

# **Comparison between different decision making tools used in the case of nuclear accident at the Slovenian Nuclear Safety Administration**

Michel Cindro, Dušan Peteh, Barbara Vokal Nemeč

*Slovenian Nuclear Safety Administration, Železna cesta 16, SI-1000 Ljubljana, michel.cindro@gov.si*

## **INTRODUCTION**

In the case of a nuclear accident, decision makers rely, among other things, on modeling tools for information on the present and future radiological situation, the extent and the benefits and drawbacks of emergency actions and countermeasures. Dispersion and meteorological models are the most important elements in any tool used for that purpose. There are many tools available at the moment, some generic that can be used anywhere with some customization and some site-specific, usually developed for a specific site. The results of those models can vary, so the aim of this paper is to investigate differences in outputs of models used within the nuclear emergency assessment group at the Slovenian Nuclear Safety Administration.

## **MATERIALS AND METHODS**

RODOS (Real-time On-line DecisiOn Support) is an on-line tool for emergency management of nuclear or radiological accidents developed to provide support to authorities in the decision making process. RODOS was installed at Slovenian Nuclear Safety Administration (SNSA) in 2004 and its development is still in progress, in Slovenia as well as in other countries where it's used. It is able to calculate contamination dispersion using the Gaussian puff model and ALADIN meteorological forecasts as basis for predictions. At the present stage of implementation RODOS can be used for modeling accidents at the Krško NPP, Slovenia's only nuclear power plant at Krško. Beside RODOS, the SNSA also uses a custom built computer model named "DOZE", which is based on the Lagrange propagation model. Some results of more generic tool INTERRAS (a version of the code used in US emergency centers - RASCAL), which is a simple Gaussian puff distribution based model, are also used as a comparison.

For the scope of the extended abstract, a case was considered dealing with a severe accident at the Krško NPP, with a relatively calm weather characterized by low winds with no prevailing direction. The final paper will discuss different weather patterns and source terms with the aim of analyzing the robustness of the results produced by different models.

The differences in results are to be expected because of fundamental differences in tools. The complex orography of the Krško region plays a major part in the propagation of the radiation cloud. From this aspect the DOZE program gives more realistic image, since its dispersion model was validated in a similarly shaped region of Slovenia. The real-time meteorological data used for both programs are the same, but RODOS also has predictive capabilities by the use of weather forecasts, which is of great value for decision makers. Both programs can suggest the countermeasures for protection of population. In case of DOZE they are adapted to Slovenian operational intervention quantities and levels, while in the case of RODOS some future customization has to be done in this direction. The scope of use of models is also

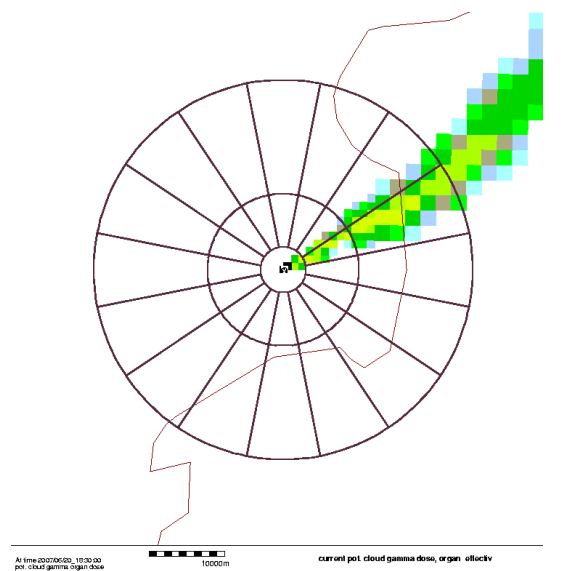
different, so DOZE can be only used in the vicinity of the power plant due to its calculation area of 24x24 km (with a 250x250 m grid), while RODOS uses a wider area, 160x160 km (1x1 km grid). This means that DOZE is primarily used as an emergency tool in the first few hours of the accident, while RODOS also has late countermeasures capabilities. That is also consistent with the fact that DOZE is simpler and faster compared to the elaborate RODOS, which in turn offers a wide range of options.

## RESULTS

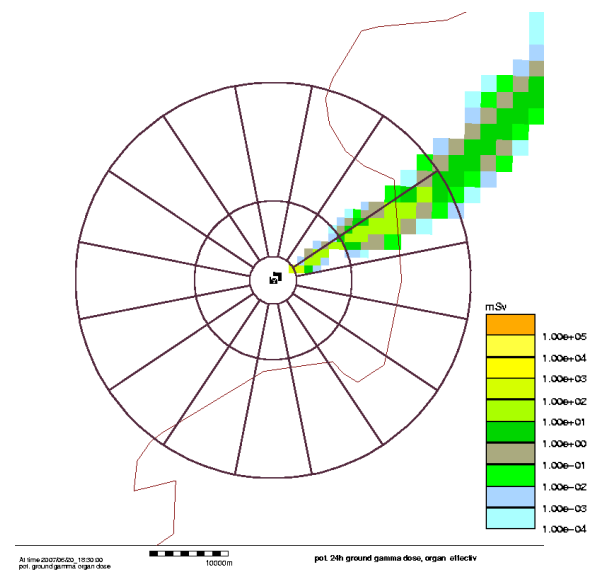
The imaginary accident used for the test was severe, a large break loss of cooling accident, with considerable fuel damage and a massive release in the environment. Normal primary coolant activity was used with no iodine spiking, heavy fuel cladding damage and a complete release to the environment within 1 hour. Such a scenario is highly unlikely, yet it was chosen to maximize the impact on the environment.

The period for this exercise was chosen to test the capabilities of the model. The Krško NPP is situated in a valley, surrounded by low hills. This is a difficult situation to tangle, especially with low wind speeds. The wind speed was nearly constantly low, around 1 m/s for two days, with changing directions. At first it blew to the south, then turning towards north-east.

Different models gave different results, as it was expected, due to the different model mechanics. The Gaussian puff model, used in RODOS (Figure 1 and Figure 2), predicted a fairly linear propagation of the cloud, with a quick turn towards north-east. The dimensions of the concentric circles are 3, 5 and 10 km respectively,

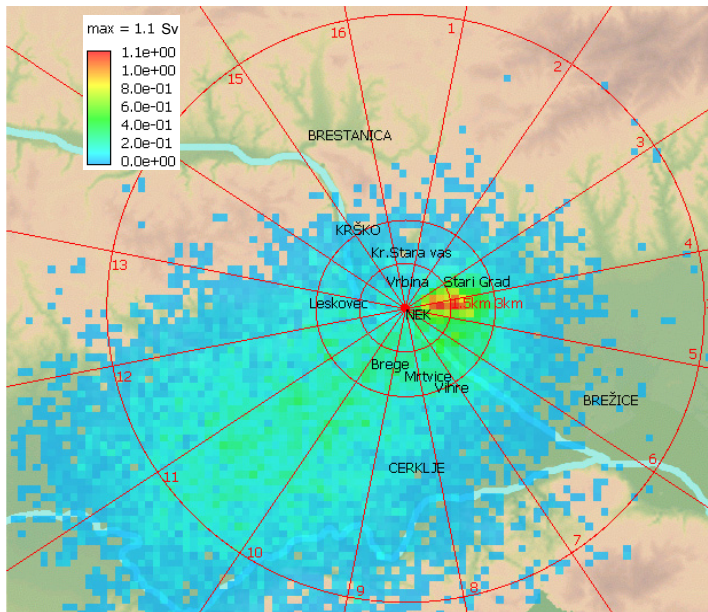


**Figure 1.** Effective dose from cloud (RODOS)



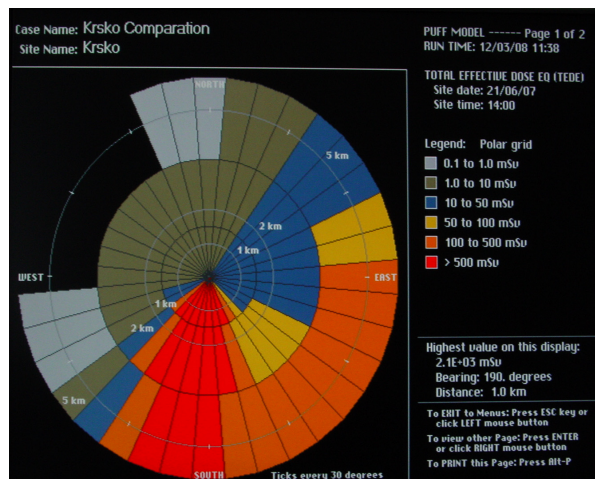
**Figure 2.** Effective dose from ground (RODOS)

The DOZE program, using Lagrange dispersion model, predicts that the cloud will mostly stay in the Krško valley (Figure 3). The highest values are to the NE, same as RODOS, but the tail of the cloud does not go as far. The circles denoting different intervention areas have same radii as in the RODOS figures.

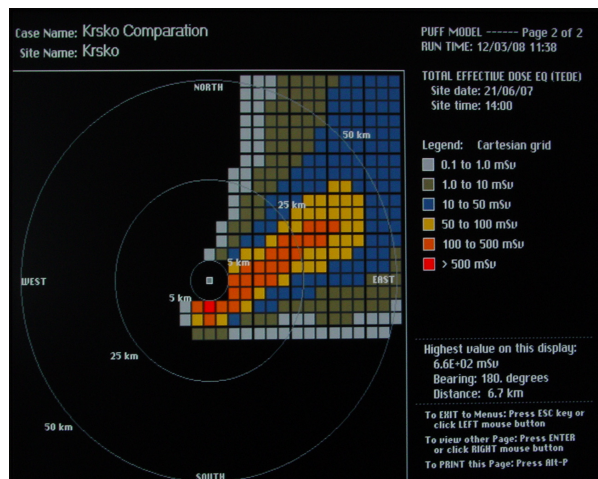


**Figure 3.** Effective dose (DOZE)

The INTERRAS simulation also yielded interesting results. Since it uses a similar dispersion model as RODOS, we expected the results to reflect that. The initial plume was predicted to go south as shown on Figure 4 (5 km radius), and it turned north-east (Figure 5, 100x100 km area).



**Figure 4.** Close range INTERRAS eff. dose



**Figure 5.** Far range INTERRAS eff. dose

The maximal doses calculated by models also varied. RODOS values were consistently higher for an order of magnitude, while DOZE and INTERRAS yielding comparable results. This is not consistent with the contamination propagation and authors at this time have no explanation. The decision makers would be very hard pressed to determine countermeasures based on these results, since all three tools show maximal values in different areas and different propagation scenarios.

If models show comparable results, one inclines to have more confidence in the calculation. That would certainly be the case if tools use different dispersion and meteorological models (the basis for the ENSEMBLE project), yet the state of the art in this field does not allow us to blindly trust the results.

## **CONCLUSIONS**

Use of modeling tools for assessment of contamination during a nuclear emergency is widely spread, yet the decision makers have to be very careful when evaluating the outputs. Low wind speeds and hilly terrain can influence results, lowering the confidence in the predictions.

We have demonstrated such a case where three models give different predictions. The weather pattern used, while chosen to emphasize this fact, was real and quite frequently occurring in the area studied. It would be very hard for the decision makers within the nuclear emergency assessment group to make any decisions based on these results.

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