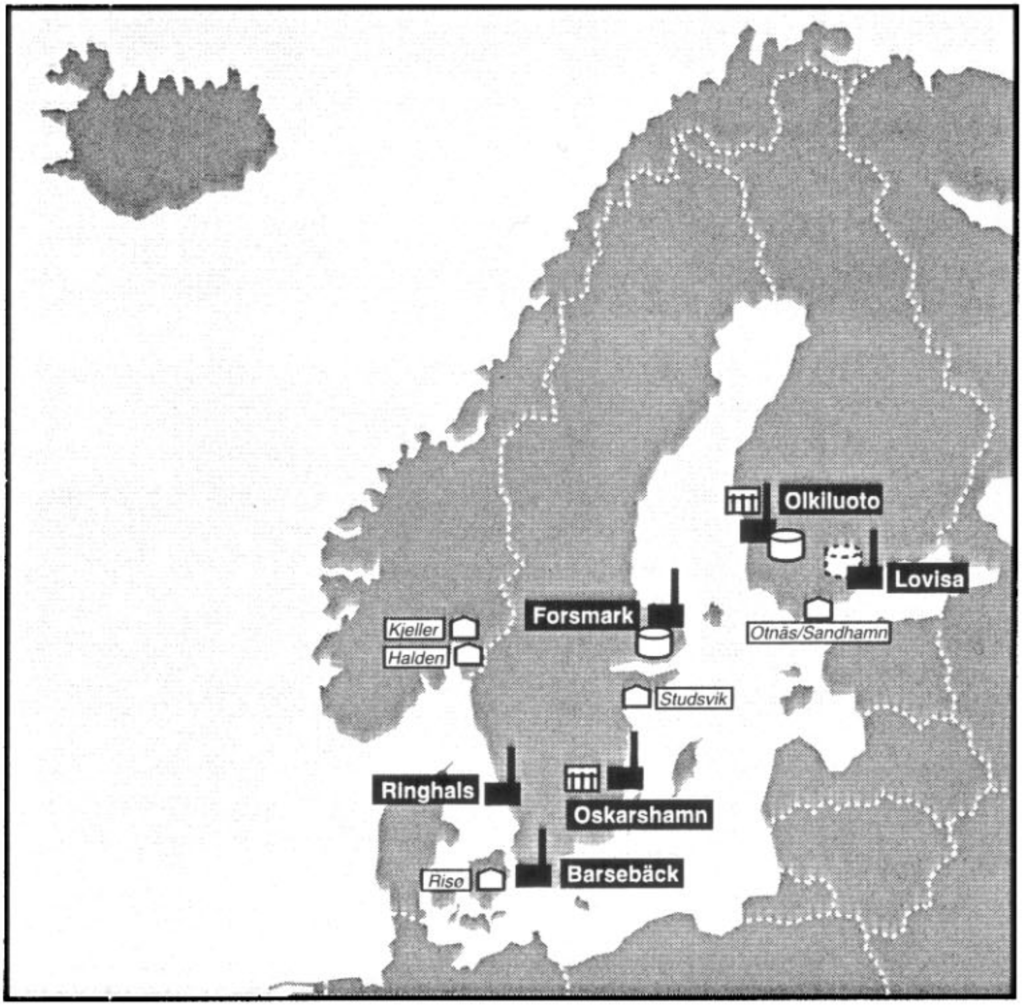
THE NORDIC WASTE PROGRAMME

1990-93



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THE NORDIC EMERGENCY PREPAREDNESS PROGRAMME

1990-93

STATUS ON NUCLEAR EMERGENCY PREPAREDNESS IN THE NORDIC COUNTRIES

Compiled by

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April 1994

The Nordic Emergency Preparedness Programme

The five Nordic countries (Denmark, Iceland, Finland, Norway, and Sweden) have a long tradition of cooperation, owing to their geographic proximity and facilitated by similar economic, cultural and societal structures. At Nordic meetings, participants can frequently use their own language, or their personal version of an artificial »Scandinavian« language, making communication easier and working patterns more efficient than is usually the case at international meetings.

The BER programme area of the 1990-1993 Nordic programme on Nuclear Safety Research (NKS) is an example of extensive Nordic cooperation in a scientific and technical field. (BER is an abbreviation of »Beredskap«, Scandinavian for emergency preparedness). Altogether BER comprised six main research projects, covering a wide and varying range of subjects. The projects have resulted in a number of up-to-date reports and reference guide books, for use in the planning of countermeasures in large-scale emergencies. The present document is a summary, based on the findings of all the BER projects. The final reports from the projects are issued in 1994. References are given in the Appendix, and the reader is urged to consult these reports for details.

Tryk: Grafisk Service, Risø, 1994

Organization of Emergency Management

The *Nordic Handbook on Nuclear Emergency Preparedness [1]* describes the general organization of emergency management in each Nordic country. It also briefly summarizes the arrangements for early notification of an accident, the information channels and the radiation monitoring system in each country.

At first glance national organizational schemes seem greatly different, especially at the national and regional administrative level. However, a closer study of tasks and responsibilities reveals that in practice there is much similarity in the way emergencies are managed in the Nordic countries.

The management of large-scale accidents and emergency situations always requires concerted action and the collaboration of several authorities. Table 1 shows which organizations have the basic responsibilities in each Nordic country.

Notification and Mutual Assistance in Case of Accidents

All Nordic countries are parties to the International Atomic Energy Agency's (IAEA) *Convention on early notification in case of a nuclear accident*, signed in 1986. Finland and Sweden, who operate their own nuclear power plants, have a bilateral agreement supplementing the IAEA convention, and both countries have separate bilateral agreements with Denmark and Norway. Furthermore, these four Nordic countries all have similar bilateral agreements with Russia and other neighbouring or closely situated nuclear power plant countries. Denmark is also a party to the European Union's regional agreement of 1987 on early information exchange among member countries.

Table 1. Authorities responsible for main areas of nuclear emergency preparedness.

Competent authority for international early notification	
Denmark:	Danish Emergency Management Agency (DEMA)
Finland:	Finnish Centre for Radiation and Nuclear Safety (STUK)
Norway:	Norwegian Radiation Protection Authority (NRPA)
Sweden:	Swedish Radiation Protection Institute (SSI)
Authority responsible for national coordination of protection of the public	
Denmark:	Danish Emergency Management Agency
Finland:	Ministry of the Interior / Rescue department
Norway:	Advisory Committee for Nuclear Accidents
Sweden:	Swedish Radiation Protection Institute
Expert body (regulatory authority) on radiation protection	
Denmark:	Danish Institute of Radiation Hygiene
Finland:	Finnish Centre for Radiation and Nuclear Safety
Iceland:	Icelandic Institute for Radiation Hygiene
Norway:	Norwegian Radiation Protection Authority
Sweden:	Swedish Radiation Protection Institute
Expert body (regulatory authority) on nuclear safety	
Denmark:	Danish Emergency Management Agency / Nuclear Inspectorate
Finland:	Finnish Centre for Radiation and Nuclear Safety
Norway:	Norwegian Radiation Protection Authority
Sweden:	Swedish Nuclear Inspectorate
Competent authority for controls of foodstuffs	
Denmark:	Foodstuffs Control Board
Finland:	Ministry of Agriculture and Forestry, Ministry of Trade and Industry / National Food Administration
Norway:	Norwegian Food Control Authority
Sweden:	Swedish Food Administration

The bilateral notification agreements are broader in scope than the IAEA convention, e.g. they require notification when increased levels of radiation or increased concentrations of radioactivity have been measured, regardless of the origin of the increase. Another important clause in the bilateral agreements is the obligation to provide technical information about nuclear facilities on a regular basis, in order to help assess the risk, should an accident occur in one of the countries.

A Nordic mutual assistance agreement for radiation accidents has been in existance since 1963, and the Nordic countries are all parties to the IAEA convention on Mutual assistance in case of radiation emergency. There is also a general Nordic agreement on rescue services, which e.g. makes possible the use of search and rescue helicopters on both sides of an inter-Nordic border.

Communicating with the Public

If the authorities in neighbouring countries do not communicate with each other during an accident, contradictory messages may result, and the public's trust will quickly disintegrate. The Nordic bilateral agreements on notification include a provision that all official information from the emergency management authorities to the general public in one country should at the same time be transmitted to the competent authorities of the other Nordic countries. This will ensure a common ground for information and avoid unnecessary confusion, e.g. when the public uses the services of news channels and media in neighbouring countries, which is common practice in several regions within the Nordic region.

The basic reason for a project about information in emergency situations is the public's need for - and right to - information. The report *Information and communication in the event of abnormal situations relating to nuclear power [2]*, prepared in the project BER-4, stresses the importance of a dialogue with the public during all phases of an emergency, in order to obtain a good understanding of the public's need. The project work has defined a *strategy* and a *policy* for the Nordic countries.

The *Nordic information strategy* can be formulated in the following way:

* The information provided shall be prompt, relevant, as complete as circumstances permit, and formulated in such a way that no uncertainty as to its interpretation can arise.

Within the framework of an established strategy, the *information policy* is a set of guidelines for the transmission of information and distribution of responsibility within an organization. The most important guidelines are:

* Authorities shall strive to provide relevant information quickly, even though such information may be incomplete. Information in the early phase should seek to specify the threat and to keep the public aware of what measures the authorities have taken.

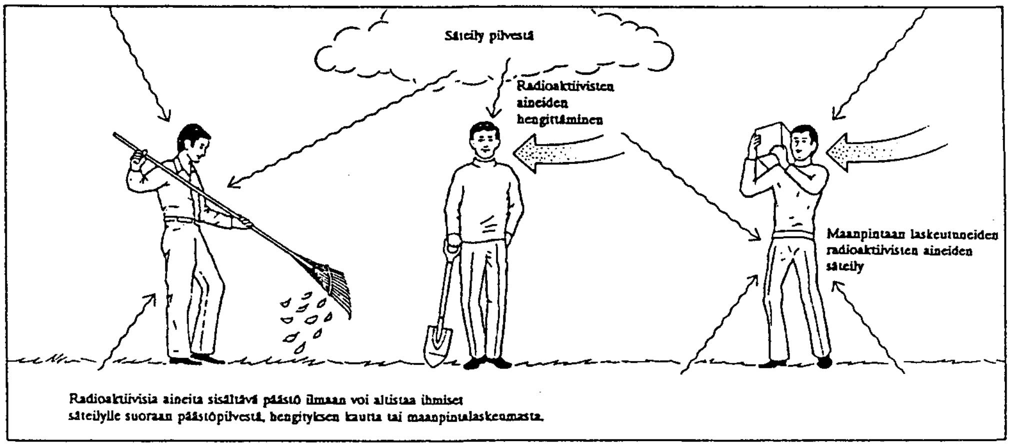
* In each event which requires information to the public, information activities shall be coordinated by the central radiation protection or central rescue services authority in each country.

A well implemented information policy gives the authorities the initiative in managing the emergency situation.

An important conclusion reached in the project work is that contacts between authorities and the media have to be based on *informal* structures. Networks have to be maintained to secure accurate and efficient communication, but networks involving journalists have to be built on mutual confidence and trust.

In cooperation with the Nordic national radiation protection and rescue service authorities the BER-4 project has produced an information package containing basic facts about releases of radioactivity, protective measures, properties and consequences of radiation and a national section about authorities' preparedness. The manuscript is in the form of data files that can be speedily modified and supplemented in an actual emergency situation, and then printed and distributed. Figure 1 gives an example of the type of information included in the package.

Figure 1. Exposure pathways



Environmental Monitoring and Radiation Data Exchange

The Nordic cooperation in measuring artificial radioactivity dates back to the age of atmospheric nuclear testing in the late 1950's and early 1960's. At that time, the techniques of environmental sampling, radiochemical separation, and measurement of radioactivity had to be developed almost from scratch, and it was very important to exchange experience and compare measuring results. The collaboration between the radiation protection institutes was started, the Nordic Society for Radiation Protection was founded, and several RIS-symposia (»Radioactivity in Scandinavia«) were arranged.

Once the monitoring of environmental radiation levels and measurements of concentrations of artificial radioactivity in the environment had been organized into daily routines, national practices and systems evolved in slightly different ways. This was unavoidable as instruments and techniques developed fast, and one should also bear in mind that geographical circumstances and other differences influence the preparedness requirements. As an example, Denmark had to deal with the plutonium contamination situation following the crash in Greenland of a nuclear-weapon-carrying B-52 strategic aircraft in 1968.

Today, the main threat to prepare for is commonly considered to be a severe accident at a nuclear power plant. The statutory regulations in Finland and Sweden require *on-site* and *off-site* emergency plans for the domestic nuclear power plants, and a high standard of emergency preparedness. This involves special emphasis on systems and methods for monitoring in accident situations. The same situation is true in Denmark, because of the proximity (20 km) of the Barsebäck plant in southern Sweden.

Surveys tend to show that the population in Denmark, Finland, and Sweden considers a reactor accident in a non-Nordic country as the most likely radiological threat. A serious accident at a Nordic nuclear power plant is considered much less probable. In Norway, nuclear submarines, naval vessels and ice-breakers constitute an additional threat, and in Iceland this is considered the most significant threat.

From an emergency preparedness point of view, rapid and territorially comprehensive monitoring is most important in the case of an accident, in order to ensure early warning and to get a rough estimate of the overall radiological situation. After the initial phase, emergency preparedness requires the capacity to produce detailed fallout maps, and make additional measurements to determine dose rates, fallout distribution patterns for specific nuclides, and food contamination.

The need for airborne equipment to find and measure contaminated areas is well realized. The Danish Emergency Management Agency has paid particular attention to developing this sector of environmental monitoring. The Danish airborne system is based on collaboration with the national search and rescue service and the use of their helicopters.

A subproject, managed by the Danish information technology company Infocon, investigated the technical requirements concerning navigation, on-line data transmission and the advantages of standardization of instruments and methods. The project has made a strong recommendation for cooperation with national search and rescue organizations. This approach could also facilitate inter-Nordic cooperation and possibly lead to a pooling of resources and savings in future expenses.

The BER-2 project report *Monitoring Artificial Radioactivity in the Nordic Countries [3]* gives detailed information about the monitoring system in each Nordic country, specifically regarding:

* automatic and manual gamma monitoring stations,
* air monitoring stations,
* airborne measurements,

* laboratory measurements of foodstuffs and environmental samples,
* survey teams,
* measurements of internal and external contamination, and
* other types of measurement, e.g. in situ gamma spectrometric measurements.

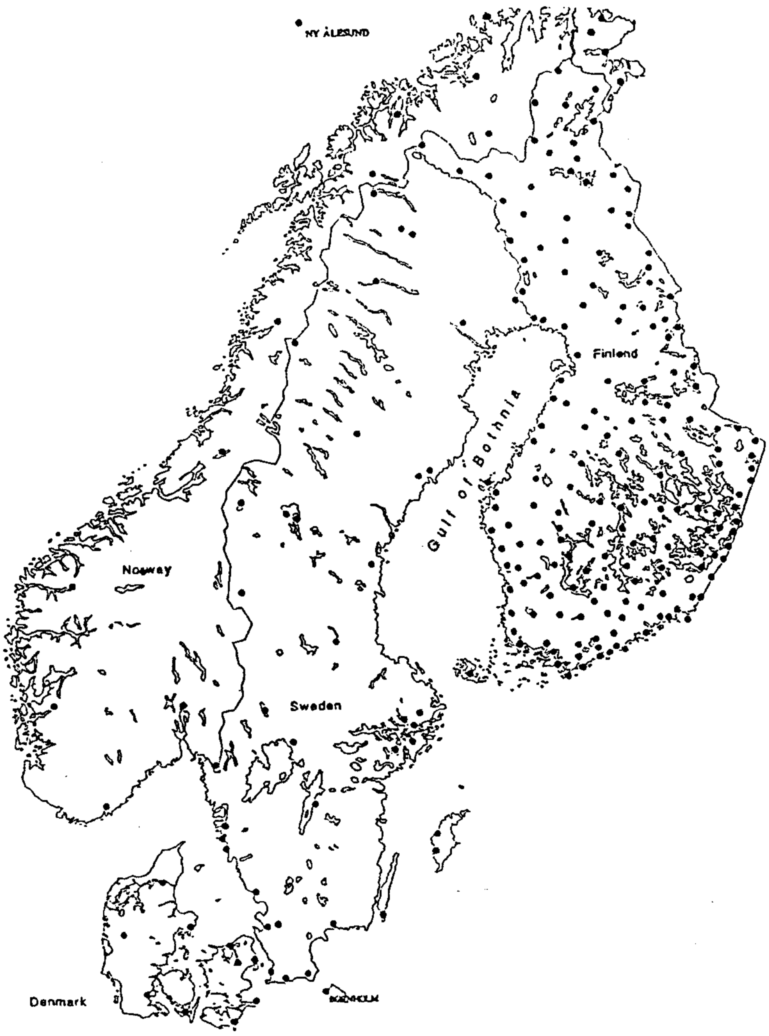
The comparison shows that for early warning the Nordic countries use a mix of stations measuring external gamma radiation and stations measuring airborne radioactivity. There is a trade-off between fast alarm and the sensitivity threshold. Total gamma measuring stations cannot detect increases smaller than the variations of normal background. Some stations, notably all Danish stations, are equipped with sodium iodide (NaI) type detectors, and operated in such a way that stray peaks due to an increase in the natural radon background can be subtracted.

On-line total beta or total gamma measurements of airborne radioactivity collected on filter paper or in activated charcoal cartridges are more sensitive, although they cannot detect levels below the natural radioactivity in air. Gamma spectrometric measurements of the filter paper or cartridge samples provide many decades better sensitivity, but in normal routine usually only one or two filters per week are collected and analyzed.

A Nordic Radiation Data Exchange System has been set up and tested on a trial basis. This system focuses on dose rate data from the automatic gamma monitoring stations. An important goal achieved in the project was to determine which data is essential, and to specify a common format for the data exchange. Various telecommunication methods have been tested, and the actual transfer of monitoring results between the Nordic countries was started.

The map in figure 2 shows the automatic monitoring stations in the Nordic countries, except Iceland, whose measuring results could be obtained through the data base in the Nordic Radiation Data Exchange System.

Figure 2. Automatic measuring stations for external radiation dose rate in the Nordic Countries. The Icelandic combined station for gamma monitoring and air filtration is located close to Reykjavik.



The communication facilities established in the experimental set-up allow two parallel ways to access the Nordic data base - via the public telephone net to a bulletin-board type »RDE Box« and via international data networks to a Unix machine. The data base is established at the project contractor's office, the Finnish State Computer Center in Jyväskylä, Finland.

The project recommends as a future approach that every country appoint one organization with the responsibility of operating a national information data base, which can be commonly accessed from all the Nordic countries. A procedure for establishing a system of this type has been outlined.

Atmospheric Dispersion and Environmental Consequence Models

Real-time atmospheric dispersion models was one of the subjects of the project BER-1. The emergency preparedness organization needs tools to predict the consequences of accidents involving large releases of radioactive material. One such tool is an atmospheric dispersion model, which should be capable of linking current weather data directly into the calculations and should be applicable over distances of several hundred kilometers. »Real-time« in this connection means that the output of the model can be presented in a relatively short time, compared to the updating frequency of the input data.

The source term, i.e. the amounts and rates of release of radioactive material to the environment, cannot be assumed to be known very accurately in a severe accident situation. Therefore, predictions of concentration of radioactive material over long distances are likely to be afflicted with large uncertainties. As an example, the height at which the material is transported can have a large influence on the dispersion pattern. In addition, the emergency preparedness organization may require predictions in a situation where a release to the environment may be imminent but has not occurred.

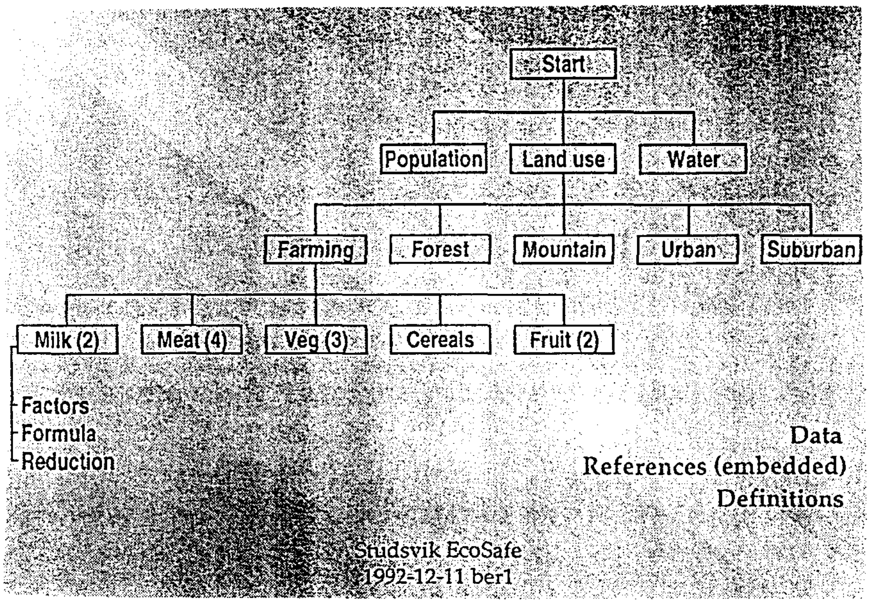
A set of trajectories often gives the most useful information in the initial phase. The calculation of long range trajectories requires the use of a three-dimensional meteorological model. All the Nordic countries now have the capability to make these calculations.

Emergency Response Assisting Systems [ERAS] are under development. Such systems employ not only a dispersion model, but should also be able to collect and accept environmental monitoring data and present the results in a manner well adapted to the needs of decision making. However, it was concluded in the project that it is unrealistic to expect the development of a common Nordic ERAS system in the near future. The common European Union model RODOS is scheduled to be available in 1995.

Much information on the behaviour of radioactivity in the environment has been accumulated in the Nordic countries. The other part of the BER-1 project responded to the need to create a fast system for retrieving information on exposure pathways in a radiological accident situation. A *Handbook on Exposure Situations Following Accidental Releases [4]* was prepared in the form of a computerized dictionary, outlined as a *Windows* help system. Figure 3 gives an example of the file structure of the dictionary.

The computerized handbook provides on-line help about factors influencing the dose, on how to calculate doses from the selected pathway and about possibilities to reduce doses from a particular pathway. The database concentrates on the most important nuclides, iodine-131 and ceasium-137, and it contains both textual and graphical information.

Figure 3. The tree structure of the BER-1 computerized dictionary files.



Intervention Levels for Protective Action

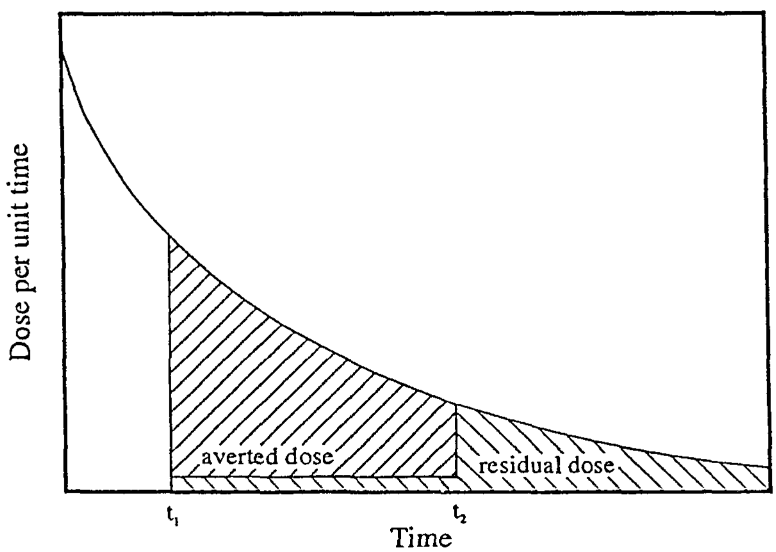
The public will not understand differences in ambition levels from one country to another in the protection of the population, nor will the public accept different decisions under very similar circumstances. Thus there is a need for harmonized *generic* Nordic intervention levels for the most important protective actions. Of course, it is clear that an even wider harmonization is desirable, and the internationally accepted basic principles for intervention should be adopted as the basis for a Nordic harmonization.

An essential aim of the BER-3 project has been to review the state-of-the art of decision making theory and to introduce and review the most commonly used decision aiding techniques, such as multi-attribute utility analysis. The purpose of introducing protective action is to avert radiation doses partly or completely.

The project report *Intervention principles and levels in the case of a nuclear accident [4]* starts by reviewing the international recommendations. However, the decision maker has to consider many aspects, some of which, but not all, are radiological. Economic resources as well as social and psychological factors influence the decision making.

As for economic considerations, the project evaluated the monetary costs of protective actions in each Nordic country and found that costs arising from moving people were rather similar in all the countries. Any protective action taken can only influence doses that may be received in the future. The averted dose is that which would have been received in the absence of the protective measure over the period considered, as illustrated by figure 4.

Figure 4. Averted and residual individual doses for a protective action which is introduced at time t_1 and terminated at time t_2.



As for psychological factors, each decision on protective action should consider whether it causes stress on the part of the public. The stress may be so strong that the individual's capability to cope with the situation is impaired. Some criteria and a measurement scale can be developed to judge the most likely outcome, as a background for decision making. The BER-3 project report also includes a discussion on important factors in risk perception.

The applicability of the *willingness-to-pay* method was also further examined in the BER-3 project. The results of a pilot study, carried out by Vilstrup Research Inc. of Copenhagen were used to calculate the monetary value of the *mansievert* (manSv), the unit of collective dose. The question asked in 141 telephone or face-to-face interviews was formulated as follows:

* »If we imagine that you, by paying a certain amount, could ensure yourself personally an extra year of life with the same health and the same working capacity as you have had in 1992, how much do you think that you could and would be willing to pay - with a reasonable payment arrangement - when you consider that you have the usual income, the usual living expenses and the same taxes to pay also in that extra year?«

The pilot investigation was intended as a first approach only, and it had some limitations. Nevertheless, interpretation of the result translated to a rounded value of USD 10,000 per manSv.

Decisions on protective actions affecting the society are in fact group decisions, i.e. they are taken by a group of decision makers. A technique known as *decision conferencing* has been developed as a tool to analyze the group decision making process. It has been argued that decision conferences produce conditions for creative and effective decision making. Thus, exercises using this technique would be useful in emergency planning. A Nordic decision conference was organized in Denmark in

1992, with participants representing local and regional government officials, emergency planners and radiation protection authorities.

A special form of protective action is the reclamation of large contaminated environments, which is very costly. If undertaken without a proper knowledge base, it may lead to a more severe impact on society than if no action were taken. The BER-6 project is intended as a guide for decision makers, in case they are faced with planning and implementation of reclamation measures.

Reclamation may involve the urban environment, cultivated agricultural environments, farm animals, forest flora and fauna, freshwater systems and fish. The study concentrates on the Nordic type of society and considers such topics as the probability of accidents giving rise to radioactive contamination, the resources available for cleanup, the safety of the cleanup workers, the management and disposal of the radioactive waste produced, and other environmental factors.

Nordic Emergency Preparedness Exercises

Within the BER programme area, a number of Nordic and national drills have been performed, to test technical functions and operational skills, and to pave the way for the two large Nordic exercises constituting the actual Nordic exercise project, BER-5.

Two functional exercises were held, in 1992 and 1993, in order to test transfer of meteorological information and to compare the resulting predictions of air concentrations, deposition and dose rate. All Nordic countries, including Iceland, took part in the second exercise, producing trajectory predictions. Denmark, Finland, Norway, and Sweden also made real-time predictions of activity concentrations and deposition.

The BER-5 project included two major Nordic exercises, an acute phase situation (NORA) and a late phase situation (ODIN). The exercise NORA was conducted on January 14, 1993, and ODIN took place on November 26, 1993. The scenarios for the two exercises were different and independent.

The reason behind the Nordic emergency exercise project was that it was deemed important to see whether the Nordic countries responded in a similar way to a given emergency situation, as far as risk assessment and countermeasures were concerned. Nordic exercises were also seen as a means to maintain the competence to act according to the international conventions on early notification and on assistance in case of a radiological accident. This aspect is particularly relevant in those Nordic countries not having their own nuclear power plants.

It can be learned from the two exercises that such undertakings are time consuming and require considerable resources in the form of manpower, funds and equipment. One major benefit, as compared to smaller national projects is the wider, Nordic perspective, and the subsequent extended national engagement. The large scale made it easier to get the necessary commitment among all the relevant authorities and organizations, and it encouraged contacts between various disciplines and expert groups.

A practical conclusion of NORA and ODIN is that such exercices should concentrate on a limited number of important aspects, since it is not possible to cover all issues in one single exercise.

Prior to the late phase exercise ODIN, the leaders of the participating organizations were informed about the initial scenario, and then had to fill in a checklist to describe measures that would already be taken when the exercise starts. In this way they contributed to the lay-out of the actual exercise. This technique can be recommended.

It was found that during the acute phase of an emergency, international contacts and exchange of information will not take place on a large scale, because all national organizations will be busy with tasks considered to be of a higher priority. During the late phase, when information to the media and the public becomes increasingly important, such contacts are required, and according to the experience from ODIN, they can also be expected to take place.

With regard to the acute as well as the late phase, it is evident that initial international coordination and harmonization of protective actions has to be achieved in advance.

The overall Nordic experience from the emergency exercises is described in the *Nordic Nuclear Emergency Exercises report [6]*. The report includes descriptions of the scenarios, the participating organizations in each country, the realization of the exercises, and a summary of the reports of the Nordic evaluation team.

Concluding remarks

The BER projects on emergency preparedness have achieved an increased mutual awareness of the emergency preparedness organizations, arrangements and strategies in the Nordic countries. The purpose has been to learn from each other and to harmonize the response to emergency situations, so that in case of an accident with consequences across the borders, the responsible authorities would act in a similar way.

The projects have also reviewed the tools available for emergency management, such as meteorological dispersion models, dose prediction models, environmental monitoring systems, and systems for rapid exchange of monitoring results and other information required by the specialists.

The decision making process itself has been the subject of investigations, and special attention has been given to harmonization of intervention levels and principles.

As a part of the work, handbooks have been produced on:

* Nordic organizations in emergency preparedness,
* Consequenses of deposition of ceasium-137 and iodine-131,
* The feasibility of reclamation of contaminated environments.

This material is now available as reference for the regulatory authorities, whose task it is to consider implementation of the findings and recommendations. The projects have collected the information and reviewed the knowledge base in the Nordic countries in a uniform way. It is therefore hoped that the project reports will prove useful to the Nordic as well as to the international radiation safety community.

List of Projects, Main Topics and Publications

BER-1 Dispersion Prognoses and Consequences in the Environment
- * Medium-to long Long Range Atmospheric »Real-time« Transportation and Dispersion Models for Use in the Nordic Countries
- * Handbook on Exposure Situations Following Accidental Releases

BER-2 Methods and Strategy in Radiation Monitoring
- * Monitoring Artificial Radioactivity in the Nordic Countries
- * Radiation Data Exchange between the Nordic Countries
- * On-line Airborne Measurements in Acute Situations

BER-3 Evaluation and Harmonization of the Planning of Countermeasures and the Use of Intervention Levels
- * Intervention Principles
- * Considerations on Economic Resources and Radiation Protection Decisions
- * Psychological Factors and Intervention Measures
- * Important Factors in Risk Perception
- * Cost of Protective Measures
- * International Recommendations

BER-4 Information and Communication in the Event of Abnormal Situations Relating to Nuclear Power
- * Information Strategy and Policy
- * The Nordic Contact Forum

BER-5 Nordic Nuclear Emergency Exercises
- * Functional Exercises
- * NORA - the Acute Phase Exercise
- * ODIN - the Late Phase Exercise

BER-6 Reclamation of Contaminated Urban and Rural Environments Following a Severe Nuclear Accident

* Contamination and Reclamation in the Urban environment
* Contamination and Reclamation in the Cultivated Agricultural Environment
* Countermeasures for Farm Animals
* Forests
* The Freshwater Environment
* Management and Disposal of Radioactive Waste from Clean-Up Operations
* Radiation Protection and Safety of Workers

Publications Referenced in the Text:

1 Håndbok for de Nordiske Beredskapsorganisasjonene mot Atomulykker (in Norwegian). Compiled by Leiv Berteig, former Head of Department at the Norwegian Radiation Satety Authority, on behalf of NKS. Oslo 1993. (In Print)

2 Information and communication in the event of abnormal situations relating to nuclear power (Draft of final report/BER-4)

3 Monitoring artificial radioactivity in the Nordic countries (Draft of final report/BER-2, editor Torkel Bennerstedt)

4 Handbook on exposure situations following accidental releases. Studsvik Eco & Safety AB, Sweden 1994 (Draft)

5 Intervention principles and levels in the event of a nuclear accident (Draft of final report/BER-3, April 1994)

6 Nordic nuclear emergency exercises (Draft of final report/BER-5, editor Torkel Bennerstedt)

The BER-programme

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The Nordic Committee for Nuclear Safety Research - NKS organizes pluriannual joint research programmes. The aim is to achieve a better understanding in the Nordic countries of the factors influencing the safety of nuclear installations. The progamme also permits involvement in new developments in the nuclear safety, radiation protection, and emergency provisions. The three first programmes, from 1977 to 1989, were partly financed by the Nordic Council of Ministers.

The 1990-93 Programme comprises four areas:

* Emergency preparedness (The BER-Programme)
* Waste and decommissioning (The KAN-Programme)
* Radioecology (The RAD-Programme)
* Reactor safety (The SIK-Programme)

The programme is manages - and financed - by a consortium comprising the Danish Emergency Management Agency, the Finnish Ministry of Trade and Industry, Iceland's National Institute of Radiation Protection, the Norwegian Radiation Protection Authority , and the Swedish Nuclear Power Inspectorate.

Additional financing is offered by the IVO and TVO power companies, Finland, as well as by the following Swedish organizations: KSU, OKG, SKN, SRV, Vattenfall AB, Sydkraft AB, SKB.

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