PERIMETER MONITORING, GPS AND OTHER ADVANCES TO SUPPORT EMERGENCY PLANNING ACTIVITIES

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SUMMARY

In the past decade, the information provided to emergency response teams has not changed significantly, while advancements in computer and communications technology have been phenomenal. As PC computers become faster and smaller, there is increasing interest in using them to support dose assessment and emergency response activities. This paper discusses methods now available for fully automating PC-based networks to facilitate sharing of information. The potential use of additional sources of data such as Global Positioning Systems (GPS) and on-line perimeter monitor locations is also discussed. In addition, some of the results from a joint NATO and United Nations (UN) drill ("Exercise '95") that took place in May 1995 near Murmansk, Russia will be presented. This exercise combined many of these tools for the first time in a real exercise.

NETWORKING DOSE ASSESSMENT FUNCTIONS

Reliable network software is in general use and enables several PC computers to make independent calculations using the same stream of on-line data. Figure 1 shows a typical configuration where a dedicated host PC data concentrator can be used to collect, process and write appropriate data on a file server at the heart of the network. The server files are then available to network workstations. Networks have the speed and flexibility to provide each user with rapid dose assessment results based on consistent and reliable data.

Networks can be configured in several ways. Typical computerized dose calculation models use four types of files: (1) fixed plant/site information, (2) on-line data (e.g., meteorological data), (3) executables, and (4) output (results). Any or all of these files can reside on a file server in the network or in individual workstations. It is advantageous to retain them on the server so that they are available for use by other stations on the network. Each workstation can work independently so that different displays can be reviewed at every active location. For example, output files created at one workstation can be read by other workstations and used to display results. In addition, software maintenance is greatly facilitated by having the executables

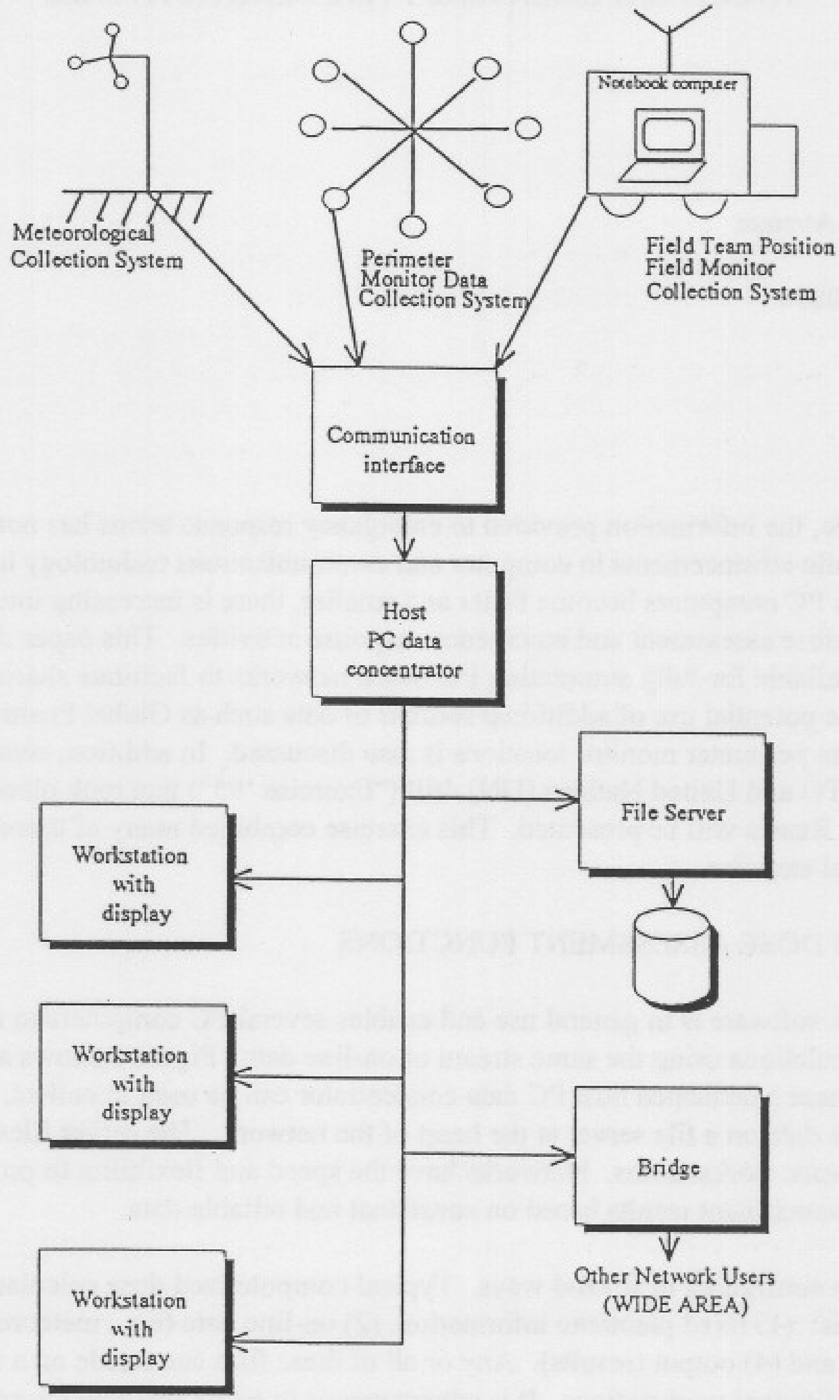

Figure 1. PC-Based Network for Emergency Response Information

in one place on the server rather than duplicated in several individual workstations where control of upgrades can be difficult to maintain. Files are brought into the workstation only when they are needed for processing. Programs must be written to prevent conflicts when shared files on the server are accessed simultaneously by more than one user.

GPS (GLOBAL POSITIONING SYSTEM)

Notebook (or any size) computers can accommodate GPS circuit boards that provide accurate field position with frequent updates and local display. The position can be directly entered into files and displayed on site-specific maps. Also, the time history of position and measurements are accumulated for review at any time. Field monitor data can be entered manually on spreadsheets or, alternatively, automated field instruments with digital readout can be used to send information to the notebook. Selected processed portions of these data can be sent to a centrally located host computer (typically in the Emergency Operations Facility - EOF) or used to provide more precise data at field team locations. When used in conjunction with plume models, the ability to position field teams in the active radiation plume is enhanced. Figure 2 is a display at the central host computer showing the tracks of three field monitor teams as well as the current measured dose rate.

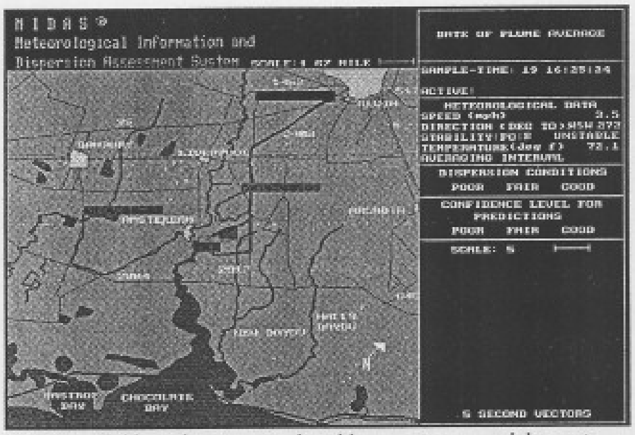

Figure 2. Field monitor team tracks with current measured dose rate.

Dose estimates and plume locations computed by the host are sent to the notebook computers in the field. With plume location in the notebook PC, the dose rate at the location determined by the GPS can be displayed on the screen. These values can then be compared with actual measured dose rates during a real event.

PERIMETER MONITORS AND BACK-CALCULATIONS

Although only a few U.S. nuclear plant sites have on-line radiation monitors in strategic offsite locations, there appears to be considerable interest outside the U.S. in installing these monitors. There is also some desire to reduce or eliminate field monitoring teams in the future to cut costs, to reduce exposure and to provide more accurate fixed readings. Algorithms have been tested to collect these data, search for abnormal conditions, infer a release rate (using a back-calculation), and make dose projections to greater distances without operator intervention. As with mobile field monitors, the data from perimeter monitors can be transmitted back to the EOF and displayed for comparison with dose predictions.

The back-calculation mode (for ring monitors) involves the following sequence.

- When the plume passes over or near a monitor, causing its readings to go above the sensor alarm limit.
- The screen display area for the monitor will turn red and an audible alarm will sound.
- If the reading exceeds the alarm limit for a set time period, a back-calculation is initiated.
- A pseudo release of a selected (or default) isotopic mix is dispersed downwind and a finite plume dose calculation is made at each monitor location near the plant as shown in Figure 3.
- The source term is adjusted to match the monitor readings. Using this source term, projected doses are calculated and displayed at downwind distances beyond the site boundary.

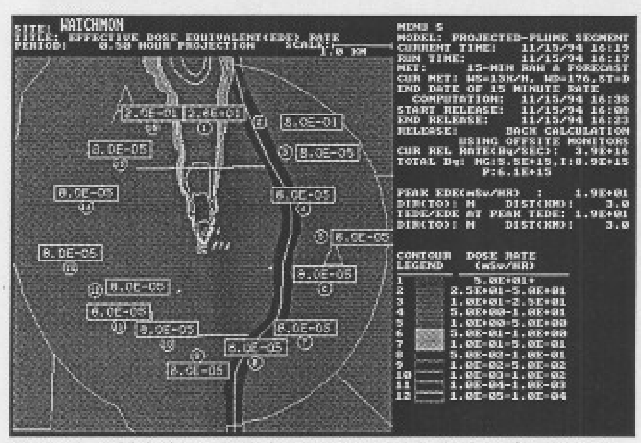

Figure 3. Initial plume EDE dose contours with display of perimeter monitor readings used for back calculation.

- The model will continue in the back-calculation mode with automatic updates every 15 minutes until it is terminated by the user or the monitor readings return to low levels.

"EXERCISE '95" INTERNATIONAL NUCLEAR DISASTER MANAGEMENT(1)

The trigger incident was an explosion in a nuclear power plant, similar to Chernobyl. Different international teams participated in an effort to determine the extent and implications of the incident, gauge radiation levels in the environment, study relief procedures, and estimate the applicability of recommended protection measures. The exercise was organized in three time scenarios, starting with the third day after the accident up to one month after the accident.

The system that PLG supplied was a scenario analysis tool based on three-dimensional dispersion calculations and forecasting capability. Radiation data was acquired by mobile teams, and permanent site monitoring instrumentation using GPS.

The practical skills of the field teams were verified under near realistic conditions. Starting with a call for international assistance, various teams were sent to the site and expected to be operational within a short time. The training not only covered practical deployment of field teams on specific missions, but also general requirements such as communication with local authorities, exchange of technical and strategic information, command structures, data evaluation in the field.

Scenario

The technological scenario was modelled as a major accident in a pressurized water reactor near Kovdor, Russia. As a consequence of pressure build-up in the system and an additional failure in the main isolating shut-off, radioactivity was released into the environment through a safety valve that was wedged in the OPEN position. After approximately 9 minutes auxiliary power was restored by the reactor personnel, the safety valve was closed, core cooling initiated, and the reactor attained a safe state.

A significant portion of the uncovered core was released as radioactive vapor into the atmosphere as a supersonic jet from the stack. Initial assumptions rate the magnitude of the total release at about 10% of core activity, with a characteristic distribution regarding noble gases, iodines, and heavier elements. In the present case this could amount to 1.4×10^8Ci resulting in major contamination of the surrounding areas. The weather assumed predominantly easterly winds, causing trans-border effects as the radioactive cloud was blown towards the Finnish border. The scale of the accident justified international assistance.

Objectives

Within the exercise, different objectives were pursued, both on the scale of international cooperation and with each particular to every team. Foremost:

- 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 practical strategies to cooperate in an effort to render urgent help in highly contaminated areas.

- Providing an opportunity for practical work by experts and field teams concerning counter measures in nuclear accident situations. Studying practical experience regarding organization and implementation of emergency measures.

<u>System Concept</u>

The systems deployed in the field were selected in support of the mission objectives. They allowed for a self-consistent operation of the team and fulfilled the following requirements:

- Monitoring environmental radiation levels at the camp and surrounding areas
- Determining local weather
- Measuring food stuffs or soil samples to determine nuclide composition
- Autonomous mobile reconnaissance system
- Flexible command and evaluation center
- Scenario analysis and forecasting tool (data interpretation and temporal development)
- Communication utility to obtain extended data

During the UN drill "Exercise '95", a satellite-based GPS system was used for on-line position detection, measurement annotation, and timing. Using an RF-transceiver, this information was broadcast to the headquarters and messages sent to the field teams. Up to three field teams could be monitored at one time and data transmitted up to 40 km.

PLG's MIDAS system was used as a scenario analysis tool to correlate the space/time annotated radiation measurement data and interpret them within the framework of the overall situation. Based on current weather data (actual reports or release projections) doses could be calculated and, for instance, heavily affected areas selected for immediate remedial action (evacuation, etc). The sample printout (Figure 4) shows a 60-hour projection of integrated dose based on scenario weather, resulting in a rain induced hot spot in the Kovdor region close to the Finnish border. This forecast was used in mission planning for a reconnaissance trip to the Kovdor region on the third day after the accident.

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

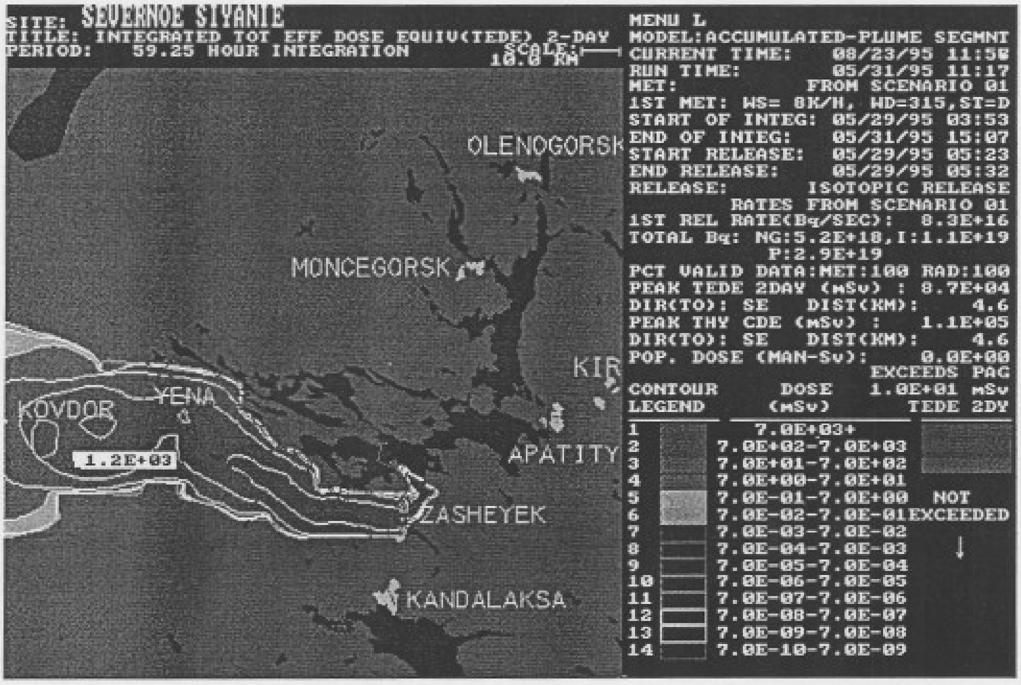

Figure 4. 60 Hour TEDE Integrated Dose

Systems used throughout "EXERCISE '95" were highly acclaimed by the international community. All tasks could be covered by the systems selected for the field mission. The scenario analyses proved to be consistent with Russian model calculations used in preparation of the simulation and thus will be adopted as a valuable tool by the international community.

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

The advances in PC computer technology and connectivity have enabled use of inexpensive hardware to build powerful systems to support emergency response activities. Information is easily consolidated and made available for sharing among network workstations. This can be enhanced further with the use of GPS to enable communication of monitoring team location and sharing data between the teams and the centrally located controllers. A UN-sponsored exercise has shown the successful application of such a system.

[(1)] Schmitzer, C. Nuclear Disaster Management. The Munmansk Exercise, Austrian Research Centre Seibersdorf.