HAZARD ANALYSIS FOR THE SITING OF AN LNG EXPORT FACILITY IN THE UNITED STATES

GEXCON

FLACS

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Objectives

Perform a fire and explosion hazard analysis on a proposed lare-scale LNG liquefaction and export facility for the purpose of demonstrating compliance with U.S. federal regulatory safety requirements.

Client

Confidential U.S. customer

Challenges

• Develop detailed 3D model of the facility based on early design (pre-FEED) information

• Optimize facility layout and mitigation strategy to achieve regulatory compliance

Software

2D screening tool for scenario screening
FLACS (version 9.1) for detailed consequence modeling

Solution/Added Value

The use of FLACS, coupled with Gexcon's experience and engineering judgment allowed the client to demonstrate to the regulatory body that the facility posed no hazard to the public for the accidental release scenarios required to be considered for permitting purposes. Additionally, the effectiveness of different mitigation approaches was evaluated and an optimized strategy was identified which saved significant costs to the client.

Introduction to the case

The construction and operation of facilities for the liquefaction of natural gas and export of LNG in the United States is subject to approval by federal regulatory agencies - the Department of Transportation, which owns the regulations (Title 49 Code of Federal Regulations, Part 193), and the Federal Energy Regulatory Commission, which applies the DOT regulations and has approval authority. LNG facility siting regulations require the quantitative evaluation of the offsite consequences from accidental loss of containment of hazardous materials (flammable and toxic); the applicant must demonstrate that the facility will pose no threat to the public or public property as a result of the credible worst case accident. This process can become particularly complex when vapour dispersion and overpressure hazard footprints are to be determined.

The hazard analysis for this LNG export facility consisted of several steps:

1. Evaluate the entire facility to identify all credible release scenarios (approximately 100), according to regulations and regulatory guidance;

2. Perform a screening-level consequence modelling study (using a 2D screening tool) on the initial list of scenarios, to identify the "critical" scenarios – that is, the scenarios with the largest hazard footprints and those which may pose regulatory compliance concerns;

3. Perform a detailed 3D consequence modelling study (using FLACS) on the critical scenarios, to take into account the presence of obstacles, obstructions and topography;

4. For scenarios which result in non-compliant consequences (i.e., the hazard footprint extends offsite), identify suitable mitigation strategies and repeat the consequence modelling (using FLACS) to verify the effectiveness of the mitigation.

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Modelling with FLACS

The two most critical steps in the facility siting study are 1) the selection of scenarios to be included in the analysis and 2) the creation of an accurate 3D geometry model of the facility and surrounding areas. Creating the geometry model of the facility often presents a challenge because, particularly at early design stages (pre-FEED or even FEED), very limited details are available from the client. Since the consequences of accidental releases – particularly the overpressures from the ignition of flammable clouds – can be highly dependent upon the levels of obstruction and congestion, using early-design CAD models is likely to yield non-conservative results. In this case, Gexcon utilized an early-design CAD model from the client and supplemented it with anticipated congestion blocks, based on our vast experience with LNG liquefaction process areas, to obtain a model which is representative of as-built conditions.

For each of the critical scenarios, the maximum dispersion of the flammable vapour cloud (to ½-LFL concentration) was modelled using FLACS and the results overlaid upon the facility plot plan, to verify that the cloud remained within the property boundaries. At the same time, the size of the flammable cloud inside congested areas (e.g., within the liquefaction trains) was tracked; the largest flammable clouds were then ignited at different locations, in order to determine the overpressure hazard footprint.

In this case, a small number of scenarios resulted in vapour clouds which extended beyond the facility's boundaries. Gexcon discussed potential locations for vapour barriers to control the cloud dispersion and prevent the ½-LFL concentration from extending offsite. FLACS simulations for the non-compliant scenarios were then repeated, with the addition of vapour barriers, to verify that the mitigation scheme met regulatory requirements.

Added value for the project

- Detailed 3D CFD modelling of vapour dispersion and overpressure hazards demonstrated that simpler modelling tools overpredicted the hazard distances for the bounding cases. This significantly reduced the number of initially non-compliant cases, which required mitigation.

- FLACS modelling allowed the client to demonstrate that vapour barriers could be used to successfully mitigate the consequences of the non-compliant scenarios

- The FLACS modelling results determined that, even though the original facility layout complied with siting requirements, a small increase in the inter-train spacing would significantly reduce the potential for overpressure damage within the plant. A layout modification of the process area was made which reduced internal risk.

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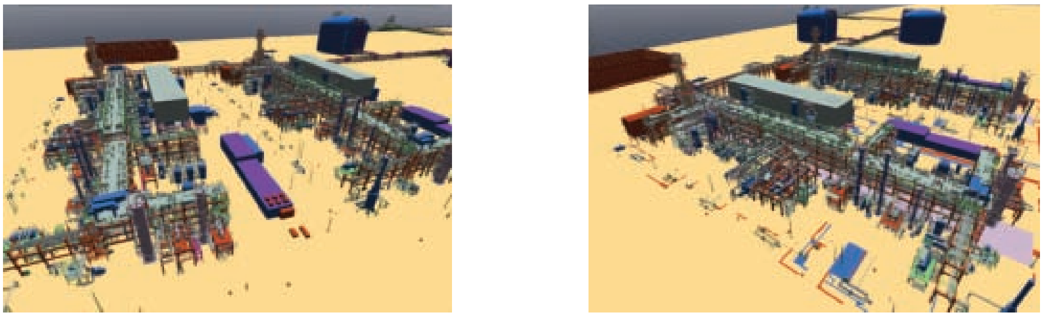

Figure 1: *3D geometry model of one liquefaction train*

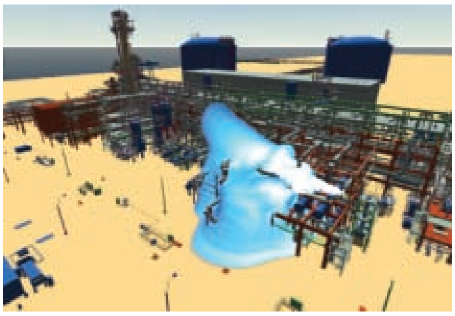

Figure 2: *Flammable vapour cloud (to ½-LFL) for a propane release in the liquefaction train*

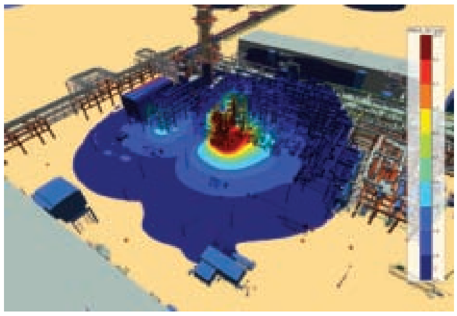

Figure 3: *Maximum pressure contours from the ignition of a propane cloud within the liquefaction area*

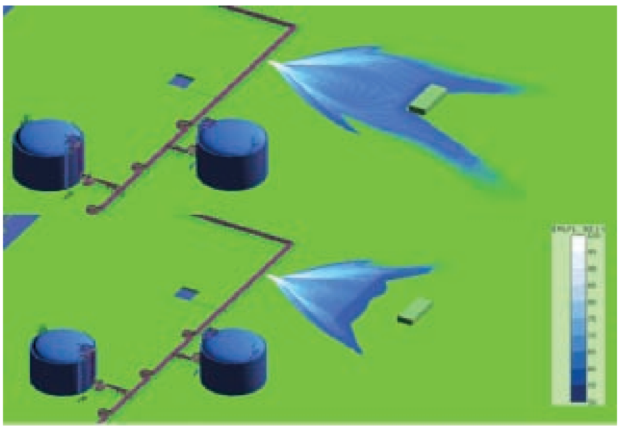

Figure 4: *Effect of vapour barrier in reducing the flammable vapour cloud dispersion distance from a pressurized LNG release*

FLACS software enquiries

Europe and Russia
Henning Olsen
Vice President Sales
Mobile: +47 469 86 920
Email: henning.olsen@gexcon.com

South-East Asia, Korea and Japan
Sune Solberg
Vice President Sales
Mobile: +47 954 81 288
Email: sune.solberg@gexcon.com

Middle East, Africa, Caspian, India and Australia
Dr Pascal Le Gal
Vice President Sales
Mobile: +971 50 666 7935
Email: pascal.legal@gexcon.com

Greater China
Bin Xie
Vice President Sales
Mobile: 13916639854
Email: xie.bin@gexcon.com

Americas
Alexander Tadesse
Vice President Sales
Mobile: +44 7792045655
Email: alexander.tadesse@gexcon.com

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