws enacted as every new hazard was identified, but the mass of regulations developed over 200 years was too different from the risks posed.
History of QRA

- 6 July 1988
6 July 1988
6 July 1988
History of QRA

- Lord Cullen report recommended that offshore safety regulation be transferred to HSE
- Recommended that safety cases should be a requirement for all offshore installations
- Quickly enacted as 1992 Offshore Safety Case Regs
History of QRA

- **1992 Regulations key parags:**
  
  Provision 8.1(d)

  **risks have been evaluated** and measures have been, or will be, taken to **reduce the risks** to persons affected by those hazards to the **lowest level that is reasonably practicable**.

- **Schedule 2 (Fixed Installations)...**

  9. A description of the arrangements made or to be made for protecting persons on the installation from hazards of explosion, fire, heat, smoke, toxic gas or fumes during any period while they may need to remain on the installation following an incident which is beyond immediate control and for enabling such persons to be evacuated from the installation where necessary, including the provision for—

  (a) temporary refuge;

  (b) routes from locations where persons may be present to temporary refuge and for egress therefrom to points from where the installation may be evacuated;

  (c) means of evacuation at those points;

  (d) facilities within temporary refuge for the monitoring and control of the incident and for organising evacuation.

  10. A statement of performance standards which have been established in relation to the arrangements referred to in paragraph 9 (including performance standards which have been established for structures and plant provided pursuant to such arrangements), and a statement of the minimum period for which the arrangements as a whole are intended to be effective following an incident referred to in that paragraph.

  11. A **demonstration**, by reference to the results of suitable and sufficient **quantitative risk assessment**, that the measures taken or to be taken in relation to the hazards referred to in paragraph 9, including the arrangements mentioned in that paragraph, will **reduce risks** to the health and safety of persons to the **lowest level that is reasonably practicable**.

- **Similar Paragraphs are included in Schedule 3 for mobile units, which also requires a risk assessment of the sea-keeping ability.**
Prescriptive vs. Goal Setting

1862

1988
History of QRA

- **2005 OSC Regs**

The 1992 OSCR required a safety case to include a demonstration that major hazard risks are ALARP. **Instead,** the **2005 OSCR require** the safety case to **demonstrate** that major hazard risks are **identified** and **evaluated** and that, in respect of these risks, the ‘**relevant statutory provisions**’ will be complied with.

This is more consistent with the principle that OSCR does not set standards for the control of major accident risks (see ‘Purpose of a safety case’, paragraphs 7-9). **In practice the ALARP standard remains** for acceptance except where the law requires a stronger standard.
QRA Methodology

Initiating Event

Safe Dispersion (PSD, 'R')

Leak / Gas Detection (P_{LB}, 'D')

Shutdown 1 (P_{ESB1}, 'S')

Blowdown 1 (P_{BB1}, 'B')

Ignition (P_{int}, 'I')

Explosion (P_{Exp}, 'E')

Flash Fire (P_{FF}, 'F')

Fire Detection (P_{FB}, 'H')

Shutdown 2 (P_{ESB2}, 'S')

Blowdown 2 (P_{BB2}, 'B')
Under the Bonnet of a QRA
Leak Frequencies
Under the Bonnet of a QRA
Leak Frequencies
Many parameters affecting cloud size:

- Isolatable sections
- Release location
- Release Directions
- Wind Directions
- Wind Speeds
- Hole sizes
- ESD/BD conditions
Under the Bonnet of a QRA Dispersion
Under the Bonnet of a QRA Dispersion
Under the Bonnet of a QRA

Gas Detection
Under the Bonnet of a QRA Explosion
Under the Bonnet of a QRA Explosion

Grids showing the distribution of values across different regions. The labels indicate specific parameters and grid configurations.
Under the Bonnet of a QRA

Fire Detection
Under the Bonnet of a QRA Escalation Fatalities
Under the Bonnet of a QRA
Escape & Evacuation Fatalities
QRA Uses: LSIR
PLL = \sum_i P_i N_i^f

Probable Loss of Life is the (Statistical) Expected Loss of Life per Annum
Societal Risk

Graph showing the relationship between frequency (F) and number (N) of fatalities. The frequency is measured in units of year$^{-1}$ and ranges from $1 \times 10^{-7}$ to $1$ on the y-axis. The number of fatalities ranges from 1 to 100 on the x-axis. The graph includes a red line and several dashed lines representing different risk scenarios.
Likelihood → Consequence → Risk

Hazard → Likelihood

Likelihood → Consequence

Consequence → Treat or Tolerate

Risk → Residual Risk

Risk → Additional Mitigations → Reduce Consequence

Risk → Additional Barriers → Reduce Likelihood

Risk → Mitigations

Risk → Residual Risk
Assessment versus Management

Risk = Hazard × Likelihood × Consequence

- Barriers
  - Additional Barriers
- Mitigations
  - Additional Mitigations

Reduce Likelihood → Reduce Consequence → Treat or Tolerate

Residual Risk
Risk Assessment

Risk Management

Are our defences currently functioning & effective?

Hazard → Likelihood → Consequence → Risk

Barriers

Additional Barriers

Mitigations

Additional Mitigations

Current Risk

Risk Assessment

Reduce Likelihood

Reduce Consequence

Treat or Tolerate

Residual Risk

Assessment Versus Management

Reduce treatment

treat
tolerate
Taking it further

- Using Consequence modelling results to aid decision making during emergencies
- 3D CAD model to automate a QRA
- Cut off on societal risk screen out big events
- Use for situational awareness training
Quantitative BowTies

- Inadequate Isolation
- Corrosion
- Defective Equipment
- Degradation of Material Properties
- Human Error
- Procedural Violation

- Installation: Loss of Containment
- 1.01 Hydrocarbons
- 1.01 Cold Water

- Fire and Smoke
- Explosion
- Earthquake
- Storm
- Ship Impact
- Overhead working

- Morecambe Bay CPC: Person Entering Sea
- Drowning
- Hypothermia
- Cold Water Shock
- Injury / Death on Water Impact
A final remark
Thank You