


The use of atmospheric dispersion models during nuclear emergency exercises in Belgium

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Introduction

Training intervention people in how to react in case of nuclear and radiological events is one of the most difficult and important challenges in emergency preparedness. Many dissimilar parties with distinct background are involved and will react differently. First-responders have limited experience in radiological emergencies due to their low frequency. Therefore each exercise should be designed, developed, conducted and evaluated accordingly to clearly identified goals and objectives which involve all potential participants. To test the implementation of radiological emergency procedures and protocols, first-responders from different disciplines and other stakeholders like local/national authorities have to work together.

Objectives

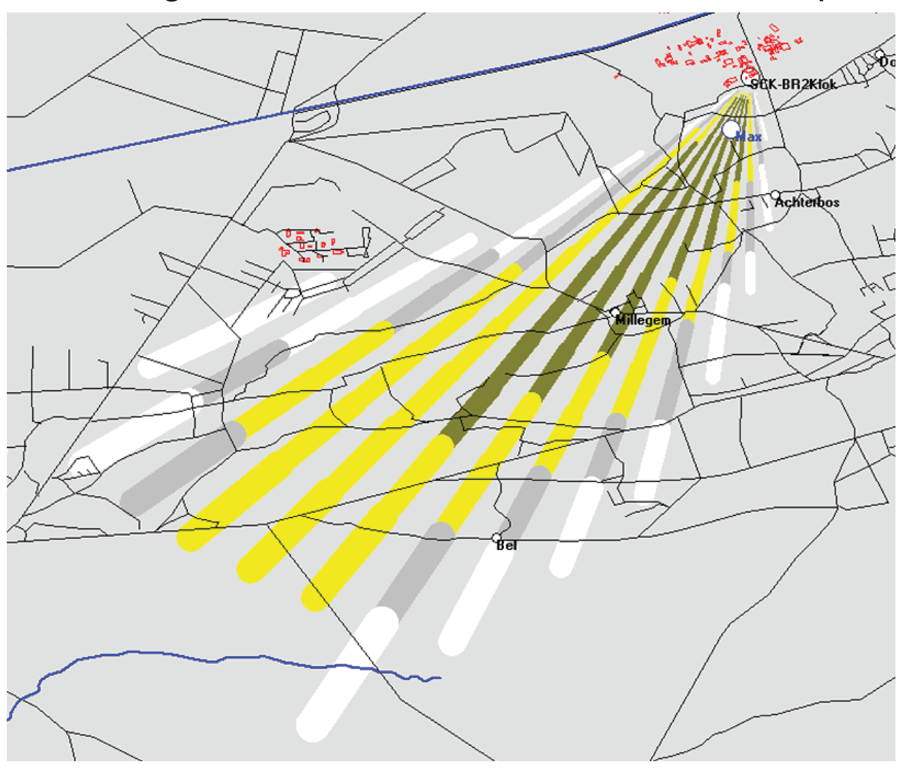
Atmospheric dispersion models are mostly used by the utilities and also by the evaluation cell of the governmental crisis centre to evaluate different types of radioactive exposure pathways and radionuclide contamination. Here we demonstrate an additional application of atmospheric dispersion models and illustrate their use during a nuclear emergency exercise on the field.

Methods

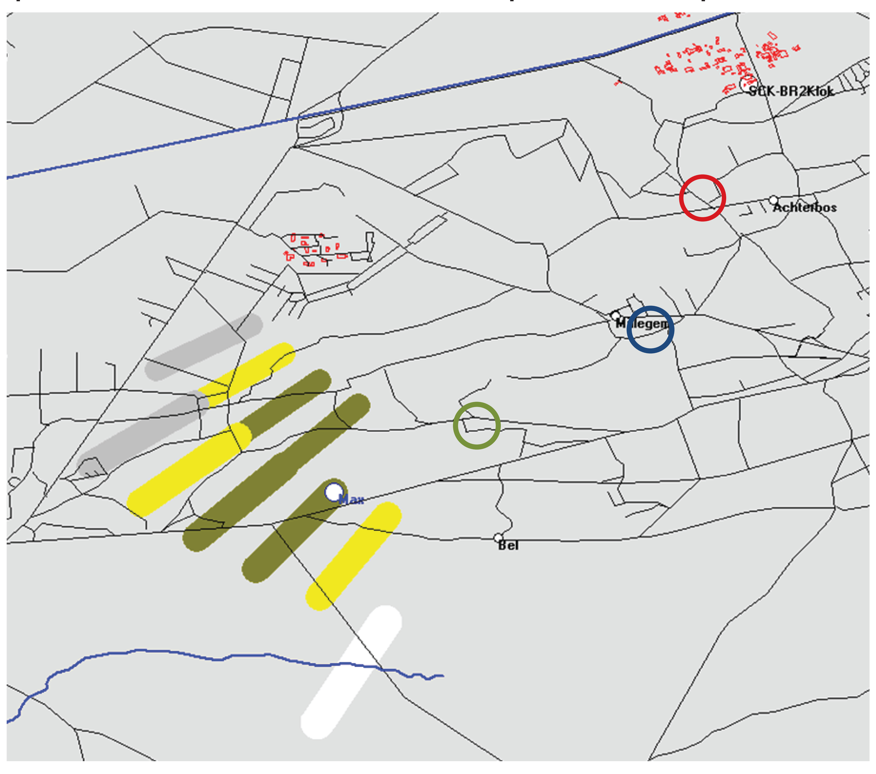
The Noodplan models, which can be used for this purpose, are a Gaussian atmospheric dispersion models [1]. A predefined or user defined source term can be implemented to calculate the impact of 5 groups of radionuclides i.e. noble gases, iodine, aerosols alpha emitters, aerosols beta-gamma emitters and tritium. Calculations are performed in a structured polar grid around the source. In this example we use a hypothetical source term which is released under normal conditions and a wind speed of 5 m/s. The models are capable of calculating the integrated effective dose due to external irradiation (cloud + soil), integrated skin, thyroid and inhalation dose and dose rate and is capable to calculate the rate of depositions of iodine, alpha and beta- gamma aerosols.

Results

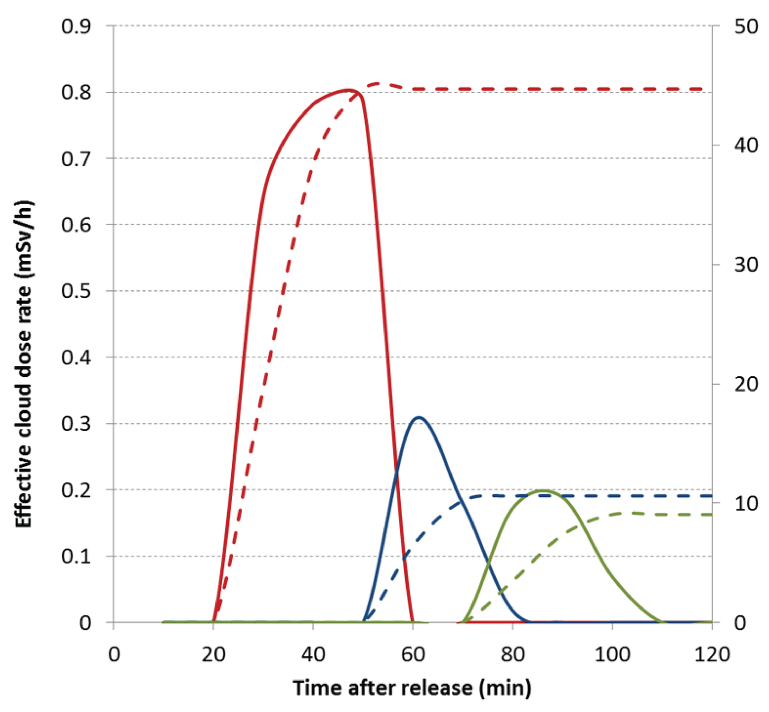
Current figures illustrate the transfer from atmospheric dispersion calculations toward operational quantities which can be used in the field.



Model simulation of beta-gamma aerosol deposition (Bq/m²) after 2 hours. Higher deposition rates are coloured green, lower deposition rates are coloured white.



Model simulation of effective cloud dose rate (Sv/h) after 2 hours. Higher dose rates are coloured green, lower deposition rates are coloured white.



Overview of the dose rate (solid line) and deposition rate (dotted line) on 3 distinct locations in function of time (locations are illustrated on left map)

Civil protection screens the population for radionuclides contamination. Contaminations can be simulated based on the location using appropriate correlation factors.

First-responder is screened for contaminations. Deposition on the skin can be simulated by model results.

Simulation of dose rate data for measuring stations is an important part in the preparation of radiological exercises.

Implementation of food countermeasure: Based on the simulated deposition rate, different countermeasures can be implemented in different locations.

Conclusion

Field exercises are more realistic and provides an in depth deployment of plans, procedures and staff capabilities. However working with high activity radioactive sources and/or large contaminated surfaces during an exercise is rather difficult to justify when following an ALARA and environmental safety policy. Atmospheric dispersion models can be used to simulate field contamination and allow a possible screening of for instance evacuees based on their locations. Furthermore, based on temporal and spatial information of the first-responders in the field, their possible contaminations and dose can be simulated. The same approach is applicable for simulating food contamination and data to be provided by measuring stations. In the preparation phase, different types of models may be used to calculated different aspects which will be used in the exercise. One has to be aware that different modellers might produce different results, based on other interpretation of the goals and objectives. Working closely together in this preparation phase is indispensable. Compiling the simulation data for a large scale exercise is however very time consuming.

Depending on the type of measurements in the field, the measurement results need sometimes interpretation (cpm has to be converted to Bq). One has to be aware that, when using model result, these simulations give already a part of the solution.

Additionally to model calculations fluorescent dyes or small low dose rate sources, can be used in limited parts of an exercise to familiarise the first responder with the aspect of contaminations and radiation, two aspects which are often mixed up.

Firemen screening a dummy with hidden alpha sources during an exercise.

Medical teams screening a victim for 'radioactive' contamination during an exercise.

Reference

Camps J., Turcanu C., Braekers D., Carlé B., Olyslaegers G., Paridaens J., e.a.- The 'NOODPLAN' early phase nuclear emergency models: an evaluation.- In: CD proceedings (also on-line available), Helsinki, Finland, 14-18 June 2010 / IRPA (International Radiological Protection Organization), Helsinki, Finland, IRPA, 2010

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