EMERGENCY MANAGEMENT IN NUCLEAR ACCIDENT SITUATIONS THE DISASTER EXERCISE 1995 'NORTHERN LIGHT'

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INTRODUCTION

Emergency management does not only start after something has happened. Initially, a feasibility study usually assesses the risk for technologically critical processes and applications. Preventive strategies will be employed both in the administrative and technical field to minimize risk. Technical solutions will increase inherent safety or provide monitoring of critical components. Administrative action would result e.g. in restricted access, training programs, or detailed operating protocols. A final stage would be preparation for remedial action and defining the groundwork for emergency management in cooperation with civil defense forces.

Appropriate precautions will be based on hazard potential, which is inherently substantial when dealing with nuclear accidents. Being the last line of defense, the civil or military defense forces will be involved if a major disaster occurs despite all precautions, overpowering on-site crew capabilities. For major disasters requiring even international assistance, the United Nations Department of Humanitarian Affairs has started to conduct disaster preparedness exercises to improve cooperation and communication among the international relief teams and the local authorities. The EXERCISE '95 was organised by the Russian ministry for disaster management simulating a major accident in an atomic power plant located on the Kola peninsula.

SCENARIO

The technological scenario was modelled as a major accident in a pressurized water reactor (VVER-230/213). After depressurization in the vapor generator a general malfunction of the emergency power systems was assumed, resulting in failure of the emergency core cooling system. As a consequence of pressure build-up and additional failure in the main isolating shut-off, radioactivity was released into the environment through a safety valve for approximately 9 minutes. Then auxiliary power can be restored by the reactor personnel, the safety valve is closed, core cooling initiated, and the reactor attains a safe state. A significant portion of the uncovered core is assumed to be released as radioactive vapor into the atmosphere as a supersonic jet from the stack. Initial assumptions rate the magnitude of the total release up to roughly 10% of core activity, with a characteristic distribution regarding noble gases, iodines, and heavier elements, resulting in major contamination of the surrounding areas. The game-weather assumed predominantly easterly winds, causing trans-border effects as the radioactive cloud is blown towards the Finnish border. Thus international assistance was justified by the scale of the accident.

Preliminary action of the Department of Humanitarian Affairs was geared towards setting up of an On-Site Operations Control Centre (OSOCC) to coordinate the international efforts and serve as a head quarter for communication to local authorities. All participating teams were supposed to furnish a liaison officer to facilitate the communication of requests to the team and results back to OSOCC. International observers were monitoring the results achieved by each team on various missions as well as the recommendations of the expert groups.

OBJECTIVES

Within the exercise different objectives were to be pursued, both on the scale of international cooperation and particular to every team, respectively. An overview of the most important objectives is contained in the following list.

- Checking applicability of disaster preparedness and overall readiness to perform specific missions in contaminated areas (e.g. reconnaissance, decontamination).

- ♦ Assessing possibilities of international scientific and engineering support for decision making on matters of radiation protection. Determining the extent of the incident and providing the relevant information for the decision making process.
- ♦ Investigating the mechanism of international cooperation in case of a nuclear accident with trans-border consequences. Developing of practical strategies to cooperate in an effort to render urgent help in highly contaminated areas.
- ♦ Providing an opportunity of practical work for experts and field teams concerning counter measures in nuclear accident situations. Study of practical experience regarding organisation and implementation of emergency measures.

Among other nations, Austria was present with a team of AFDRU (Austrian Forces Disaster Relief Unit), manned by 30 members of Austrian NBC-forces and specialists from Seibersdorf. Approximately 20 tons of equipment were air-lifted to the affected area on the Kola peninsula, comprising of 3 search troops with vehicles, heavy decontamination equipment, as well as a command post and evaluation centre. Associated ancillary equipment included power generators, sanitary facilities, heating equipment and medical supplies.

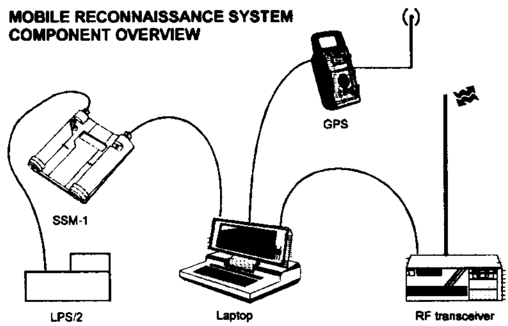
The composition of the team was carefully selected to sustain prolonged operation in the field. Medical care, decontamination strategies as well as dosimetric coverage of the personnel were considered, to name just a few items. Experts from Seibersdorf assisted with special tasks regarding radiation protection and scenario analysis. In the preparatory phase much attention was paid to the selection of instrumentation and development of new techniques to implement a successful system concept, a cooperative effort between Seibersdorf and the NBC-division.

SYSTEM CONCEPT

Seibersdorf was the main contributor in defining the system concept for measuring purposes and situation reporting [1]. A cooperative project was launched together with the NBC-school to define the system requirements, which should allow a self-consistent operation after deployment into affected territory. Basic requirements were considered to be:

- ♦ Monitoring of environmental radiation levels at the camp and surrounding areas
- ♦ Determination of local weather situation, communication utility for general weather data
- ♦ Possibility for measuring of food stuffs or soil samples
- ♦ Autonomous mobile reconnaissance system
- ♦ Flexible command and evaluation centre
- ♦ Scenario analysis and forecasting tool (data interpretation & temporal development)

All of the above functions were implemented to some degree: a satellite telephone and computer hook-up served as communication utility to supplement the local weather information, which was constrained to the camp site; a NaI-based food stuff probe was also used for approximate determination of nuclide composition in soil samples, because a HPGe-detector was not considered feasible for extended field deployment.



The mobile reconnaissance system was a prototype development, based on an Aerial Monitoring System, developed and discussed at Seibersdorf [2]. A laptop computer monitors and profiles ambient radiation levels as determined by a radiation survey meter and high sensitive probe. A satellite based GPS system is used for on-line position detection. The current position is registered on the laptop and all measurements are annotated with positional and timing coordinates. A RF-transceiver digitally broadcasts position and measurements as well as messages to the headquarter and relays commands to the field team. The headquarter may track up to 3 field teams simultaneously and communicate up to a distance of approximately 40 km. All data are stored internally in case of communication failure.

A scenario analysis tool (MIDAS [3]) was used to correlate the space/time annotated radiation measurement data and interpret them within the framework of the overall situation. Based on current and game-specific weather data, actual reports or projections of the radiation situation could be calculated and for instance heavily affected areas selected for immediate remedial action (evacuation, etc). Hot spots induced by precipitation (rain during passage of the radioactive plume) were modelled based on predefined weather information. These forecasts were used in mission planning for a reconnaissance trip to a heavily affected region on the third day after the accident. Artificial soil samples (provided by the organisers) were then used as corrective inputs to the model calculations, adjusting the assumptions of the source term.

Various inputs simulate the accident (source term, physical properties, local weather). A complex dispersion algorithm tracks individual elements of the release through a 3D wind field. If available, upper air data may be utilized to define wind shear layers aloft. Transfer factors within the model allow calculation such as estimated ground deposition, air-borne iodine, or impact on the food chains. All results are superimposed on a digitized map of the environment, allowing even demographic analysis (population affected, calculation of man-Sv).

RESULTS

The Austrian team and their systems used throughout the EXERCISE '95 were highly acclaimed by the international community. The mission objectives - reconnaissance work, decontamination, medical assistance, decision making support, and expert opinion - could be covered successfully. The scenario analysis - refined with results of simulated measurements - proved to be consistent with Russian model calculations used in preparation of the simulation. The mobile reconnaissance system - and specifically the automatic data acquisition and correlation of measured data with geographical position - significantly contributed to the overall success in forming a clear picture of the large scale situation. This might even be more important in a realistic scenario, where stress and human error can introduce additional problems with data integrity.

CONCLUSION

Emergency management on an international level requires major organisational efforts, in this case furnished to a great degree by the local UN coordination centre. To provide assistance effectively, the international teams have to operate autonomously in the affected territories. This requires not only a high level of training and expertise, but also a sophisticated technical infrastructure. Regarding reconnaissance, results of many different measurements have to be mapped and interpreted to form a comprehensive picture of the overall scenario and its implications. This information might then be used for planning of relief missions to heavily affected areas and in decision support to local authorities. Especially with nuclear accident situations, specific emphasis has to be placed on the future development of the situation. Forecasting capabilities have therefore to be integrated in the decision support systems. Disaster exercises provide a possibility for testing such components under realistic conditions.

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