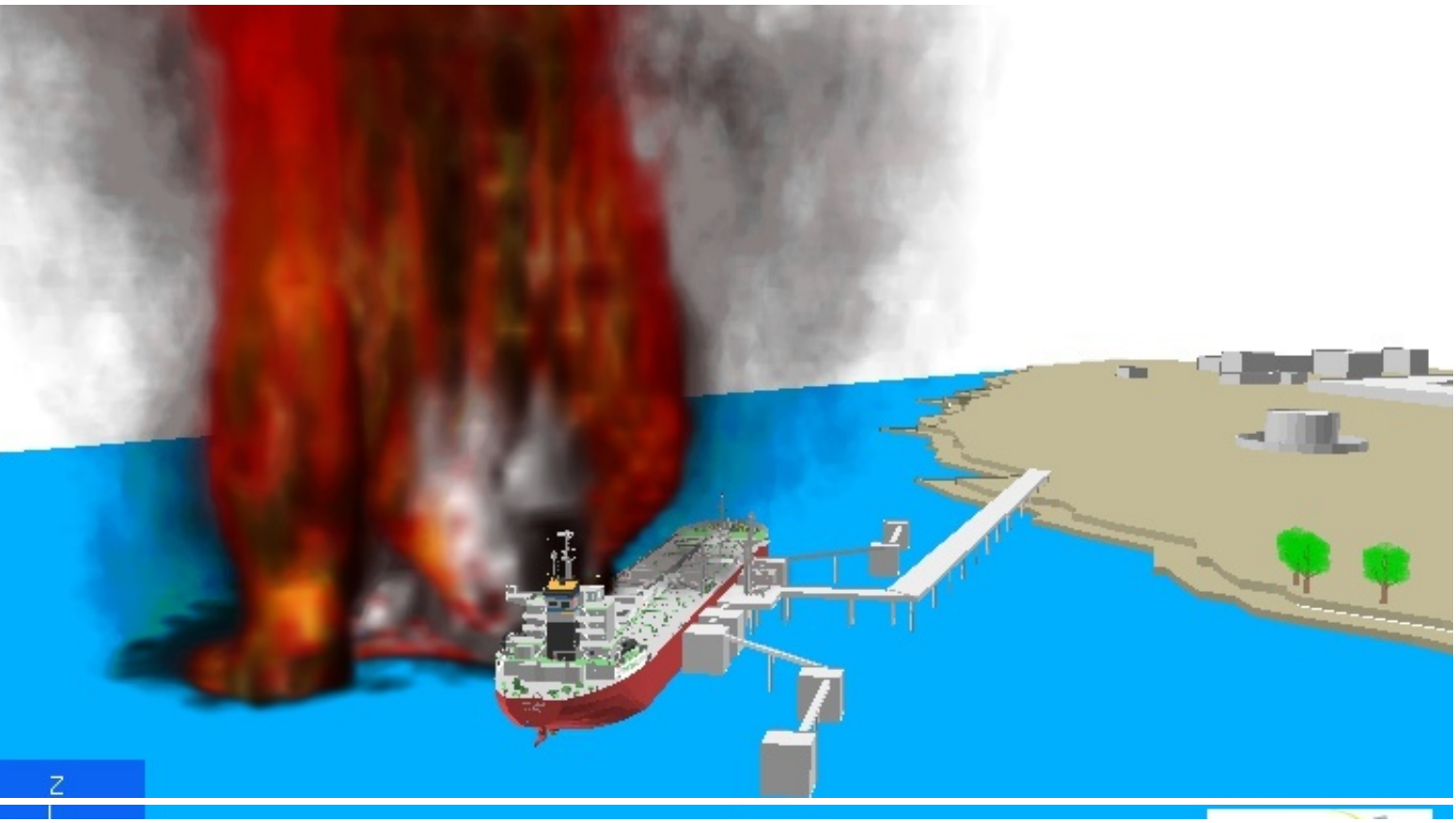


OIL AND GAS

# CFD RELATED NEWS

## for DNV GL in Houston, June 2015.

**DNV GL Houston lands its first LNG fire study**

DNV GL in Houston has won a contract to do a Computational Fluid Dynamics (CFD) fire study for a Liquefied Natural Gas (LNG) transfer and jetty facility on a river in Vancouver, British Columbia. The project consists of two main parts: performing CFD simulations and conducting a Quantitative Risk Analysis (QRA) using DNV GL's software PHAST with the CFD simulation results used as input. Quality Assurance (QA) of the CFD simulation results will be performed by DNV GL in Houston.

ComputIT, based in Trondheim Norway, will perform the CFD simulations with their software Kameleon FireEx® (KFX™). The contract calls for a total of 54 LNG pool and spray fire simulations. The mitigating effect of natural barriers (in the form of trees near the riverbank) and two (2) different manmade barriers will be analyzed in the study. The LNG fire for one of the vessel collison scenarios are depicted above.

KFX™ was selected as the preferred software to use in this study because it has a LNG pool fire model that accounts for the transient pool spreading, heat transfer from the water to the LNG and thermal radiation from the fire to the LNG pool. The distortion of the pool due to the river current is also accounted for. The aforementioned mechanisms are all crucial in correctly modeling the evaporation rate from the LNG pool which in turn determines the severity of the fire. In addition, KFX™ has an LNG spray model. KFX™ is a commercial software but its LNG capabilities have not yet been released to the general public.

The CFD results will serve as input to the QRA part of the project. This project is the first direct CFD based QRA study, using PHAST, undertaken by DNV GL in Houston.

**DNV GL uses CFD to predict Vortex Induced Motion (VIM) in Offshore Oil&Gas**

As the industry shows an increasing interest in relying on analytical studies, as opposed to expensive and time consuming model testing, CFD may be a powerful engineering tool to predict offshore hydrodynamics, such as vortex induced vibration of subsea pipelines or dynamic motions of floating

structures (vortex-induced motions). DNV GL Maritime advisory together with Oil and Gas have already gained substantial experience in developing and adopting CFD for maritime and offshore applications in recent years. Shown below, at the bottom of the page, are the vorticity contours from a CFD simulation for a structure with an elliptical cross section partially submerged in water.

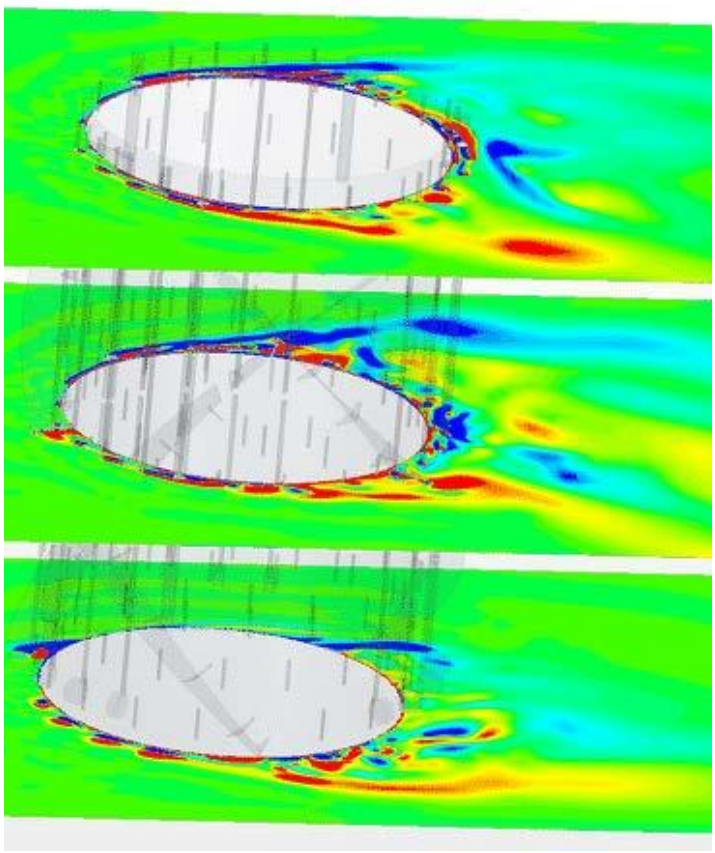
DNV GL is serving in the steering committee of US Dept. of Energy (RPSEA)'s VIM Study for Deep Draft Column Stabilized Floaters. DNV GL propose to use OPENFOAM (a license-free CFD solution) to address VIM and would like to contribute to the program by running CFD simulations to validate model testing. The availability of large in-house HPC resources together with the license-free CFD solution of OpenFOAM will give DNV GL the opportunity to generate more CFD related business in offshore technical advisory services.

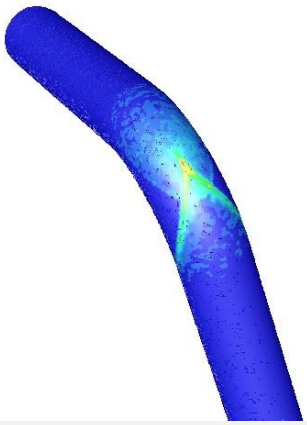
**DNV GL and a major oil and gas operator are collaborating on sand management modeling using CFD**

In the oil and gas industry, sand production from the reservoir causes deterioration of metal and its properties. This common problem is difficult to prevent and it can be the cause of mechanical failure of many process facilities such as flow loops, control valves, pipeline fittings and processing vessels. To prevent process failure and minimize downtime it is important to predict erosion through modeling.

In order to prevent and mitigate erosion, erosion modelling must account for the many factors that govern particle behavior. CFD can be used to model erosion in pipelines and other components with the aid of theoretical models. CFD provides an important supplement to experimental results when determining erosion rates. CFD can be used in complex geometries and the numerical simulations can give valuable information about particle tracks. Moreover, CFD erosion modeling can account for turbulent fluctuations and estimate the erosion profile fairly well. The contours of the erotion rates for a bent pipe as predicted by CFD is shown below.

The operator and DNV GL have agreed to conduct a collaborative study on erosion prediction. The collaboration will also require access to experimental data at either DNV GL's UK or Oslo Laboratory facilities. At the conclusion of the study, both parties will have a better understanding of process facilities, how to maintain pipeline systems and how to extend the life of subsea equipment which should equate to big cost savings.





For more information about CFD activities at DNV GL in Houston please contact:

Vebjorn "BJ" Nilsen, Ph.D.: phone: +1-281-770-1097, email: vebjorn.nilsen@dnvgl.com or

Partha Sharma, PE: phone: +1-713-397-9327, email: partha.sharma@dnvgl.com or