Safety & Risk Management Services

Consequence Evaluation (Fire, Release, Explosion, Dispersion), including CFD

Germanischer Lloyd – Service/Product Description

GL OPERATING 24/7

Consequence Evaluation (Fire, Release, Explosion, Dispersion), including CFD

Service Title: Safety & Risk Management Services

Lead Practice: GL Safety & Risk (UK)

Contents

Service Description and Values Generated:

Since the late 1970s, staff from Germanischer Lloyd (GL) have been involved in a wide range of safety related projects, including fundamental and theoretical research into gas explosions, liquid and gas jet fires and other related hazards. GL operates a unique test facility at Spadeadam, UK, that allows it to undertake major hazard experiments at full-scale. The data generated at the Spadeadam test facility, in many cases through major joint industry projects, has been used in the validation of oil and gas industry related models for dispersion, explosions, jet fires, pool fires and other hydrocarbon hazards. Many of the models have been published in refereed journals and have been presented at industry conferences.

In recent years, the emphasis has changed from pure research to the application of this knowledge to improve safety and influence designs through good hazard management. We have developed knowledge-based packages, primarily for calculating the consequences (and risks) of major releases of hazardous materials from onshore plant, offshore facilities and buried pipelines. These packages contain suites of mathematical models, capable of predicting the various processes associated with gaseous or liquid releases, including outflow, dispersion and accumulation, fires, explosions and their effects on people and buildings. The models can be run individually, ('stand-alone' mode), or, for specific scenarios, linked together in a logical manner according to pre-defined 'knowledge bases'.

a. Consequence Models and their Validation

Oil and gas related production, storage, processing, transmission and distribution infrastructure has, in general, a good safety record, but the possibility of accidents can never be discounted. Of primary concern is the accidental release of flammable or toxic material from pipework, vessels and other equipment, which can affect personnel in the immediate vicinity and surrounding populations. The released material can be in the gaseous or liquid phase (including natural gas in its liquid form – LNG), flammable or toxic. In addition, there are circumstances where planned operations (e.g. flaring) have the potential for harm and need to be assessed accordingly. Consequence modelling is needed to understand the potential for harm of the many and varying release scenarios for operations in the oil and gas and chemical process industries – GL have a wide range of predictive models to undertake such studies.

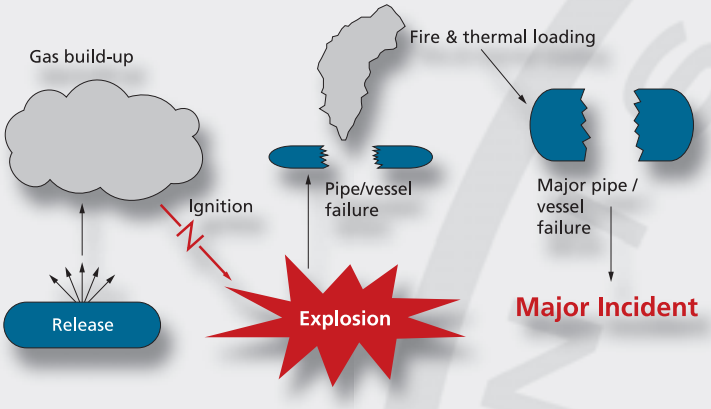
To give confidence that such predictive models give accurate predictions, it is essential that they are validated against appropriate data. This is particularly important because many of the phenomena relating to hazardous events are scale dependent. This arises as the physical and chemical processes involved vary depending on the size of the release.

In developing the GL consequence models, data from large and full-scale experiments undertaken at our Spadeadam Test Site as well as other data from incidents and published sources has been used to validate and give confidence in the accuracy of the output. This has led to models which give predictions for:

- Release conditions – vessels, pipelines, evaporating pools
- Dispersion / Accumulation – dense gas, toxic gas, jet / 2-phase jet dispersion, gas volumes, gas build-up
- Fires – jet fire, pool fire, fireball, vapour cloud
- Explosions – gas-air explosions (detonation and deflagration), instantaneous vessel failure (BLEVE), rapid phase transition (RPT)
- Effects – thermal effects, explosion response, toxic dose

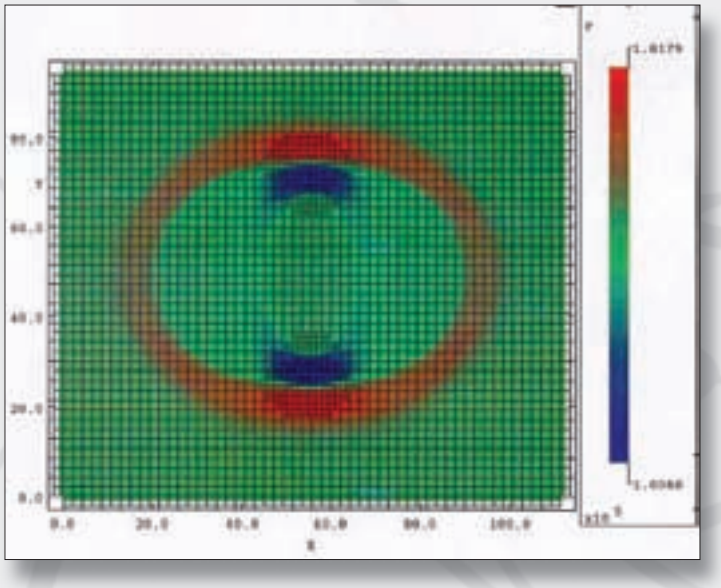
b. Linking of Consequence Models

Whilst the GL consequence models can be run on an individual basis, frequently the output from one calculation (e.g. leakage rate of a flammable gas) is required as an input to a follow-on calculation (e.g. gas build-up). Therefore many of the models have been linked together in a logical manner in line with pre-defined scenarios to form knowledge bases. A diagrammatic representation of how models may be used together to understand the potential consequences of an escalating incident is shown below.



c. Computational Fluid Dynamics (CFD)

For the majority of consequence assessment scenarios, the models developed and used by GL provide an effective and cost efficient solution. However, for particularly complex scenarios, or where, for example, detailed information on specific hazard scenarios is required for detailed design or by a regulatory authority, GL is able to offer CFD modelling within its consultancy offering portfolio. CFD uses advanced tools which allow the modelling of ventilation, gas dispersion, vapour cloud explosions and blast in complex process type areas.



a. Flare Radiation Acceptability

Date: 2001
Customer: BG Group
Savings: >£1m

Issue:

BG was investigating the possibility of developing an existing field by adding subsea tie backs. One of the concerns for this plan was whether thermal radiation from the existing flare system during emergency blowdown would rise to unacceptable levels with the greater throughput.

Methodology & Results:

There were two phases in the solution to the above issue. Firstly, a worst-case thermal radiation level was calculated and found to be unacceptable. Because the flare radiation model takes into account the atmospheric wind conditions, the radiation was then calculated for a complete array of conditions seen at the platform: 360° of directional variation and 60mph of wind speed variation. The incident thermal radiation on the platform for each case was then matched to the frequency of the wind conditions to produce a radiation/frequency exceedence curve. Using a validated, computationally fast, fire model, ensured the accuracy of the solution. From this it could be seen that the radiation was within guidelines for approximately 95% of the time and so the original flare could be used with simple, low-cost precautions.

Savings:

The project was able to avoid the redesign and reinstallation of the flare system by the use of sophisticated flare radiation modelling, making savings in the order of several million dollars.

Safety & Risk Management Services

Safety Case and Compliance Consultancy

Hazard Identification Studies (HAZID)

Hazard Operability Studies (HAZOP)

SIL Studies (Safety Integrity Level)

- **Consequence Evaluation (Fire, Release, Explosion, Dispersion), Including CFD**

EER Analysis (Escape, Evacuation, Rescue) (GL-Aeneas)

Quantitative Risk Analysis (QRA)

Decision Support (Risk Based Layout Studies)

Performance Standards

Large Scale Hazards Testing (Spadeadam)

Incident Investigation

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Issue no.001 15.05.2008