Using CFD in Platform Design

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CFD (Computational Fluid Dynamics) in Fire & Blast Assessment

Optimal Solutions Result In:

1. Increased Safety
   • Deeper understanding of potential consequences
   • Knowing in detail where the risk drivers are
   • Knowing what efforts that will best improve safety
   • Better control of the actual risk level

2. Reduced Cost
   • Mitigation efforts may more easily be proven to not be required
   • Knowing how much steel is required to meet an acceptable level
   • Reducing weight (both steel walls and passive fire protection)
Explosion Risk Example

Level of Explosion Analysis Selection

- **Level 1** – Entire Module Filled at LFL & exploded
- **Level 2** – Gas Dispersion with most credible cloud exploded
- **Level 3** – Probabilistic QRA using Multivariate CFD in Conjunction with Risk Acceptance Criteria.
\[ \sum \text{Cond. Prob./yr} \] vs Explosion Overpressure (F-P)

Accumulated Explosion Conditional Probability
vs. Pressure

Design Load
Identified
for
Acceptance
Criterion of
\(10^{-4}/\text{yr}\)
Level 1: Designing the blast wall to resist the largest theoretical cloud size.

Level 2: Designing the blast wall to resist the largest realistic cloud size (estimated from gas dispersion).

Level 3: Designing the blast wall to resist the cloud size with a frequency of $10^{-4}$ (NORSOK Z-013).
Cost Comparison associated with 3 Explosion Levels: Blast Barrier Construction; Analysis; Sum

<table>
<thead>
<tr>
<th>Level</th>
<th>Construction Costs</th>
<th>Analysis Costs</th>
<th>USD ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td></td>
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<tr>
<td>Level 2</td>
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<td>Level 3</td>
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Note: The image shows a bar chart with levels and costs, but the specific values are not visible in the image.
Flammable Gas Volume depends on leak: location, direction, rate, duration; congestion & confinement; meteorological conditions.
Flammable Gas Volume depends on leak: location, direction, rate, duration; congestion & confinement; HVAC system.
LNG Pool Formation & Associated Natural Gas Dispersion

Flammable Gas Volume depends on leak: location, direction, rate, duration; physical obstructions; meteorological & surface conditions.
CFD - Flammable Liquid Spray Release

Flammable Volume depends on:
- leak: location, direction, rate, duration;
- congestion & confinement;
- flash & boiling points liquid; & surface conditions.
Blast Loads depend on plume size & location; ignition location; gas composition; congestion & confinement; pressure relief panels; deluge system.
CFD – Pool Fire on Sea Surface

Fire Loads & Smoke Development depend on pool size & location; gas composition; congestion & confinement; wind conditions.
CFD – Fire Simulation Inside Enclosed Module

Fire Loads & Smoke Development depend on leak: location and direction, rate (pool size - diffusive fire), duration; congestion & confinement, HVAC.
CFD - Dynamic Non-Linear Structural Fire Response Simulation
CFD - Dynamic Non-Linear Structural Explosion Response Simulation
CFD – Turbulence & Temperature Fields for Helicopter Operations
CFD Simulation of Outdoor Working Availability for Harsh Weather (related to Wind Chill Index)

Includes: Layout effects; meteorology; climatology (monthly wind & temperature statistics)
Concluding Remarks

• Employing CFD is Increasingly Important in Effective Risk Management for Offshore & Onshore Facilities.


• Effective Means to Improve Insight of New Hazards & Potential Consequences Where New Technologies are Applied.
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