A DATABASED DECISION SUPPORT SYSTEM FOR NORWEGIAN NUCLEAR EMERGENCY PREPAREDNESS

Ole Harbitz and Steinar Backe
Norwegian Radiation Protection Authority (NRPA)
Grini Næringspark 13, P.O. Box 55
1345 Østerås, Norway

Abstract

In order to be prepared to handle a nuclear emergency accident situation the Norwegian Government has established a central emergency organization. Considering the vast amount of information and data needed to keep an updated overview of a nuclear emergency situation, this central emergency organization needs an efficient information an retrieval system. Accordingly the Norwegian Government has decided to develop a computerized system for continuous monitoring and decision support in an accident situation. This system is called NORMEM (Norwegian Major Emergency Management).

The main purpose of this system is to assess consequences of nuclear accidents and to form a basis for making right decisions on countermeasures in order to reduce health effects and economical consequences. The system must therefore be able to make model predictions of dispersion and fallout of radioactive materials and to store, synthesize and present all available information and data during all phases of a nuclear accident. In order to assess consequences of a new accident the system must include all available data on the present radioactive contamination in the environment and in the food chains. The system will therefore serve as a tool in the daily work at the Norwegian Radiation Protection Authority and thus ensure knowledge of the system and efficient operation in an accident situation.

1. Introduction

When the Chernobyl accident happened in april 1986 there was no organization for coordinating nuclear emergency preparedness in Norway. Only a few laboratories maintained the expertise and the equipment to measure and analyze radioactivity in the air, in the environment and in the food chains. As a result of this the first phase after the Chernobyl accident was characterized by no clear distribution of responsibility, lack of a plan of organization and lack of equipment. A number of authorities did have duties and responsibility connected with radioactivity and accidents. The lack of planning meant that the affected agencies had to improvise their actions and only after a series of problems had arisen was the necessary coordination of efforts established. The large and legitimate demand from the public and the media for information represented a strain for which the system was unprepared, and made the work of the authorities more difficult.

In december 1986 The Norwegian Government appointed The Norwegian Emergency Organization (AVA). This organization should act as a coordinating body, should submit contingency plans and should make decisions or give advise on actions in case of an accident.

In the period from 1986 to 1993 systems for monitoring radioactive fallout and measuring equipment for mapping and measurements in the food chains were established.

In 1991 the Norwegian Government established an Inter-Ministerial working group to evaluate the existing emergency preparedness. This Inter-Ministerial working group presented their report to the Ministry of Health and Social Affairs in 1992. In order to make the emergency handling more effective in the early phases of nuclear accidents, changes in the existing organization and further development of the monitoring and measuring systems were suggested.

2. The emergency organization

A new emergency organization for nuclear accidents was appointed by the Government 15. april 1993. This emergency organization consists of:

* The Advisory Committee for Nuclear Accidents,
* The Crisis Committee for Nuclear Accidents,
* The Ministerial Coordination Committee,
* The regional emergency organizations.

The Advisory Committee consists of 18 authorities and organizations representing expertise and responsibility within fields of importance in handling a nuclear accident. In case of an accident they shall act as advisors to the Crisis Committee. During development and maintenance of the emergency preparedness the Advisory Committee will act as an advisory body for the Ministries and their Coordinating Committee.

The Crisis Committee consists of 6 authorities and organizations. In case of a nuclear accident, this committee has been given authority and responsibility to decide and order remedial actions in order to prevent or reduce radiological and economical consequences.

A secretariat for the Advisory Committee and the Crisis Committee has been appointed at the Norwegian Radiation Protection Authority (NRPA). The secretariat shall develop and maintain the emergency preparedness and act on practical matters on behalf of the emergency organization. The secretariat include the newly formed Emergency Unit on the Norwegian-Russian border at Svanhovd in the county of Finnmark. The Crisis Committee and the Advisory Committee will gather in the premises of the Norwegian Radiation Protection Authority during a nuclear accident.

In the Norwegian counties, local emergency organizations are established under the leadership of the chief administration officer.

3. The threat from installations and activities

As a part of the evaluation of emergency planning and the need for further developments, a survey of installations and activities representing a nuclear threat against Norway has been prepared. Both the location, the probability of a major accident and possible consequences for Norway were considered. The situation for Norway can be summarized as follows:

* The Norwegian need for electric power is supplied by hydroelectric power plants and Norway has no nuclear power plants. The Institute for Energy Technology in Norway own and operate two small research reactors, one with a thermal power of 2 MW and one with 25 MW thermal power.
* Nuclear power plants in our neighbouring countries must be taken into account as installations representing a threat against Norway.
* The nuclear power plants at the Kola peninsula and at Ringhals in Sweden are located approximately 250 km from the Norwegian border. The nuclear power plants in Sosnovyj Bor near St Petersburg and in Ignalina in Litauen are located approximately 800 km from Norway while installations at the east coast of United Kingdom are located 600 km from the south and west coast of our country. The two nuclear power plants in Finland must also be taken into account.
* Finnmark county has a common border with the Kola peninsula. The concentration of atomic weapons in this area together with the number of military installations for the Russian sea and air forces and the Kola nuclear power plant represent, in our opinion, a special threat

against our northern territories.

* The activity of nuclear powered military vessels, particularly submarines, in the northern parts of the Atlantic ocean and the Barents sea, and also the fleet of Russian ice breakers with their base in Murmansk, represents a threat against our northern territories and the Arctic marine environment.

The dominating nuclear threats against Norway given by priority are therefore:

* Accidents at foreign nuclear power plants,
* Accidents in nuclear powered vessels in the proximity of the Norwegian coast,
* Unintended detonation of atomic weapons during transportation, handling and storage,
* Reentry of nuclear powered space vessels and satellites,
* Accidents in Norwegian research reactors.

4. Systems for monitoring and measurements

The LORACON-system

The LORACON system (Local Radiation Control) consists of approximately 80 instrument sets located at 67 local laboratories for food control in Norwegian municipalities. The purpose of these instruments is to measure radioactivity in foodstuffs and samples from the environment.

Stationary monitoring stations

A network of 22 stationary stations for monitoring fallout in Norway is operated by the Norwegian Institute for Air Research (NILU). One station is located at the Kola peninsula half way between the Kola Nuclear Power Plant and the Norwegian border.

NILU has established a cooperation with seven of the LORACON stations. When the LORACON instruments are not used to measure radioactivity in food samples, the instruments are interfaced to form a part of the NILU stationary monitoring system.

Air sampling stations

Eight air sampling stations are located in Norway, including one on board the coastal steamer "M/S Midnattsol". Three of them are characterized as high volume air sampling stations. One of these are located at Svanhovd in the county of Finnmark approximately 1 km from the Russian border at the Kola peninsula.

Transportable dose rate meters

The civil defence groups at various locations in Norway have 176 transportable dose rate meters at their disposal for measurements of external dose rates in contaminated areas. They perform routine measurements by specific procedures at defined locations throughout Norway. In this way we gain experience with the radiation levels at these points. In case of a new fallout, it will be possible to analyze the amount at these locations. The civil defence groups and their instruments will also be used to map the fallout from an accident in contaminated areas.

5. A databased decision support system

The central emergency organization for nuclear accidents, the Crisis Committee and the Advisory Committee, are responsible for management of nuclear accident threatening or having consequences in Norway. The Crises Committee has been given extensive authority to decide and order remedial actions in order to prevent or reduce radiological and economical consequences in the Norwegian society.

The 18 organizations in the central emergency organization have information, data and operating responsibility for

various measuring systems and equipment in order to evaluate an emergency situation. All these data and information must be available to the central emergency organization at their operation centre at the Norwegian Radiation Protection Authority. In addition these organizations have specified areas of responsibility during an emergency situation, all of which must be coordinated.

The daily maintenance and support of the emergency preparedness is carried out by the secretariat at the Norwegian Radiation protection Authority. The secretariat is responsible for maintaining a high level of readiness and availability of information required in accident situations. This implies that it must be a continuous activity to survey and monitor releases and the current radiation levels in Norway and in the neighbouring countries.

Considering the vast amount of information and data needed to keep an updated overview of a situation both during the daily surveillance work and during accident situations the need for an efficient information an retrieval system is evident. Accordingly, it has been decided to develop a computerized system for continuous monitoring and decision support in accident situation.

The main objectives of this system called NORMEM (Norwegian Major Emergency Management) is to:

* Assess consequences of nuclear accidents,
* Establish a basis for right decisions on countermeasures in order to reduce health effects and economical consequences.

The health effects considered are increased cancer risk for individuals and increased frequency of cancer in population groups or in the whole population. Only in special situation acute radiation effects must be considered.

To fulfil the main objectives, the NORMEM system must include functionalities covering the following areas of application:

* NORMEM shall contain tools for assessing the impact of real accidents to provide guidance and decision support for the emergency organization in accident situations.
* NORMEM shall contain tools for assessing hypothetical accidents to provide guidance and support for developing the emergency preparedness.
* NORMEM shall provide data and presentations necessary to support a continuous and updated public information and press service in an emergency situation.
* NORMEM shall function as an information collection an retrieval system for the NRPA, supporting the staff in maintaining an overview of the radiological situation in Norway and its environment, including the marine environment in the Arctic regions.
* NORMEM shall contain the means required to run in a training mode for use in preparedness exercises and in training of staff within the emergency organization.

The time phases of a nuclear accident are often divided into the early phase, the intermediate phase and the late phase. The decision support system must be available and give support to the emergency organization in the various phases.

We have found it convenient to describe the functions in NORMEM as administrative functions or technical functions.

Administrative functions

The functions described as administrative are those usually found in an emergency handbook, and includes:

* Description of the various parts of the emergency organization, its members and their responsibility within the organization.
* Description of procedures for alarming and mobilization of all parts of the emergency organization.
* Contact points within the Ministries and other relevant organizations in Norway.
* Descriptions of other Nordic emergency organizations with contact points and information on communication systems.
* Description of international organizations to be contacted and how.
* Descriptions of bilateral and international agreements and the requirements and procedures to fulfil these agreements.
* Descriptions of all resources available to the emergency organization, described as what, where, how many, responsible person and contact point.
* Means for receiving, logging, management and storage of all messages received or transmitted.

Technical functions

As a part of the basis for management of a nuclear accident we must have:

* Information on fixed installations containing radioactive sources and examples of expected source terms in case of accidents. This information shall include knowledge of incidents and accidents for these sources. These sources are nuclear power plants and other reactors, reprocessing plants, stocks and dumping areas of radioactive waste, nuclear weapon test sites and concentrations of atomic weapons if possible.
* Information on movable installations containing radioactive sources. This includes reactor powered military vessels i.e surface vessels and submarines, the fleet of Russian icebreakers and nuclear powered satellites.
* Data on the present levels of contamination in the air, at the ground, in water, in the environment (vegetation, animals), in the food chains and in foodstuffs. These data can be used during the regular work on radiation protection at the Norwegian Radiation Protection Authority and in cooperation with other institutions, but must also be available in order to assess the consequences of a new accident.
* Data on the external exposure rates from natural sources and from the present contamination at the ground and in the environment.

In the acute phase of a nuclear accident we must have:

* Meteorological data and models for predicting transport of radioactive materials from a given source term in air and in water.
* Models for predicting air, ground and water contamination levels given the source term, meteorological conditions and aquatic conditions.
* Models for predicting the radiological impact of radioactive substances and their migration in the environment and the food chains.

These models are tools for predicting consequences and make decisions on countermeasures in the early and intermediate phases of a nuclear accident when little is known about the situation and how it will evolve.

In the intermediate and late phases of a nuclear accident:

* Information and data from all kinds of measurements made during and after an accident shall be available. This includes data on dose rates and contamination levels in air, at the ground, in water,

vegetation, animals, the food chains and in foodstuffs. All considerations of consequences must be based on this total amount of information. It must therefore be possible to register and to store a vast amount of data in a systematic way in the NORMEM system.

* Necessary functions for handling, synthesizing and displaying information and data on digital maps in graphs and charts. Presentation of information and data in a comprehensive way either as predictions from model calculations or from measurements must be possible for assessing the evolvement of the situation and for assessing the present situation all the time.

* Models and algorithms for estimation of doses to individuals and population groups either from predictions of contamination levels or from measurements of dose rates and contamination levels. Radiation doses to individuals and to population groups must be known in order to assess the health effects and also as a basis for introducing countermeasures.

* Models and algorithms for calculating short term and long term consequences from predicted contamination levels or from measurements.

* Models and algorithms for calculating the cost-effectiveness, optimization and adverted doses for countermeasures. The main rule in radiation protection is that countermeasures shall be justified by producing a net benefit for individuals and the society. The reduction in detriment resulting from the reduction in dose should be sufficient to justify the harm and costs, including social costs, of the countermeasure. In addition countermeasures shall be optimized in form, scale and duration.

* Means of assessing long term impact taking into account all countermeasures and consequences on the Norwegian territory and for the Norwegian population. Consequences are increased frequency of cancer and economical and social costs.

5. Software and hardware tools

The basic software tools behind NORMEM will be a data base management system (DBMS), a user interface management system (UIMS) and a geographical information system (GIS). The data base will be used to store heterogenous information in the NORMEM system. Institute for Energy Technology (IFE) will incorporate their UIMS tool PICASSO in NORMEM to give access to and to present data and information stored in the data base. A GIS-tool will be used for displaying information and data from the data base on digital maps. The Norwegian Radiation Protection Authority has already a SYBASE SQL server available for the system.

The NORMEM system will be developed to run on a HP 9000/735 work station under UNIX located at the Norwegian Radiation Protection Authority.