4.23   RACON – SOFTWARE TOOL FOR FAST RADIATION CONSEQUENCES PREDICTION AND FOR CRISIS MANAGEMENT OPTIMISATION

Jan Svanda, Jiri Tschiesche, Vladimir Fiser
Nuclear Research Institute, 25068 Rez near Prague, Czech Republic

INTRODUCTION
Emergency situations in nuclear facilities with release of radioactive material into atmosphere need fast and efficient tools for evaluation radiation doses to population and immediate decisions for urgent countermeasures. The earlier the countermeasures are practised the efficient they are. The RaCon (Radiological Consequences) system, developed by NRI Rez, is one of the representatives of advanced supporting tools, which allows fast prediction of radiation consequences and gives support to decision makers in organizing countermeasures and actions of mobile emergency teams.

MAIN GOALS OF RACON PROGRAM SYSTEM
Computer program RaCon is designed for radiological impact prediction in the case of a nuclear emergency connected with a accidental release of radioactive materials into the environment, prediction of the radiological consequences in the affected locality, formulation and optimisation of the population protection actions as well as for their monitoring optimisation. The tool is focused on the early stages of an accident, especially on the prediction of expected population doses, and on evaluation of excess over the dose guidance levels when urgent population protection measures must be implement. The software proposes these measures and their implementation in a shortest possible time after the accident when they are most efficient.

USER'S INTERFACE AND DIALOGUE WINDOWS FOR DATA INPUT
Source-terms from the pre-calculated source-term database are taken in accordance with selected accident scenarios for Czech nuclear power plants. It is also possible to select regime when the own source-term is retrieved, however only after the failed installation measured data are available, as a rule – after the radioactivity release into the atmosphere, which limits the advantage of early prediction. Input of immediate and forecasted meteorological data follows, which is supplied be the Czech Hydro-meteorological Institute or defined by user in interface dialog. In the next step the program provides a fast prognosis of the radioactive cloud transport, dispersion in atmosphere and deposition, consequential exposures of population and proposal for the immediate mitigation measures. User's friendly interface is used for all input data.

MODEL OF RADIOACTIVITY TRANSPORT AND DISPERSION
The program module for evaluation of transport and dispersion of radioactivity released to the environment uses for calculations modified Gauss segmented model of atmospheric dispersion. The individual release phases of radioactivity are divided into a series of consecutive short time releases (e.g. 10 minutes as a maximum), and their transport and dispersion is evaluated under changing meteorological conditions. Corrections on the effective release height, wind velocity changes along the height, roughness of the terrain and relative elevation above sea level are included. Radioactive contamination of the terrain is computed taking into account dry and wet deposition processes. Computations of the individual isotopes volume activity in the atmosphere and surface activity on the contaminated terrain include corrections taking into account their radioactive decay.

CALCULATION OF POPULATION EXPOSURE

This calculation covers effective doses and equivalent doses on thyroid for adult persons and group of children from 2 up 7 years age. The following ways of exposure are taken into account:

- External exposure from radioactive cloud
- External exposure from contaminated terrain
- Internal exposure from inhalation of radioactive substances.

There are included corrections on the final dimensions of radioactive cloud. Computations of the doses without protection measures are different for daytime and night: for daytime the doses are calculated for non-shielded terrain, for the night − it is assumed that people are within buildings, so the corresponding shielding factors are included. The effective doses and equivalent doses on thyroid are also computed for the cases when the urgent protection measures have been taken:

- Sheltering
- Iodine prophylaxis
- Evacuation

At the same time averted doses are computed, and the comparison with the guidance levels for implementation of urgent protective measures is made, in accordance with the State Office for Nuclear Safety Decree No. 307/2002 Coll. requirements. In the first run of the programme the pre-selected time for implementation of the iodine prophylactic and sheltering is used. Evacuation is not included in the first run. On the basis of the calculated radiation values the user of the software can in the next runs subsequently enter the proposed new time for evacuation, sheltering, iodine prophylactic and optimise countermeasures. Computed doses are presented graphically in the form of map sheets showing in different colour places where intervention levels were exceeded (Fig. 1). Values for adults and children, without and with protection measures are displayed separately. One window shows effective doses map sheets, the second one − equivalent doses on thyroid. Map sheets for the nuclear installation vicinity are displayed in three map scales.
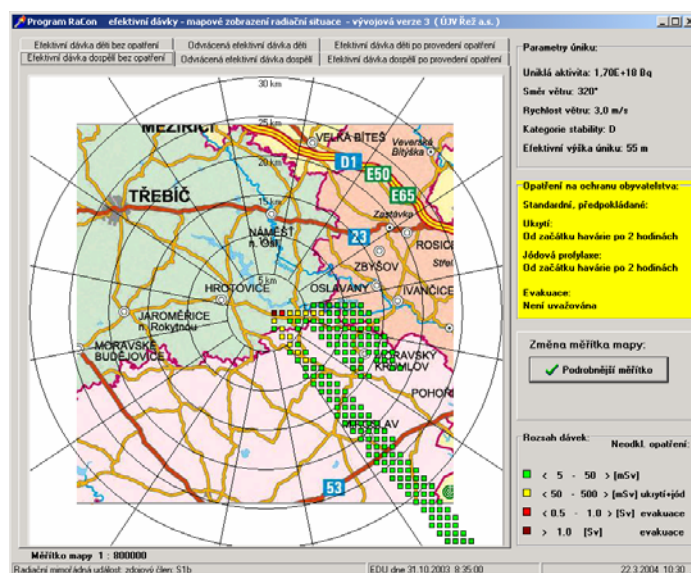

Figure 1. The map presentation of effective doses in affected area on six map sheets.

The main output of the system is an immediate table presentation of the affected settlements (Fig. 2) which includes also radiation doses without protection measures, after their

implementation, averted doses, proposal of the urgent interventions, number of inhabitants affected, and distance of a settlement from the nuclear installation. The table can be arranged in accordance with different criteria, for instance – dose value, number of affected inhabitants or distance from nuclear installation. Movement of the radioactive cloud under changing meteorological conditions is presented in the separate map window and time of the first and the last radioactive cloud appearance in the place elements is recorded (Fig. 3).

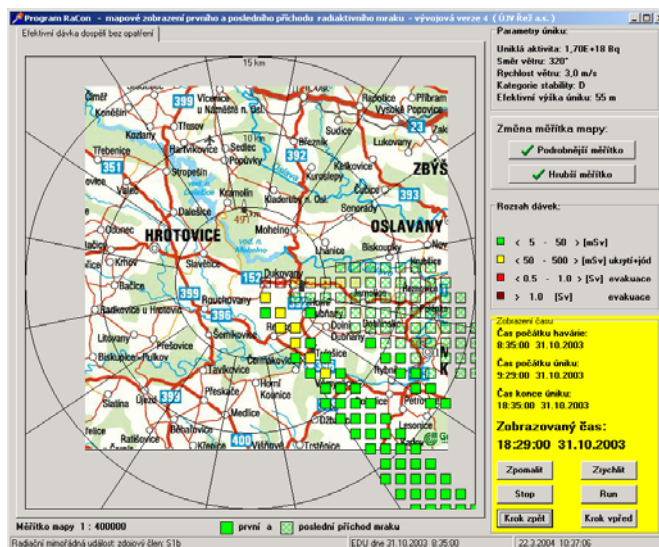*Figure 2. The table presentation of affected settlements and proposed countermeasures.*

Figure 3. The map presentation of movement of radioactive cloud (the first and the last appearance of radioactive cloud in the places are recorded and displayed).

EVALUATION OF EXPOSURE FOR THE INTERVENING MOBILE TEAMS
Integral part of this software tool is the possibility to easily select localities (using mouse in the map presentation) for which the expected dose rates and doses for the monitoring and intervening personnel will be computed and presented in a table form (Fig. 4 and Fig. 5). Dose rates and doses are computed for non-shielded persons and persons in motor vehicles either with protecting mask or without it. Independent user's window and database table allows selection of various types of vehicles with different shielding coefficient.
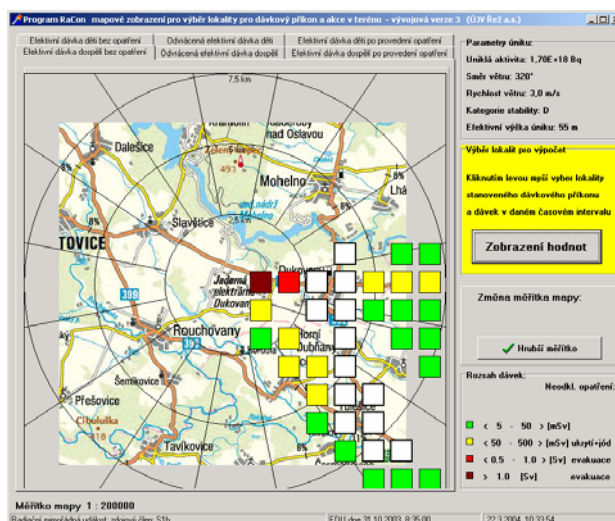
Figure 4. The map selection of routes of mobile monitoring or operating teams.

Figure 5. The table presentation of effective doses and dose rates for mobile teams in action at affected area.

CONCLUSION

Computer tool RaCon is a modern SW tool developed in compliance with crisis management requirements. Its user's friendly interface allows simple end fast navigation and does not require continuous "consultations" with the documentation. The outputs are illustrative both as map presentation and tables of the settlements affected for which the immediate protective interventions are proposed (Decree No. 307/2002 Coll.). The user's environment is realised in compliance with the standards and results of human failure research, with the objective to minimise any misinterpretation of the results.

REFERENCES

Svanda J., Tschiesche J., 2002: Programme tool RaCon for radiation accident consequences evaluation, NRI Rez plc, UJV Z-803-T, (in Czech)

Svanda J., Tschiesche J., Fiser V., 2002: RaCon - Decision Maker's Support for Radiation Consequences Prediction and for Crisis Management Optimisation, Enlarged Halden Programme meeting, Storefjell (Norway), Vol. 2, p. C4.17