RISK ANALYSIS AND SAFE DISTANCES CALCULATION CONSIDERING ATMOSPHERIC PARAMETERS UNCERTAINTY

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***Abstract*— This work presents a computational tool, useful in risk assessment of hazardous material releases. It is based on a methodology that takes into account the stochastic uncertainty of atmospheric parameters. This is relevant for calculating risk of hazardous gases, particulate matter or bioaerosols diffusion when an accidental release or continuous emission occurs. This methodology can be applied to risk analysis of static sources (a stack or a fixed tank in a facility) or transportation accidents (road, train, maritime and pipeline transport) involving different scenarios. After carrying out a stochastic simulation based on well-known diffusion models (heavy and light gases or particulate matter), downwind concentrations are obtained so that individual and societal risks can be computed. This work contributes mainly to the formal presentation of the procedure, and the real application of the stochastic simulation avoiding large (prohibitive) computational effort, by introducing a translation algorithm and the Stochastic Reference Emitter (SRE) definition. This new approach also shows to be a fundamental step to organize a software prototype for risk assessment. Besides, taking advantage of the new computational capability a SRE-based algorithm for safe distances calculation is introduced. Finally, an example shows the main capabilities of the new tool.**

***Keywords*— Atmospheric parameter uncertainty, Consequence and vulnerability analysis, Risk assessment.**

I. INTRODUCTION

Road-accident rates are growing as industrial activity increases. For example, the extent of hazardous material transportation accidents is as important as releases from process equipments, stacks, tank releases, etc. In fact, 95% of cases reported in the 20th Century took place in the last 30 years (Planas-Cuchi *et al.*, 1997). Consequently, the available tools should be improved and new ones developed to compute risk indexes and to estimate safe distances when considering an emergency /contingency planning.

In a recent publication (Scenna and Santa Cruz, 2005), a method for a risk assessment study case considering the stochastic nature of meteorological parameters is presented. It demonstrates that it is possible to achieve good approximated distributions over the whole impact area using the Monte Carlo strategy. In order to improve the previous prototype, a special algorithm, capable of handling the long computing times associated with the simulation step is included together with a Stochastic Reference Emitter and a translation algorithm.

The following sections explain the main aspects of the risk calculation procedure. As it will be shown, we can model a toxic substance release as a consequence of a transportation accident or fixed emission, either involving single or multiple fixed sources. Moreover, safe distances can be easily calculated as a stochastic variability is considered.

II. CALCULATION STRATEGY FOR TRANSPORT RISK ANALYSIS

It is possible to define several indexes to represent risk analysis results. Common representations for individual risk are contour plots, profiles and/or different average indexes, such as maximum individual risk and average individual risk among others.

Societal risk includes quantification in terms of the number of affected people. Generally, it is represented as the Frequency-Number (F-N) curve, a plot of the complementary cumulative frequency versus the number of fatalities.

For risk definitions and risk estimation methodologies, see IEC (2002); TNO (1999); Christensen Møller *et al.* (2003).

For transport accident releases there are several aspects to be considered in a Quantitative Risk Analysis (QRA) (see Scenna and Santa Cruz, 2005): involvement of a dangerous-substance transportation vehicle in an accident, breakage occurrence and characteristics (type, size, etc.), release characteristics and calculation of the individual or societal risk and its distribution over the impact area.