CONVEX-3: A CASE FOR FLEXIBLE STRATEGIES IN NUCLEAR EMERGENCY ASSESSMENT

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INTRODUCTION

The paper points at several aspects relevant in the decision support-assisted (DSS) management of radiological emergency, with emphasis on the compelling need of having ready-for-use, alternative and mutually supportive assessment resources. In May 2005, the International Atomic Energy Agency has conducted a comprehensive nuclear alert exercise, code-named *ConvEx-3*. More than 20 countries in Europe and overseas have participated, in an attempt to verify the capability of assessment and reaction to a significant abnormal event in a nuclear facility, with Cernavoda Nuclear Power Plant, Romania selected as a test ground. While eventually coming round to the standards of a successful endeavor, the exercise had initially been fraught with a series of shortcomings, mainly concerning (a) actor interaction; (b) data adequacy and flows; and (c) communications. All combined, these factors have impeded, for some time into the drill, an effective utilization of the decision support tools and, largely by way of consequence, have kept the mitigative intervention in a state of confusion. From NIPNE's standpoint, a saving factor was that the crisis cell there has entered the *ConvEx-3* drill with two (as opposed to a single) assessment toolkits - RODOS and RAT, which provided for a flexible strategy in handling the available data. On drill's conclusion, the lesson was two-fold: (i) *in virtually all disasters the crisis mangers' performance falls below expectations and/or the planned contingencies*; and (ii) *having a 'Plan B' (redundancy of assessment and reaction resources) ready is always a must*.

THE CONVEX-3 ASSESSMENT AT NIPNE

Seen from the NIPNE's perspective, the ConvEX-3 theatre of action featured (a) *the RODOS server*, located on the Institute's premises, and the operating team around it; (b) *the RODOS remote operator*, on duty at the *National Emergency Response Center*, downtown Bucharest; (c) *the RODOS authorized correspondents* abroad; and (d) *the ancillary team* operating RAT as a RODOS assistant, also at NIPNE's.

The working sequence went as follows:

Step 1: the ancillary RAT assistants have expeditiously provided 8-hour meteo forecasts emphasizing the wind and precipitation regime at, and near the accident site, with a potential coverage of the mesoscale. To this effect, the RAT team has issued a dedicated software capable of offline-browsing a public meteorological forecast data resource – *U.S.A. Weather Channel/UK.Weather.com* in order to mine-out parameters of prime consequence in determining the motion and the dispersive properties of masses of air overflowing the Cernavoda NPP area prior, and during the (simulated) abnormal release. These include *wind direction and speed*, *cloud cover*, and *precipitation*.

By the date of the exercise more than 4000 *UK Weather Channel*-covered locations were on record with RAT's data library, and the number has increased ever since. *A separate code snippet* was in charge with inferring, from such primary data, the evolvement of the atmospheric stability category. The facility is supposed to be operated around the clock, as a standing watch agent, so that up to 48-hour forecasts be available on a permanent basis, in view of assessments – should a release occur.

Step 2: has seen RODOS at work, given the input described. For the sake of illustration, several capabilities of RODOS are presented 'on-the-job' manner in the sequel, as these have performed during *ConvEX-3*.

Figure 1 introduces part of the data menu offered by the system, after a quick evaluation using the Web Interface. Accident's Day-1 had a first release reportedly occurring at 06:30 hours. The source term was provided – if with a considerable delay - by the *NPP Cernavoda* and consisted of 10 radionuclides: H-3, Kr-83m, Kr-85m, Kr-85, Kr-88, Kr-89, Xe-133m, Xe-133, Xe-135m, Xe-135, Xe-138, I-131, I-132, I-133, I-135, Cs-134, Cs-137 and Cs-138. No information about the power in the plume was available.

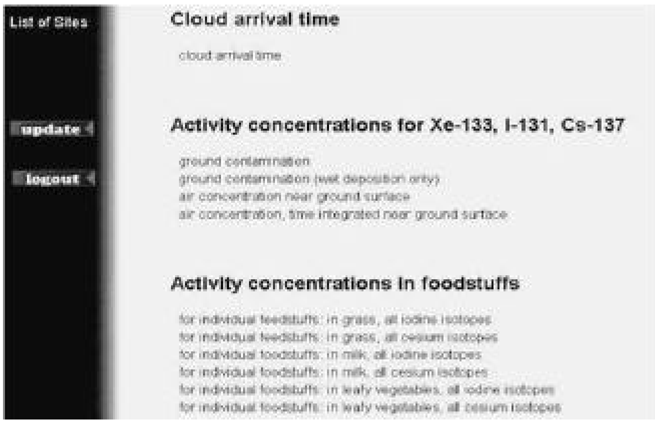
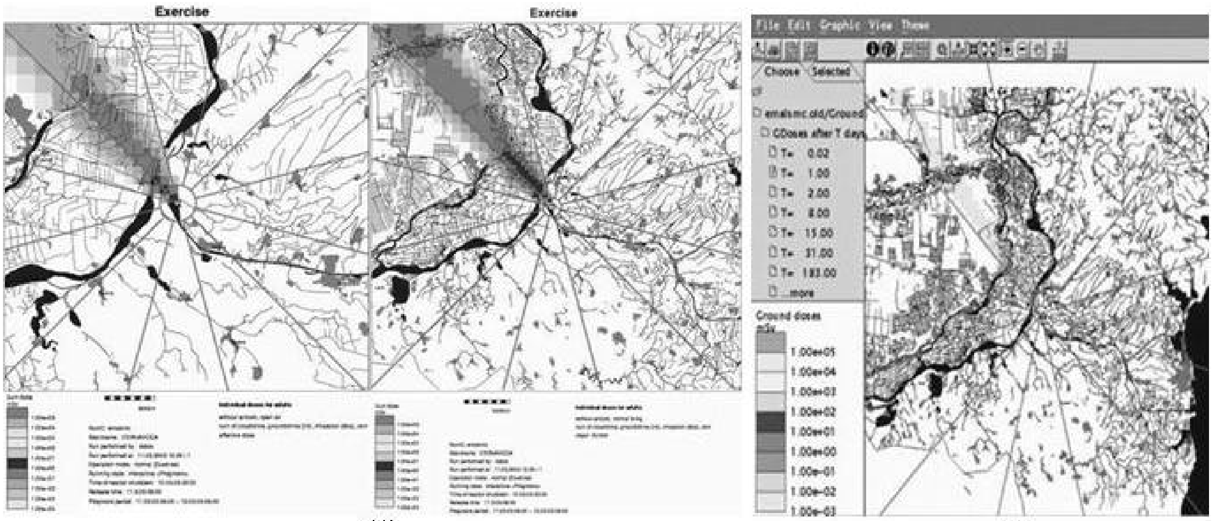


Fig. 1; RODOS Web menu

The meteorological scenario for the first hours into the release has *presumed* that the wind direction is towards the city of Cernavoda, to favor the deployment of intervention forces in the field and the mobilization of the population as a part in the drill.

EARLY COUNTERMEASURES

RODOS (*M. Rafat, W. Raskob and T. Schichtel*, 2006, *RODOS Working Group*, 2005) is a comprehensive software package in development by a consortium of European research institutions, and promoted by the EC as a reference DSS. The system covers the early (1-7 days) as well as the intermediate and long (ingestion) phases (months, years), in the development of an accidental release, with health, environmental, and economic consequences consideration. RAT ('*Radiological Assessment Toolkit*') is, on the other hand, a 'minor league' player in NIPNE's decision support business. Based on a predecessor developed for U.S. NRC in-house exercises (*Vamanu, D. and McKenna, T.J.*, 1996) and drawing upon the U.S. NRC/DOE/EPA's technical specifications (*McKenna, T.J., Trefethen, J.A. and Li Zhiguang*, 1995) RAT is designed to operate at a PC desktop/laptop level, dwelling in radioactive inventories, source terms, environmental dispersion dose and derived response level assessment. The two systems working in conjunction and the cross-assessment performed had several merits: (i) an opportunity was provided, to check the validity of several working assumptions and postures adopted over the years by NIPNE in nuclear energy preparedness; (ii) it was confirmed by various authorities and expert parties that RODOS is indeed a viable and functional decision support system; (iii) the reaction of the stakeholders – mainly the Civil Defense, has clearly evidenced that, beyond the knowledge of the contaminated air advection and diffusion, there is a need for dose and derived intervention level assessment; countermeasure design; consequence and mitigation cost determination; and ALARA observance – to qualify a computer-assisted problem solver as a valid DSS for purposes of nuclear emergency management. As expected, the first information required by the decision makers has targeted the appropriateness of *early countermeasures* - sheltering and evacuation of population, administration of iodine tablets - and the dose levels expected in the potentially affected area. Fig.2 illustrates the doses consecutive to the first round in the (virtual) release, that was assumed to last for 4 hours. Based on this evaluation the RODOS system recommended the administration of iodine tablets to children, in a specified and charted area. RODOS also concluded that sheltering in a small area surrounding the source of release would be in order, but no evacuation was warranted, anywhere in the DSS-monitored area.



(A) (B)

Fig. 2; (A) Effective dose distribution for adults, open air(left) and Thyroid dose distribution for adults in case of no countermeasures assessed on short range (right); (B) Evaluation of ground dose, one day after the release

In a second phase, an important result of RODOS concerned the evaluation of the radiological impact of *tritium* – a nuclide expected to abound in releases from CANDU reactors like the one at Cernavoda. The system has also offered evaluations of the radioactivity in the food and feedstock. Based on these results a recommendation was issued – to ban the local milk and diary product consumption in an area 10 km in radius around the NPP. *In the second day of the exercise* a controlled release through the stack was assumed and the true wind direction was taken into account. On these, RODOS had no countermeasure to recommend, as the predicted doses were below the normative levels.

RADIOLOGICAL ASSESSMENT OF 'WHAT IF' RELEASE SCENARIOS

Complementarily, RAT has also engaged in the *radiological assessment* and the *countermeasure design*. However, in contrast with RODOS – that was bearing the prime responsibility for issuing, near-real time manner, information of immediate relevance for directing the response, RAT has adopted a strategy of *alternative situations coverage,* based on '*what if*' scenarios. The approach was largely driven by previous experience gained during the international drills in the INEX series (IAEA Vienna and the NEA-OECD), that indicated that prompt, unambiguous, and stable meteorological projections during emergencies are a rare occurrence – a fact which, given the extreme sensitivity of the dosimetric projections to the atmospheric stability, can only recommend a preventive knowledge of what the doses should be e.g. *if* the atmosphere is class A, or B, C, D, E, F; and *if* the release can be categorized as 'ground', or 'elevated'; and *if* the release was, or was not, under rain. Figure 4 presents essential countermeasure areas that would follow from RAT assessments conducted as described. One can see that the variation assumed in the atmospheric conditions – stability and precipitations – may result in recommendations that are more conservative that RODOS' – involving, apart from sheltering and iodine tablet administration, also some limited evacuation. It is again to be stressed that, in so doing, RAT only evokes *possibilities* that the decision makers should be aware of.

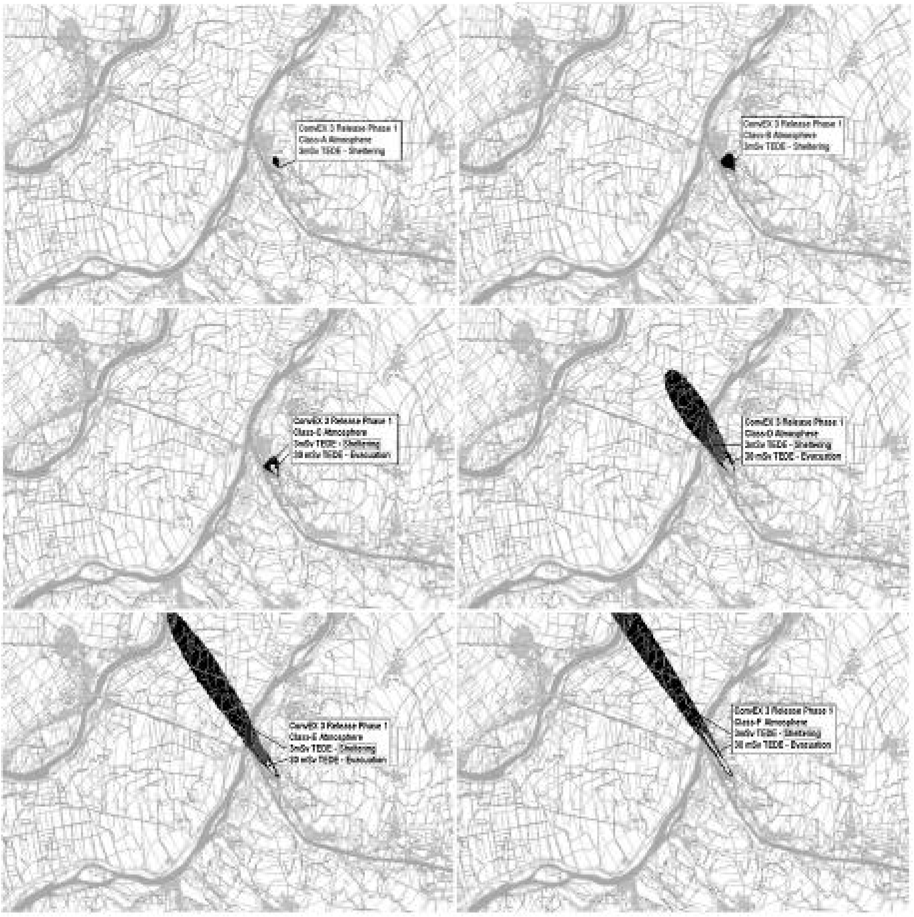


Fig. 4; Doses by classes of atmospheric stability (Pasquill A, B, C, D, E, F).

CONCLUSION

A post-drill evaluation (*Slavnicu, D., Vamanu, D., Gheorghiu, D., Acasandrei, V. and Vamanu, B.*, 2005) had eventually sorted out several findings of consequence. Thus, it was confirmed by the various authorities and expert parties present and participating in the exercise, that RODOS is indeed a viable and functional decision support system, worth implementation in the National Emergency Center, and a commitment was publicly expressed to this effect. The reaction of the chiefly-interested parties - essentially the Civil Defense, to the kind of data offered by the decision support facilities has clearly indicated that their needs go beyond the knowledge of the contaminated air advection and diffusion – into the *dose and derived intervention level assessment*, *countermeasure design*, *consequence costs determination*, and *cost-benefit analyses of response* – a kind of information that RODOS is indeed prepared to deliver. On the other hand however, it became apparent that RODOS is a demanding tool in several respects, including (i) the need of having the system implemented and fully operational *in the Situation Room*, wherever it may be, to avoid forbidding telecommunication stopgaps that may get aggravated in a real crisis; (ii) a prompt and sufficient supply of meteo forecast data, most desirably originating with the National Meteorology and its professional, international links, yet also welcome from alternative sources, as an alternative recourse; (iii) a prompt and sufficient information on the accident source term, expected from the plant Operator – whose cooperation with the offsite actors in the nuclear safety business remains a key factor for an appropriate emergency preparedness and response.

In the context, it was demonstrated that the ancillary assessment support from domestically-developed and established facilities may prove valuable and non-conflicting with the commitment to promoting RODOS as *the* reference DSS for the management of nuclear emergencies in Europe. This finding is believed consistent with the general operational safety requirement - *to secure a sufficient redundancy in input resources, assessment means, and communications*. While maintaining a firm interest in promoting RODOS, many project participants would also insist on diversifying product's coverage (v. chemical accidents) and implementations (e.g. Linux implementations of PC-scaled versions) thus contemplating ancillary spin-offs, and also mention domestic products as supportive tools, and pre/post-processing facilities for the mainstream software.

If anything, *ConvEx-3* has shown that, at more than a decade from Chernobyl, emergency preparedness is still an ongoing process, with plenty of room for supportive tool inventories and the regional methodological/operational coherence left to be desired.

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