Optimization of gas detectors

FLUG Bergen

Asmund Huser

01 June 2016
Content

- DNV GL JIP invitations
- Gas detector optimization
  - Background
  - Risk based vs geographic approach
  - Optimal number of detectors
- Summary
OIL & GAS and ENERGY

Leaner and faster design

CostFX
Cost Efficient Explosion Load Descriptions for Process Areas
Joint Industry Project – Call for Partners

Image From DNV GL CFD Team - FLACS software

Project Scope and Deliverables
The JIP will:

- Develop fitted, integrated explosion loads on relevant structural support items
- Obtain experimental evidence for the combined drag and pressure load on intermediate size cylinders.

Experimental and model developments will be combined, where dedicated experiments will measure the total foundation forces directly and models will be further developed and validated.

New near full scale experiments will be performed at the...
JIP Partner invitation: Phase 2 of Sub-C-O₂ JIP:

JOINT INDUSTRY PROJECT “SUB-C-O₂”
SMALL SCALE EXPERIMENTAL PROGRAM: DEVELOPING SAFETY GUIDELINES FOR OFFSHORE CO₂ TRANSPORT

CFD modeling and comparison with experiments

Joint Industry Project Partners

Figure 4: LES simulation of 10 mm upward release. Below the surface is seen as particle traces of the bubbles, and above the surface the interface between water and air is plotted as a 3D surface. All are colored with the velocity from 0 to 2 m/s (red).
Gas detector optimization
Background

- Petrobras required gas detector optimization studies in 2004.
- DNV GL developed GDOZ (Gas Detector Optimization program)
  - Combines results from large number of dispersion cases, each is weighted by its frequency
- Method refined with optimal location finder, DETLOC 2010
  - P. Araujo FLUG meeting Houston 2014
- Paper by Gabriele 2016 compared with geographic approach
  - G. Ferrara¹, R. Zhvansky¹, T. Bengherbia¹, S. H. Ledin¹, G. Rocha², I. Ahmed¹, D. M. Johnson³, V. Tam³ “Performance Based Gas Detection: Geographic Vs Scenario Based Approaches using CFD” Hazards 26, 2016,
Volumetric vs Source Approach: Potential Weaknesses of the Source Approach

Point Detectors
Scenario Based vs Geographic Approaches: Potential weaknesses of the Geographic Approach

The Geographic Approach is based on the regular spacing of detectors based on the minimum size of the gas cloud that can result in a damaging overpressure.
Scenario Based Approach – 3D CFD for Dispersion

Leak Point

Idealised Simulation
3D model is used to realistically define the most likely release points: flanges, valves, rotating machinery, instrument connections, drain points, small bore tubing etc.
Leak Source Definition: Leak Position
Scenario Based Approach – Modelling of Gas Dispersion

- Hundreds/thousands of gas dispersion simulations are performed for each process area

The accurate 3D CFD modelling will allow considering the main parameters affecting the gas detection effectiveness:
- Specific/realistic wind flow patterns
- Specific/realistic behaviour of the released gas (heavy gas)
Frequency Maps

• Correct physics of dispersion
• Realistic points of release
• Actual frequency of the release
Frequency Maps: Example for an onshore process module

y = -7m

y = 0m

y = 20m
Frequency Maps: Example for an onshore process module

y = -7m
Y = 0m
Y = 20m
Frequency Maps: 3D iso-contours for an offshore platform
Frequency Maps: 3D iso-contours for an FPSO
DNV GL F&G Mapping
Comparison with Geographic Approach
Location of Detectors comparing geographic and scenario based approach

- Geographic approach

- Scenario based approach
Coverage Plots for Scenario Based and Geographic Approach (I)

Scenario Based

Geographic Approach

- 100N Existing Layout
- 200N Existing Layout
- 100N Optimised Layout
- 200N Optimised Layout

Frequency Based Coverage (%)

Number of Detectors
Coverage Plots for Scenario Based and Geographic Approach (II)

Coverage (frequency of detected leaks as a % of total leak frequency) vs Number of detectors.

Scenario Based:
- 100N Coverage
- 200N Coverage

Geographic Approach:
- Coverage line

Ungraded
Cost benefit assessment

- A cost benefit is necessary to identify the optimal number of detectors.
- An economical approach is used applying the following parameters:
  - Platform value and lifetime;
  - Oil production;
  - Cost of detectors (installation and maintenance);
  - Cost of spurious failure

![Graph showing cost benefit analysis](image)
Gas occurrence probability

No detectors

Existing detectors’ layout

New detector layout proposed by DNV GL
Conclusions

- Performance Based approach is needed instead of Prescriptive (following IEC 61511).
  - Also called, risk-based “Scenario-Based”, or “Volumetric” approach.
  - 3D CFD modelling gives most effective locations
- “Source Volume Approach” and “Geographic Based Approach” are less effective
  - Quick geographic methods OK early phases of Projects.
- Efficiency increase is large:
  - Number of detectors can be reduced by more than a factor two
  - Detection probability can increase more than 50%
- The cost optimal number of detectors gives minimum cost
Thank you

Asmund Huser
Asmund.huser@dnvgl.com
+47 91730337

www.dnvgl.com

SAFER, SMARTER, GREENER

Ungraded