The background of the entire page is a silhouette of an offshore oil rig against a gradient background that transitions from orange at the top to yellow at the bottom. The rig's structure, including its derrick, cranes, and various pipes and platforms, is rendered in black. A large, vibrant red ribbon graphic is positioned in the lower right corner, looping and overlapping itself. The text is presented in white on a dark blue rectangular background.

THE FLACS DIFFERENCE:
FLACS CFD modelling of offshore gas leak
and explosion delivers realism,
understanding and results

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THE FLACS DIFFERENCE: FLACS CFD modelling of offshore gas leak and explosion delivers realism, understanding and results

► Objectives

- Determine realistic cloud sizes as a consequence of a flammable gas release on an offshore platform
- Determine the realistic explosion loads
- Investigate the effects of consequence modelling and explosion analysis approaches

► Challenge

- Analysis of complex offshore geometries

► Software

- FLACS - v10.3r2 (CFD tool)

► Solution/Added Value

Detailed CFD modelling from the market's leading software solution.

The benefits are clear:

- FLACS delivers realistic results for ventilation, dispersion and explosion. This provides a reliable platform for the subsequent design of structures and protection equipment.
- Safety comes first with FLACS. Modelling results ensure that adequate safety levels are maintained and any unnecessary conservatism is eliminated.
- Optimising operations: FLACS analyses empower smart layout choices for optimal efficiency, as well as the lowest risk.

► Introduction: the vital role of CFD

Accidental release of toxic and flammable substances is a major hazard within the offshore industry. Flammable gases and liquids are a major concern, due to their potential for triggering explosions that can exert extreme loads on structure and equipment.

It is therefore essential that the risks and consequences of potential releases and explosion hazards form a central component of Risk Assessments for any offshore facility.

The consequences of a release (e.g. cloud size) and subsequent explosion (e.g. overpressure) are dependent on several factors, such as fuel type, concentration, leak rate/direction, environmental conditions, cloud size, ignition location, etc. and the presence of any mitigation measures (e.g. ESD, deluge, etc.).

More importantly, the complex geometry of offshore facilities (congestion and confinement, as well as layout of equipment, walls, etc.) plays a key role in determining the magnitudes of gas cloud size (following a release) and overpressure/drag loads (following an explosion).

As geometry plays such a determining role in a potential hazard scenario, it must also be included in effective risk assessment modelling. To achieve this, however, there is a requirement for modelling tools based on Computational Fluid Dynamics (CFD).

FLACS is the market's leading 3D CFD ventilation, dispersion, explosion and fire modelling software. Its sophisticated and user-friendly nature allows users to accurately model the exact geometry of any offshore facility, determining its effect on the complex interaction of flow, turbulence, chemical reaction, and combustion.

This provides a detailed picture of the consequences of an explosion, delivering essential insights related to the effect of environmental conditions, release parameters, mitigation measures, and much more.

Simplified tools based on integral models cannot account for geometry, limiting their effectiveness in this complex simulation arena.

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► FLACS at work: modelling and analysis

Accurately modelling the effects of a gas leak at an offshore facility involves a three-step process: the development of geometry, modelling of representative leaks and explosion assessment.

► Geometry: building the platform for accuracy

Offshore facilities are never simple. Multiple work areas, decks and a labyrinth network of pipes, equipment and structural features are present and have a complex impact on the behaviour of gas leaks and explosions.

FLACS has an unbeatable capability for accurately modelling offshore facility geometry, but to ensure reliable results in simulations it is imperative that the model represents the real geometry as closely as possible. Any obstructions - such as equipment, piping or buildings - can not only restrict airflow, thus reducing localised ventilation, but also alter flow patterns and the resulting gas dispersion during an accidental release.

The correct density of the objects (congestion density) must also be captured – an essential element in effective explosion modelling.

By accurately representing the exact layout and density of obstructions, FLACS users can be assured of optimal results from their CFD analysis.

► Modelling leaks: the danger of simplicity

A comparison between simplified and FLACS CFD modelling of gas leaks provides stark results.

In this scenario, ventilation simulations are performed for eight wind directions to establish the module's environmental conditions. A gas leak from the platform is then defined, with the resultant gas clouds closely monitored.

As the simplified model does not account for obstacles, ignoring geometry, and can only consider one wind direction, the gas cloud may be estimated in a 'non-conservative' manner (as seen in Figure 1). Now compare that to the FLACS model, where all geometrical details are taken into account.

As illustrated in the example, the development of the gas cloud is dependent on the facility's geometry, radically influencing its size. In fact, the FLACS simulations reveal that the resulting gas cloud is 50 times larger than that predicted using a simplified approach. The potential consequences of this disparity are profound.

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► Explosion Assessment: realism the key to risk mitigation

FLACS' ability to represent detailed geometry within its modelling provides the key to making design changes and optimising layout, mitigating the potential consequences of an explosion. Here's how:

The international standard ISO 19901-3 (2010) requires frequency for accidental escalation to be less than once every 10,000 years. The standard is, however, also open for using a worst-case approach. The initial approach is to carry out a **"worst-case"** consequence study, i.e. modelling the explosion of a stoichiometric gas cloud completely filling the region.

If potential consequences of this worst-case analysis are not acceptable, the assumptions may be further refined in order to make the evaluations more realistic and to reduce unnecessary conservatism. From the dispersion simulations, a **"realistic worst-case"** gas cloud is determined and explosion simulations performed based on this. For this case study, this corresponded to a 25% fill in the FLACS simulation.

Figure 2 contrasts the worst-case and realistic worst-case approaches for explosion risk analyses. The left picture shows the explosion overpressures obtained using the worst-case approach, while the right picture demonstrates the corresponding results for a realistic worst-case approach. The explosion overpressures may differ by up to a factor of 10 for certain targets. This realistic worst-case approach allows the structure to be sensibly designed while ensuring that the risk remains ALARP (as low as reasonably practicable).

In contrast with the FLACS results, the use of a simplified tool for explosion analysis provides users with the pressure contours as shown in Figure 3. Due to its inability to take the facility's geometry into consideration, this model cannot provide the same degree of realism, presenting a very conservative picture of the explosion strength.

FLACS can also capture directional effects; an important factor since loads from non-symmetric scenarios in the near field can be significantly different than those predicted using symmetry assumptions.

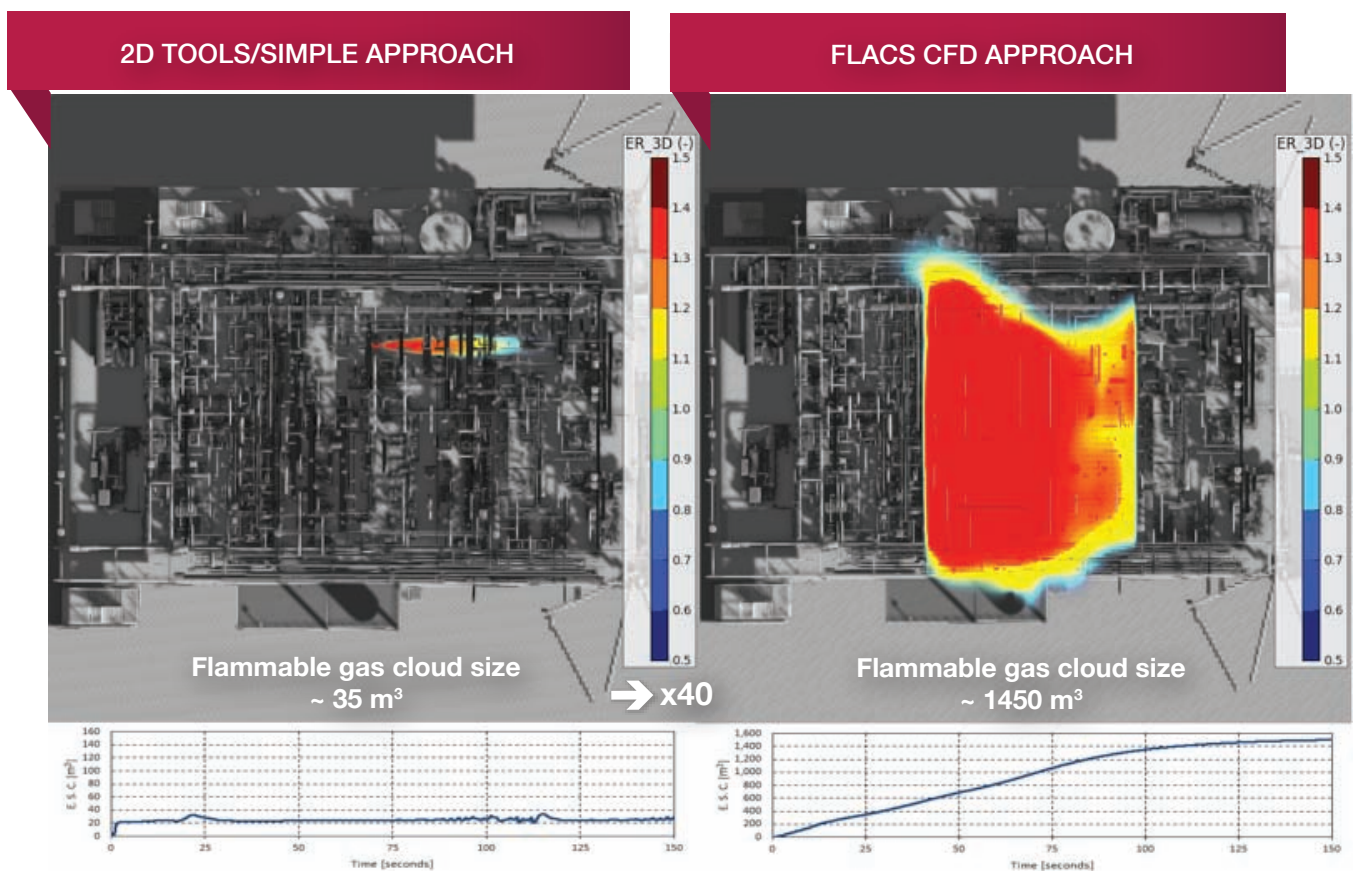
In this manner, FLACS provides users with a powerful tool for optimising geometry layout/making changes and thus mitigating the consequences of explosions caused by gas leaks.

► FLACS: added value through added benefits

Realism, accuracy and results – the advantage of FLACS

- FLACS delivers realistic results for ventilation, dispersion and explosion. This provides a reliable platform for the subsequent design of structures and protection equipment.
- Safety comes first with FLACS. Modelling results ensure that adequate safety levels are maintained and any unnecessary conservatism is eliminated.
- Optimising operations. FLACS analyses empower smart layout choices for optimal efficiency, as well as the lowest risk.

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*Figure 1: Comparison of gas cloud sizes for a horizontal 6 kg/s natural gas release
(left) No geometry considered (2D tools/simplified approach) - (right) Geometry effects included
External wind from left to right – external wind speed 7 m/s*

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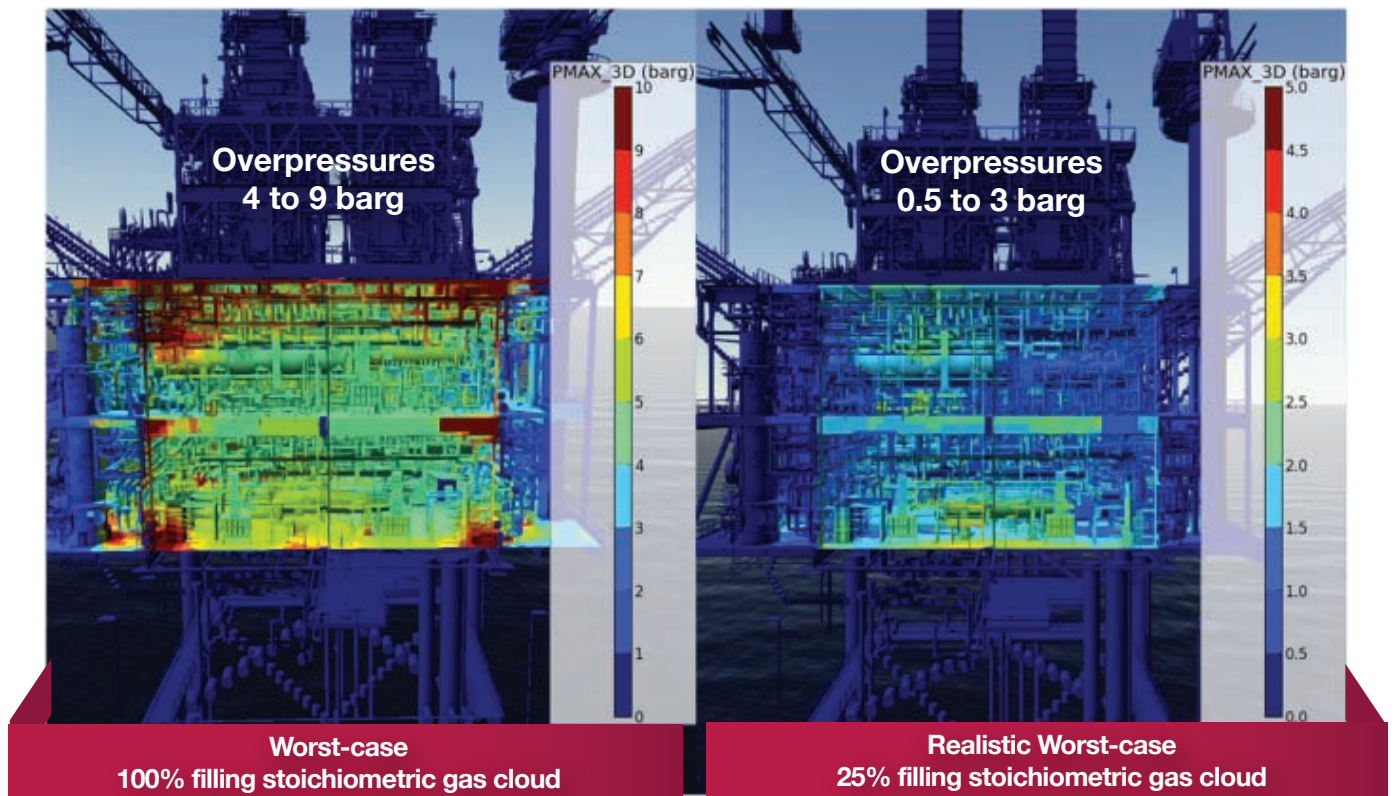


Figure 2: Comparison of explosion overpressures subsequent to ignition of natural gas release
(left) 100% stoichiometric cloud - (right) 25% stoichiometric cloud. Central ignition position (FLACS Simulations)

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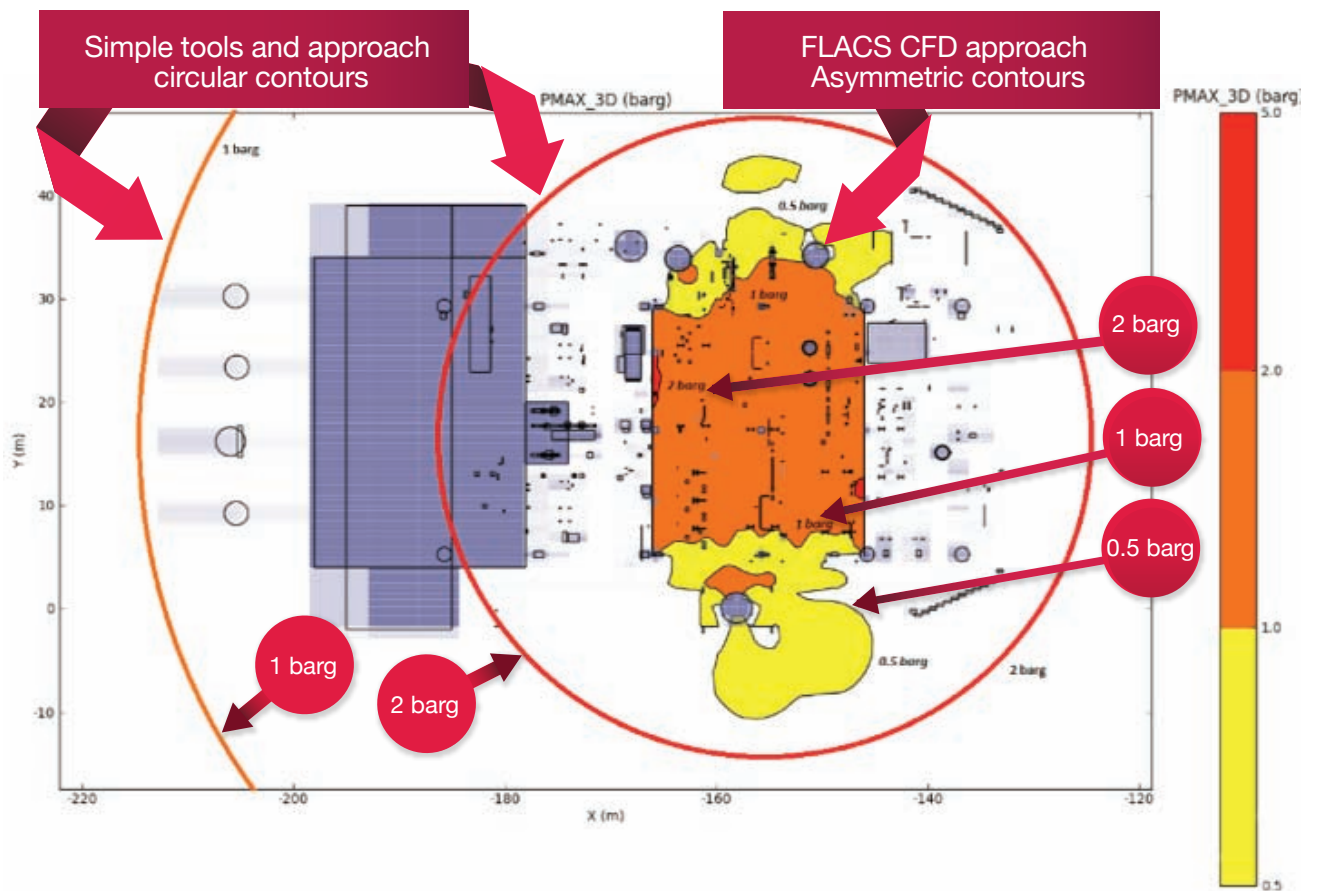


Figure 3: Comparison of CFD explosion simulations for a 25% cloud fill with a simplified approach (circular contours).
Cloud location in centre of module with ignition in the middle



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FLACS software enquiries

Email: Info@gexcon.com or Sales@gexcon.com

Tel: +47 55 57 43 30