Contribution ID: **189** Type: **Paper**

State-of-the-science atmospheric dispersion and source reconstruction modelling applied to the nuclear security

Nuclear and/or radioactive materials may present a serious health risk for the population when disseminated into the atmosphere (or as liquid effluents) or present as irradiating sources. The exposure of human beings to these materials can occur in various circumstances ranging from more or less serious accidents to criminal activities. Let it be of uncontrolled or of deliberate origin, events such as the dispersion of radionuclides or the existence of hidden / lost sources may be anticipated to potentially result in adverse human consequences and social disruption.

Thus, these events are a matter of concern for the governmental authorities together with their specialized security services. They can also be at the crossroads of the scientific and technical advances, inter alia in the field of dispersion and radiation modelling. Indeed, decision-makers need reliable, and preferably quick, health impact assessments of the events mentioned before to take proper protection measures of the people. Nowadays, such accurate assessments may be drawn on 3D modelling capabilities and computational resources that have been drastically improved in the last decades. The paper and presentation will develop three topics illustrating the input of modelling to nuclear / radiological security.

(1) Dispersion modelling in complex environments –Urban districts and industrial plants concentrate most of the economic activity and a large part of the population and are thus likely targets. They deserve a special attention, all the more that modelling the dispersion in such areas is very complex due to the influence of the topography and the intricate buildings geometry in evolving meteorological conditions. To address this critical issue, a toolbox of generic and flexible models has been developed by the CEA to evaluate the dispersion (and irradiation) of radionuclides from the regional scale to the local scale, and especially around and inside buildings, and critical infrastructures as the case may be. The models account for the effects of the buildings on the local flow, dispersion, deposition and irradiation, as well as the indoor/outdoor (or vice versa) transfer of radioactive materials. Computations are carried out in 3D with high space and time resolution in all the potentially affected area.

(2) Radioactive / nuclear source term estimate –In several cases, the irradiation or release by the source can be surreptitious without immediate obvious trace (like smoke or an explosion). However, the presence of the source may be detected by a network of sensors or people in trouble. Then, the quick and efficient identification of the source location and strength is of vital importance for the security teams. Once more, mathematical methods developed by the CEA can help in reconstructing the source term parameters, given a set of measurements coming from sensors. The probabilistic Bayesian approach combined with the retro-dispersion modelling yields several upsides as it allows the incorporation of model and observational uncertainties and the use of prior information if any about the source. While this approach was validated against measurements adapted to benchmarking source term estimate methods, it was also applied to realistic situations in complex built-up landscapes.

(3) Models "in-depth"validation –Even now it remains very challenging to model environments with complex characteristics, more specifically within and around buildings in urban or industrial areas.

Last years, European and international activities (like the European COST Action ES1006 or the UDINEE exercise) were dedicated to validate models against experiments with an increase in the complexity level, from idealized to realistic urban mock-ups, from wind tunnel scale to full scale real situations, from continuous releases to highly variable puff releases, and from simplified to full CFD models. The performances of the CEA models were evaluated through statistical analyses proving that they are compliant with the validation criteria, established in literature for complex environments. Moreover, in the interest of the benchmarking exercise, computations with the CEA modelling system were carried out by three independent teams of modellers making different parametric choices, therefore pointing out the robustness of the CEA models.

After commenting on the topics (1), (2) and (3), the paper and presentation give feedback and guidance about several concepts of use of models integrated in decision-support systems. For the purpose of planning and emergency preparedness, modelling is of help in the development of evacuation routes and procedures or the optimal design of detection networks inside and around critical infrastructures or urban districts. Furthermore, in the course or the post-event phase of a nuclear / radiological emergency, modelling can support rescue teams in improving their awareness of the situation and deciding if, when, and where counter-measures should be taken. To sum up, the CEA modelling toolbox has worthy properties of timeliness, accuracy, reliability, and relevance making the models qualified and a real benefit for nuclear / radiological emergency preparation and response. Moreover, the soundness of the approach developed in the last decade translates into increasing appreciation and trust of the emergency players for state-of-the-art 3D simulations to diagnose and anticipate critical situations.

State

France

Gender

Male

Primary authors: Dr ARMAND, Patrick (CEA); Mr DUCHENNE, Christophe (CEA); Mr PATRYL, Luc (CEA)

Presenter: Dr ARMAND, Patrick (CEA)

Track Classification: CC: Emergency preparedness and response and nuclear security interfaces