Development of meta-models for the optimized Fire & Gas sensors layout in the framework of a risk analysis for an offshore deck

Introduction

The development of quantitative risk assessment methodologies related to accidental events in the *Oil & Gas* framework is a research and industrial theme of national interest in the perspective of a sustainable transition in the decarbonisation process of the Italian energy mix.

This specific topic is the central theme of a research activity funded by the Italian Minister of Economic Development (MiSE) and carried out in the SEADOG (*Safety and Environmental Analysis Division for Oil & Gas*) laboratory of the Energy Department of Politecnico di Torino.

Among the research topics currently underway, the definition of an engineering protocol aiming at the definition of an optimised *Fire & Gas* sensors layout on offshore decks is a fundamental support to improve the early warning of potential accidental scenarios and, thus, to enhance the extraction plants safety.

Aim of the work

A possible approach for optimising a *Fire & Gas* sensors network installed on an offshore deck consists in minimising the risk related to the flammable and/or toxic gases accidental release in the working environment. Nevertheless, due to the high complexity level of a deck and to the large uncertainties affecting the phenomena involved (pipe break size and position, wind direction, presence of obstacles…), a brute force approach based on the Computational Fluid-Dynamics (CFD) simulation of each possible scenario is not practically affordable, due to the high computational cost associated to CFD simulations.

One of the possible answers to the computational time issue related to the optimisation step consists in the generation of a reduced number of scenarios to be employed as a training set for a meta-model, i.e. a surrogate model able to emulate, with a very low computational cost, the high fidelity CFD simulation results.

The first step of whatever surrogate model construction is the definition of an effective training points set, able to cover a significant number of possible scenarios, and their following simulation with the high fidelity CFD approach. In this specific case, the events to be considered are the accidental release and consequent dispersion of flammable gases on the deck, due to a small break in the pressurised pipes.

The achievement of this first step is the main goal of such Master thesis proposal, whose accomplishment requires the adoption of the CFD two-steps approach developed in the last years at the SEADOG laboratory with the commercial software Ansys Fluent.

As a complementary activity for the thesis work, a preliminary validation of the meta-model predictive performances is foreseen, in order to test its capability of reproducing the CFD results also for untrained sets of parameters.

The candidate should have the basic knowledge of both the fluid-dynamics and the phenomena related to the release and dispersion of gaseous substances in the atmosphere. In addition to this physics notions, the candidate should also have a strong background related to the Monte Carlo method and the risk analysis. Any previous knowledge on CFD methodology is welcome, but not mandatory.

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References

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