DECISION MAKING SUPPORT SYSTEMS FOR EMERGENCIES IN ZONES OF CHEMICAL WEAPONS DESTRUCTION FACILITIES LOCATION

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International emergency management activities clearly demonstrate the efficiency of the specialized software systems implementing various aspects of decision-making support concept. This concept comprises both the development of new trends in software engineering and the creation of specialized hardware/software programs including computer-aided information security tools.

A decision making support system related to emergencies at chemical weapons destruction facilities is a set of hardware and software installed on the control centre computing system to provide appropriate, prompt and efficient reactions of the target user being responsible for making management decisions at the facility.

The diversity of chemical substances, the complex character of chemical weapons accidents as well as significant expenses for prevention and accident elimination activities make it necessary to justify decisions and the plans of their implementation. Computer-based management of health care facilities in a chemical disaster enables efficient and prompt decision-making in case of large volumes of data to be processed or in case of deficiency of time.

There is a number of factors that determine the scale and danger of an accident at a chemical facility accompanied with chemical release:

- The character and the amount of chemical weapons and other toxic chemical substances stored at the facility.
- The presence of other industrial plants and population density level in the area attached to the chemical facility;
- The landscape features and wind direction at the accident scene;
- The capability of emergency medical services to provide exposed population with care while in the contaminated environment and at the stage of evacuation.
- Weather forecast in the disaster area.

The aim of the decision-making support system we have created is to enhance the efficiency, speed and quality of decision-making in rescue emergency care management at chemical weapons destruction facilities. This system provides the following tools:

- Databases for objects and processes being controlled and for the emergences happened in the past;
- Infological and mathematical methods of data processing;
- Prognosis for exposed victims and triage categorization;
- Representing data processing results as a text, a diagram or a map that can be outtyped, displayed or copied to a CD to be used by decision-makers;
- Planning mitigation operations and monitoring their performance;

- Providing officials and analysts with supplemental information on vulnerable and high risk facilities, relevant rules and regulations, phones and addresses, airline, bus, train or other schedules, etc.;
- Processed data plotting.

We should take into account that an accident may affect neighbouring chemical industrial facilities using toxic substances provoking the extension of a contamination area due to the so-called knock-on effect. The secondary source of the population contamination may result from the pollution of the equipment, buildings, sanitary protection zone, water reservoirs, fishponds, water supply, food and feedstuff with toxic agents stable in the environment.

Emergency prediction

The origin, the development and outcomes of chemical accidents can vary greatly due to a large number of toxic agents and industrial technologies, diverse climatic conditions and different geographical position.

The gravity of an accident (comprising the number of casualties, the promptness and efficiency of rescue operations and health or environment effects) is determined by the level of chemical release, the origin of an accident and weather conditions at the point of release. In many cases, it also depends on emergency medical services facilities reinforced by comprehensive and proficient emergency prediction and advanced training programs for emergency personnel. These aspects may be realized through the following actions:

- The chart-making of the manufacturing, transportation and recycling chemical facilities areas with respect to possible accidents. Insufficient information about the degree and extent of contamination hinders rescue emergency care and accident elimination activities, prevents correct diagnostics and treatment and appropriate use of protective equipment;
- Assessing probable health and environmental effects of disasters at the local CW facilities and producing reduction strategies. The understanding of biological influence of chemical substances and the comparison of the degree of chemical release with environmental effects allows to predict expected consequences;
- Establishing guidelines for optimizing medical and environmental protection of the personnel and the population at an accident. We should establish special emergency regulations that are the criteria of emergency danger (or safety) of substances for first responders to facilitate decision-making process, rescue operations planning and defining the amount of health care to be provided.
- Carrying out environmental and health analysis of chemical facilities and chemical products;
- Automating medical and ecological prediction of the effects of chemical accidents.

The systems that support decision making in medical service management at CW destruction facilities are built on the basis of the regulations and guidelines issued by Russian Ministry of Emergency Situations**,** Russian Ministry of Health, National Committee on Sanitary and Epidemiological Inspection, National Environmental Protection Committee, the official information about high consequence chemical weapons demilitarization facilities at Gorny, Kambarka and Schuch'ye, foreign and Russian experience in the creation of similar decision-making support systems.

Stages of danger analysis

We can distinguish three stages of decision-making in emergency management planning, which are danger identification, vulnerability evaluation and risk assessment.

Danger analysis is the first essential stage in creation of a comprehensive plan for emergency response. The degree of comprehensiveness depends on the clear perception of the danger and on the knowledge of exposure levels for different population groups. Such systems are mainly designed to analyze the risk of releasing toxic agents with inhalation effect. Danger analysis is carried out in order to identify all possible sources of danger and the hazard level of each source, and to detect the most dangerous stages of the manufacturing process.

Danger identification is the receiving of specific information about chemical releases that imperil the population. It includes chemical identification, measurement of hazardous substances released into the air and discovering the sources of the danger (toxic gases or fumes this system primarily focuses on or other sources such as fire, explosion, an excessive amount of hazardous materials being stored or recycled, manufacturing management failures, etc).

A complete vulnerability analysis results in information about the scope of contamination (i.e. areas which are to be substantially contaminated as a result of a release or a spill of a certain substance) and about the population composition in contaminated area (number, age, sex).

Risk assessment is the analysis of the likelihood of toxic agents release and its probable effects. Risk assessment activities are based on the data provided by vulnerability analyses, on the information about previous accidents and on the possibility to use the advanced technologies. The following factors are being assessed:

- The probability of a chemical release including the assessment of the working conditions and control management, of the unusual environmental conditions (e.g. a flood) and their influence on disaster consequences;
- The amount of adverse effects associated with the population exposure to chemical substances (acute, sub-acute and/or chronic effects), estimated number of patients and lethal cases and corresponding risk groups;
- The impact on public facilities (hospitals, fire stations, communication centers) and the environmental effects.

This information can be used for the development of decision-making support systems in emergency response at high-risk facilities.

The research offers a technique of predicting an area of dangerous chemical contamination in emergencies at high consequence CW demilitarization facilities. The problem solution technique applied in this system can be extended to the cases of hazardous chemical atmospheric emissions in the form of gases, aerosols and fumes.

The scope of chemical contamination can be calculated for the primary cloud (the cloud of a substance formed as a result of its instant release (1-3 min) into the atmosphere from damaged containers). The initial input data for predicting the level and the extent of contamination with hazardous chemical agents are as follows:

- The total amount of chemical agents at the facility;
- The amount of atmospheric emission of a substance;
- Weather conditions including air temperature, wind speed at ten-meter altitude and the degree of vertical stability.

In preliminary prediction of contamination levels in case of emergencies at chemical facilities the following input data was used:

- The amount of a chemical agent which is the maximum volume in a single container;

- Weather conditions together with inversion and wind speed in meters per second;

To predict contamination levels right after a disaster we should use the actual information on the amount of released substances and weather conditions.

The external borders of chemically contaminated area are inferred from the threshold level of a toxic dose by inhalation intake.

The decision support system is a self-contained software product intended to aid emergency medical services and other rescue teams and to support the decision-making process related to emergency management when information updates are not available.

The system makes it possible to register accident notifications, to predict the extent of contamination and to define expected casualties. The information about the facility and the degree of exposure under certain climatic conditions may be presented in a text format or may be plotted on a map.

The software program is equipped with the reference information on regulations and guidelines for emergency response and with a database for other 1 619 toxic substances.

It requires minimum user-level proficiency as its work consists of a consecutive choice of elements from the limited lists.

There are the following three stages in the automated system operation with the use of this technique:

- Defining the conditions which provoked a disaster;
- Defining the extent of contamination with respect to given conditions;
- Defining the area of actual and possible contamination.

The system is typical information system of processing; therefore it was expedient to create databases as the components of information storage. To perform this task we used the Delphi 6.0 software media.

Interaction with the user in system is based on a combination of the initiative of the user and system, by means of the screen interface.

The system is built on a modular principle and consists of procedures, each of which is responsible for the certain mode of operation of system.

The structure of system includes the following subsystems:

- Subsystem of distribution of the help information on dangerous substances;
- Subsystem of operative reaction;
- Subsystem of the help information under normative documents.

The program runs at an IBM PC which has a SVGA display and Windows 95/98/NT OS.

The basic criterion of the necessity of evacuation and of the degree of its urgency is the threat to the lives of people or irreversible health effects that cannot be prevented with protective equipment.

The system has three modes of work aimed to provide prompt and effective emergency response and the performance of prevention or mitigation operations.