GEXCON

TECHNICAL NOTE

New Sotra bridge - gas exposure from worst case release of LPG from Asphalt plant

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Author: Are Bratteteig
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Checked by: Ørjan Knudsen

Approved by: Are Bratteteig

1 Introduction

The objective of this study is to determine gas exposure of the new Sotra bridge, due to a worst-case gas leak from the LPG tank at the asphalt facility located next to the bridge landing, on the Sotra side. The gas exposure is simulated using the CFD tool FLACS.

The newest version of FLACS (version 10.5) is used. FLACS is a well-known and thoroughly validated tool developed for ventilation, dispersion and explosion simulations in complex geometries. FLACS is developed and maintained by GexCon AS in Norway. Further details on FLACS can be supplied on request.

1.1 Leak case

The worst leak case is a vertical full bore release of pressurized LPG (7 barg) from the 40 mm pipe on top of the tank. The system will contain excess flow values which, will limit the maximum flow to 90 gallons per minute (Rego part number 7574).

The CFD tool FLACS only handles gases, thus the DnV software Phast 7.11 is used to model the transition from liquid release from the pipe until the fluid entirely consists of gas.

The LPG will consist of a mixture of propane and butane, where the butane content may vary from 5% to 100%. The bridge is located above the leak, thus it is conservative to represent the flow with 100% propane, since propane is lighter than butane.

The Phast calculation uses the following input: vertical leak of propane liquid at 7 barg with an evaporated gas temperature of 10 C and a hole diameter reduced from to 40 mm to 15 mm to give a release rate of 3 kg/s (= 90 Gallons per minute). The calculations showed that all the liquid has evaporated at a height of 8 m above the leak point.

Gexcon AS
P.Box 6015
NO-5892 Bergen, Norway

Visiting address:
Fantoftvegen 38
Fantoft

Telephone: +47 55 57 43 30
Telefax: +47 55 57 43 31
www.gexcon.com

Bank: 5210 05 26018
NO 979 879 342 VAT

1.2 Geometry

In order to perform dispersion simulations with CFD, a 3D geometry model is needed. In this study a 3D geometry model is generated based on maps of terrain and buildings (contour lines)[ii], drawings of the LPG tank, Google Earth and drawings of the new Sotra bridge[i]. The 3D model is shown in Figure 1-1.

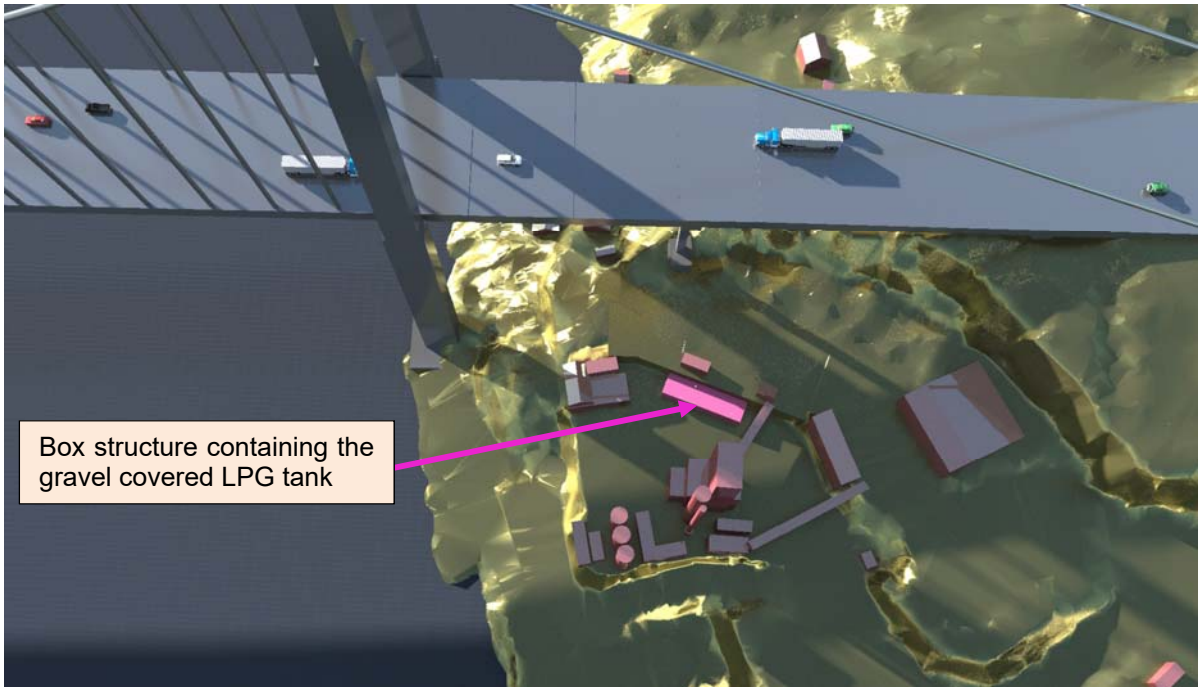

Figure 1-1 3D model of asphalt plant and the new Sotra bridge

1.3 Dispersion simulation

In FLACS, the leak is modeled as pure gas leak at the top of the tank with conditions set in order to match the Phast calculations at a height of 8 m, where all of the liquid LPG has transitioned to a gas state.

In general, the wind affects dispersion from a vertical leak of heavy gas by diluting the gas concentration, changing the horizontal direction and bending the plume in the vertical direction. Here the worst case is a moderate wind blowing from the leak towards the bridge. Initially, a wind from north was simulated, but this resulted in the leak being in the wake of the structure north of the LPG tank. Based on this, wind from north-east was used. Testing a few different wind speeds showed that a wind speed of 3 m/s (at a height of 10m above sea level) gave the worst case (gas plume directed towards the bridge).

2 Results

In accordance with industry practice, 50% of Lower Explosion Limit (LEL) is used as a limit for the gas concentration with regards to exposure to flammable gas. Figure 2-1 illustrates the maximum extent of gas above 50%LEL.

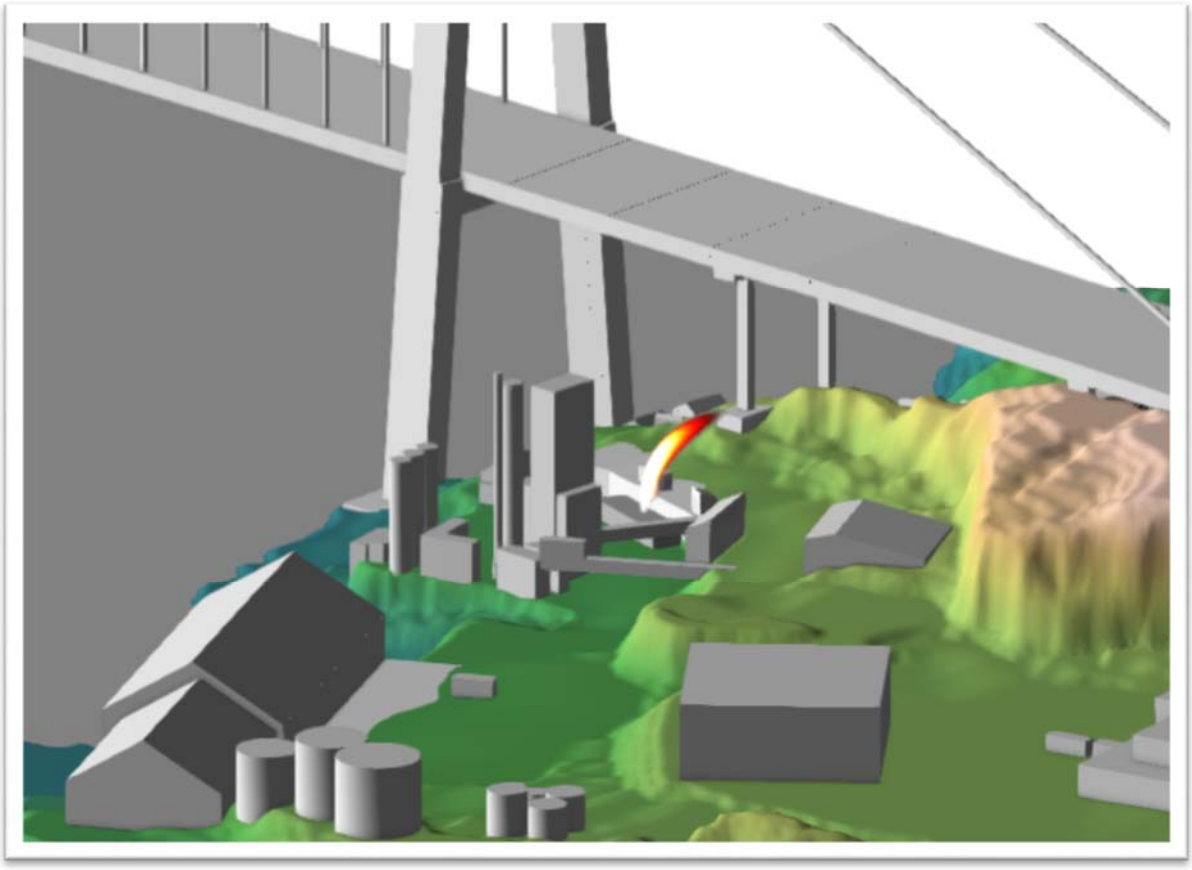

Figure 2-1 Gas plume, view from North-West (Gas concentration between above 50%LEL)

3 Conclusion

The simulation results, Figure 2-1, clearly show that a “worst-case” LPG release does not expose the new Sotra bridge to flammable gas.

4 References

[i] Drawing of “Ny Sotrabru”, 1.6.2015, Doc No K2100, Statens vegvesen
[ii] Terrain maps ordered from Ambita/Infoland by Stian Herrebrøden (TolCom AS)