Radiation Protection

OECD

Short-term Countermeasures in Case of a Nuclear or Radiological Emergency

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NUCLEAR ENERGY AGENCY
ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

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Pursuant to Article 1 of the Convention signed in Paris on 14th December 1960, and which came into force on 30th September 1961, the Organisation for Economic Co-operation and Development (OECD) shall promote policies designed:

- to achieve the highest sustainable economic growth and employment and a rising standard of living in Member countries, while maintaining financial stability, and thus to contribute to the development of the world economy;
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- to contribute to the expansion of world trade on a multilateral, non-discriminatory basis in accordance with international obligations.

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NUCLEAR ENERGY AGENCY

The OECD Nuclear Energy Agency (NEA) was established on 1st February 1958 under the name of the OEEC European Nuclear Energy Agency. It received its present designation on 20th April 1972, when Japan became its first non-European full Member. NEA membership today consists of 28 OECD Member countries: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Luxembourg, Mexico, the Netherlands, Norway, Portugal, Republic of Korea, Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The Commission of the European Communities also takes part in the work of the Agency.

The mission of the NEA is:

- to assist its Member countries in maintaining and further developing, through international co-operation, the scientific, technological and legal bases required for a safe, environmentally friendly and economical use of nuclear energy for peaceful purposes, as well as
- to provide authoritative assessments and to forge common understandings on key issues, as input to government decisions on nuclear energy policy and to broader OECD policy analyses in areas such as energy and sustainable development.

Specific areas of competence of the NEA include safety and regulation of nuclear activities, radioactive waste management, radiological protection, nuclear science, economic and technical analyses of the nuclear fuel cycle, nuclear law and liability, and public information. The NEA Data Bank provides nuclear data and computer program services for participating countries.

In these and related tasks, the NEA works in close collaboration with the International Atomic Energy Agency in Vienna, with which it has a Co-operation Agreement, as well as with other international organisations in the nuclear field.

FOREWORD

Following the Chernobyl accident, the Nuclear Energy Agency substantially increased its activities to assist in the improvement of nuclear emergency and post-emergency preparedness and management, both nationally and internationally.

With the first international nuclear emergency exercise (INEX 1) in 1993, participating countries were able, for the first time, to test approaches and policies for managing the international and transboundary aspects of a nuclear or radiological emergency. The lessons learnt during INEX 1 led to an improvement in nuclear emergency management.

In order to follow up on the issues identified during INEX 1, the NEA organised three workshops covering the following topics: short-term countermeasures; agricultural aspects of nuclear and/or radiological emergency situations; and nuclear emergency data management.

In preparation for the first of these workshops, the NEA distributed a questionnaire to its member countries in order to establish an overview of currently used short-term countermeasures. The answers received were analysed and discussed during the workshop on “The Implementation of Short-term Countermeasures” held in Stockholm in June 1994.

National practices regarding short-term countermeasures subsequently evolved, thus inciting the NEA Working Party on Nuclear Emergency Matters to modify the questionnaire and to redistribute it in spring 2001 with the aim of preparing an updated overview of these practices. The NEA received 15 completed questionnaires from 14 countries: Australia, Canada, the Czech Republic, Finland, Germany, Hungary, Ireland, Japan, Luxembourg, Norway, Sweden, Switzerland, the United Kingdom and the United States.

Sabine Bittner evaluated the completed questionnaires and prepared a draft report. Her report was further elaborated and finalised by the NEA Working Party on Nuclear Emergency Matters, the results of which are reproduced herein.

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1. INTRODUCTION

Nuclear emergency planning, preparedness and management are essential elements of any country's nuclear power programme. Part of nuclear emergency planning and preparedness is the implementation of national emergency plans, including detailed procedures for the implementation of short-term countermeasures, before during and after the release of radioactive substances.

The timely and appropriate implementation of short-term countermeasures, such as sheltering, evacuation and iodine prophylaxis, can, in case of a nuclear emergency with a release of radioactive material, considerably reduce the doses to the public in the vicinity of the nuclear installation.

Although international guidelines exist, national procedures and practices may differ due to different national habits, cultural specificity and societal needs. Different national procedures and practices, however, may, in the case of a radioactive release affecting two neighbouring countries, lead to different decisions in the implementation of countermeasures.

In order to better understand existing approaches and to facilitate the comparison of national practices, the NEA decided to launch a questionnaire on current practices regarding short-term countermeasures, updating a similar survey performed in 1994, as countries' practices have since evolved and been modified.

The information collected may be used to understand the basis for decisions in various countries, and, if deemed necessary, as a basis for international harmonisation. This may also assist member countries to explain to the public affected by an emergency why the decisions in neighbouring countries may vary.

This report summarises the information given by member countries, following, in general, the structure of the questionnaire. The overview includes information on the relevant national and regional organisations responsible for developing the legal framework, who recommends and those who decide upon the implementation of a short-term countermeasure. General objectives for implementing short-term countermeasures are given followed by descriptions of emergency plans. More specific information, including intervention criteria, will be found regarding the countermeasures ***evacuation***, ***sheltering*** and ***iodine prophylaxis***. Finally, informing the public, countermeasures for special groups, international harmonisation and economic consequences of countermeasures are discussed.

The NEA questionnaire, as it was distributed to the member countries, is given in Annex 1.

2. GENERAL OBJECTIVES OF IMPLEMENTING SHORT-TERM COUNTERMEASURES

This chapter will summarise the objectives of implementing short-term countermeasures in case of a nuclear emergency. It will give an overview on the urgent countermeasures for the general public employed in NEA member countries, and describe the basis for setting intervention levels for the different short-term countermeasures.

Aim

The general objective of implementing short-term countermeasures is to reduce health consequences; in particular to avoid deterministic effects and to keep stochastic effects as low as possible.

The measures implemented should aim at a minimisation of the contamination of the environment in general and the food chain in particular. Special attention should be given to a reduction and minimisation of psychosocial impacts.

Australia mentions, as general objective, the removal of the source – in the case of a nuclear-powered warship.

Table 2 gives an overview of the urgent countermeasures, which are planned by the different countries. For the countries with nuclear power plants or nuclear installations, evacuation, sheltering and stable iodine are the preferred short-term countermeasures in the near field. In addition, there are other countermeasures such as access control, and a variety of precautionary agricultural countermeasures. In case of a far field accident, evacuation plays a minor role. Sheltering and stable iodine would be implemented, depending on the distance to the accident place.

Some countries had difficulties with the wording "far field" accident. A definition of what is meant by "far field", in terms of distance, would have been helpful.

Planned urgent countermeasures for the general public

Table 2. Urgent countermeasures for the general public

Countries	Near field accident: Evacuation	Near field accident: Sheltering	Near field accident: Stable Iodine	Near field accident: Others		Far field accident: Evacuation	Far field accident: Sheltering	Far field accident: Stable Iodine	Far field accident: Others
Australia	X	X	X	X[a]					
Canada	X	X	X	X[#]					X[#]
Czech Republic	X	X	X				X	X	
Finland	X	X	X	X[b,c,#]					X[e]
Germany	X	X	X	X[d]					
Hungary	X	X	X				X		
Ireland							X	X	X[c]
Japan	X	X	X	X[b]					
Luxembourg						X	X	X	X[b,#]
Netherlands	X	X	X	X[b,f]			X	X	X[b,f]
Norway	X		X				X[o]	X	
Sweden	X	X	X	X[b,c,e,*,#]					
Switzerland	X	X	X	X*		–	–	–	X
United Kingdom	X	X	X	X[#]		–	X[~]	X[~]	X[#]
United States	X	X	X	X[b,c,d,*,#]		X	X	X	X[b,c,d,*,#]

a. (Re) move the ship.

b. Access control.

c. Shelter dairies cows, and where possible protect feedstuffs stored outside, crops, etc.

d. Warning of the consumption of fresh harvested foodstuff.

e. *Advice for Finnish (the following is also applicable in Sweden) citizens in an affected country:* such as to follow advice from authorities in affected country, iodine prophylaxis, sheltering.

Advice for Finnish Embassy in an affected country: such as recommendations to Embassy personal as for private Finnish citizens, organise measures for Finnish citizens.

Advice for Finnish travellers to an affected country: such as cancelling travelling to affected country or parts of it, iodine prophylaxis.

Advice for travellers from affected country: such as counselling travellers, monitoring travellers, decontamination of travellers.

Advice concerning transport and trade with affected country: such as ban on food from affected country, recommending restrictions on trade with affected country, monitoring goods, foodstuffs and feeding stuffs from affected country, decontamination of goods.

f. Food and feeding stuffs control and eventually restrictions; and if relevant: skin decontamination; decontamination of goods, including cars; closing water intakes to drinking water reservoirs; closing green houses; forbidding irrigation; advice not to drink rainwater.

* Traffic control.

\# Food and feedstuff restrictions.

~ Only for Beyond Design Accidents (BDA).

o Sheltering in private homes.

Planning basis

For **Australia, Canada, Czech Republic, Finland, Germany, Hungary, Ireland, Japan** and **Norway**, the International Basic Safety Standard for protection against ionising radiation and for the safety of radiation sources (IAEA Safety Series No. 115) is the basis for the development of intervention levels for urgent countermeasures.

Australia also uses NHMRC Radiation Health Series No. 32.

In **Norway**, the Basic Safety Standard is part of the planning basis. In addition, the Nordic co-operation and harmonisation effort is important (e.g. "Nordic Intervention Criteria for Nuclear or Radiological Emergencies – Recommendations")

The intervention level for iodine prophylaxis in **Finland** is based on WHO 1999 guidelines for Prophylaxis following Nuclear Accident. Information regarding intervention levels for other countermeasures were not mentioned.

Several sources of input form the planning basis in **Sweden**. The Nordic harmonisation efforts are of great importance, e.g. "Nordic Intervention Criteria for Nuclear or Radiological Emergencies – Recommendations." Intervention levels for iodine prophylaxis are based on WHO 1999 guidelines.

In the **United Kingdom**, NRPB has a statutory duty to recommend intervention levels. However, in developing its advice, NRPB takes account of international guidance. **Luxembourg,** too, uses the philosophy of the NRPB documents, Volume 8 No. 1, 1997, Application of emergency reference level of dose in emergency planning and response, for the development of their intervention levels.

Switzerland and **Germany** use ICRP publication 63 as planning basis. As a member of the European Union **Germany** and **The Netherlands**, like other EU Member Countries, adopted the maximum levels for contamination of foods and animal feeds laid down by the EU.

The Netherlands had as a planning basis several international standards and recommendations, but divers somewhat from those.

The **United States** bases its intervention levels on a variety of different sources of information and recommendations. These include reports from the National Council on Radiation Protection and Measurements, the International Commission on Radiological Protection, the International Atomic Energy Agency and the World Health Organization. In addition, there are numerous Federal reports and studies that provide a substantial basis for the United States' intervention levels.

3. IMPLEMENTATION OF SHORT-TERM COUNTERMEASURES: EMERGENCY PLAN

In connection with the emergency plan, member states were asked to give information on:

- national organisations involved in the development of general guidelines for the implementation of the emergency plan and the development of procedures for the implementation of short-term countermeasures;
- factors considered in developing emergency plan guidelines (general rules);
- public consultations before establishing countermeasure guidelines, if any;
- what is considered necessary and sufficient to justify the implementation of short-term countermeasures;
- physical zones that are pre-established for the purpose of countermeasure implementation and the reasons for the sizes of these zones; and
- whether phased implementation of countermeasures is considered in emergency plans.

National organisations involved in the development of general guidelines and the development of procedures for the implementation of short-term countermeasures

Australia

Emergency Management Australia and ARPANSA provide guidance. State emergency services develop plans for nuclear powered warship visits. ANSTO develops plans for emergencies at the research reactor site.

Canada

The provincial emergency measures organisations and, at the federal level, Health Canada develop the general guidelines for the implementation of emergency plans. The provincial emergency measures organisations also develop procedures for implementation. There are no procedures for sheltering, evacuation and stable iodine at the federal level. Concerning food restrictions, procedures are developed by Health Canada and the Canadian Food Inspection Agency.

Czech Republic

General guidelines for an on-site plan were developed by SUJB through its regulation Nos. 184/1997 Coll. and 219/1997 Coll. The Ministry of Interior developed general guidelines through its regulation No. 25/2000 Coll. for an off-site plan.

The nuclear power plant and Regional (District) Offices developed procedures for implementing sheltering and stable iodine. Regional (District) Offices developed procedures for evacuation and other short-term countermeasures.

Finland

The Act on Emergency Preparedness (1991), Act on Rescue Services (1999) and Decree on Rescue Services (1999) defines the basic obligation of Finnish authorities to plan for emergencies. The basic planning obligation for NPPs is also included in the Nuclear Energy Act and Decree (1988) and in the Council of State Decision General regulations for Emergency Response Arrangements at Nuclear power Plants (397/1991).

The guidance needed for application of the legislation is developed by the Ministry of the Interior in co-operation with STUK and other relevant counterparts for governmental, provincial and local authorities and by STUK for NPPs.

All authorities in Finland have a responsibility to develop procedures for their own administrative sector.

Germany

The general guidelines are laid out in the “Basic Recommendations for Disaster Response in Areas Surrounding Nuclear Facilities” which were endorsed by the Radiological Protection Commission (federal level) and approved by the Conference of Ministers of the Interior (Länder level) as well as the Länder Committee for Nuclear Energy – Executive Committee. The responsible organisations of the Länder, e.g. the county district magistrates or the district authorities, developed procedures for the implementation of short-term countermeasures.

Hungary

The general guidelines for the existing emergency plan were developed by the Ministry of Interior, Civil Protection, in collaboration with other ministries and national organisations. The emergency plan is currently under revision. Guidelines for the revision have been elaborated by the Hungarian Atomic Energy Authority, in co-operation with the newly-formed Directorate General for National Emergency Management (which belongs to the Ministry of Interior) – based on the IAEA guidelines. The Ministry for Interior, the Directorate General for National Emergency Management, the Ministry for Public Health and the Hungarian Atomic Energy Authority developed procedures for the implementation of countermeasures, in co-operation with other sectoral organisations, which play a role in emergency preparedness.

Ireland

The National Competent Authority (RPII) developed the general guidelines in consultation with the Department of Public Enterprise, the government department responsible for the Emergency Plan. The views of other Government departments and national agencies were sought and incorporated into the final document.

Each organisation with responsibilities under the National Emergency Plan for Nuclear Accidents is required to have written procedures for carrying out its responsibilities under the Plan.

Japan

General guidelines entitled “Nuclear Disaster Prevention Guidelines” were developed by the Nuclear Safety Commission. Procedures for the implementation of short-term countermeasures are provided in the Law for Nuclear Emergency Preparedness and the Basic Plan for Emergency Preparedness, which is developed by the Central Emergency Preparedness Council headed by the Prime Minister.

Luxembourg

The Radiation Protection Department (Ministry of Health) and the Civil Defence Organisation (Ministry of Interior) developed general guidelines for the implementation of the emergency plan as well as procedures for the implementation of short-term countermeasures

The Netherlands

The Ministry of the Environment in consultation with all other relevant Ministries developed the general guidelines for the emergency plans. Procedures for the implementation of short-term countermeasures are provided in the Nuclear Energy Law and in the Plan for Emergency Preparedness (NPK). These were developed by the same organisations.

Norway

The Norwegian Radiation Protection Agency (NRPA) developed, on behalf of the Crisis Committee, the general guidelines for the emergency plans. The members of the Crisis Committee (NRPA, Police, Civil Defence, Health Authorities, Food Control Authorities, and Defence) provide procedures for the implementation of short-term countermeasures.

Sweden

The Rescue Services Act, the Decree on Rescue Services and the Decree with instruction for the Swedish Radiation Protection Authority defines the basic obligations of Swedish authorities on local, regional and central level to plan for emergencies. Central authorities develop guidelines and provide regional and local authorities with expert advice, based on the actual – or expected – radiological situation. The implementation of short-term countermeasures is mainly performed by regional authorities.

Switzerland

The Federal Commission on NRBC protection developed the general guidelines for the implementation of the emergency plan in close collaboration with NEOC, HSK and federal agencies responsible for emergencies at federal and local level. This Commission, with its working groups, develops procedures for the implementation of short-term countermeasures. Local authorities are supported by HSK.

United Kingdom

In the United Kingdom, the HM Nuclear Installations Inspectorate and the Home Office (Government Department) developed general guidelines for the implementation of the emergency plan. Procedures for the implementation of short-term countermeasures are developed by the independent government advisor, the National Radiological Protection Board (NRPB).

United States

In the United States, the development of intervention measures is generally accomplished through the Federal Radiological Preparedness Co-ordinating Committee (FRPCC). The FRPCC is comprised of 17 Federal departments and agencies with responsibilities for preparing and responding to nuclear or radiological emergencies. The primary agencies involved in developing intervention measures include the Environmental Protection Agency, the Department of Agriculture, the Food and Drug Administration (Department of Health and Human Services), the Nuclear Regulatory Commission, the Department of Energy and the Department of Defense.

Factors considered in developing emergency plan guidelines

In developing emergency plan guidelines and procedures, the responsible organisations consider a variety of factors. Table 3 summarises the factors considered by the countries. The most important factor for all countries seems to be the time necessary to implement countermeasures, followed by public health risk, the shielding qualities of average houses and public trauma.

Table 3. Considerations for emergency plan guidelines

	Countries														
Factors	Australia	Canada	Czech Republic	Finland	Germany	Hungary	Ireland	Japan	Luxembourg	Netherlands	Norway	Sweden	Switzerland	United Kingdom	United States
Public health risk	X	X	X	X	X	X	X	X	X	X	X	X	X		X
Time necessary for the implementation	X	X	X	X[b]	X	X	X	X	X	X	X	X	X	X	X
Shielding qualities of average house	X	X	X		X	X		X	X	X	X	X	X	X	X
Availability of basement and shelters			X		X			X	X	X	X		X		
Transportation availability			X		X			X	X	X	X	X	X	X	
Public trauma		X	X			X	X	X	X	X	X	X	X	X	X
Night or day			X		X			X	X	X	X		X		
Nuclear power plant near a border			X		X	X			X		X	X	X		
Costs		X	X			X		X	X		X	X	–	X	X
Counter-measure applied to entire population		X	X		X	X	X	X	X	X[c]	X		X		
Other					X[a]					X[d]		X[a]	–		

a. Weather conditions.

b. Only for evacuation.

c. Stable Iodine and Sheltering could be only for children. In the case of Evacuation, if there is not enough time and/or transport facilities pregnant women and children first.

d. Weather conditions and Number of people involved.

In general, there is no public consultation before establishing countermeasure guidelines, except in the **Czech Republic**, **Japan** and the **United Kingdom**. In **Switzerland** local authorities are consulted before implementing the guidelines.

In **Australia**, revised recommendations on intervention will undergo a period of public consultation. Some state plans are publicly available. In **Finland**, according to the Act on Rescue Services, the public has to be informed about plans and given an opportunity to comment.

In **Canada** studies on how the population accept risks are taken into account at local level when establishing countermeasure guidelines.

In **the Netherlands** the Parliament was consulted for the Plan for Emergency Preparedness and for the Law all official steps to adopt a Law are taken including the pre-publication of the Law and the possibility for the population to make comments and complaints.

Information or criteria to justify the implementation of short-term countermeasures

The implementation of the countermeasure stable iodine is in **Australia** based on the measured concentration of the radionuclide Iodine-131 in the atmosphere.

In **Canada**, the implementation of a countermeasure will be justified with an estimated averted dose greater than the intervention level, the time of release, and the ability of a safe implementation of the countermeasure. This includes, e.g. weather conditions and availability of transportation, but does not take into account the costs to implement the measure.

In the **Czech Republic**, the safety status of and the radiation situation in the nuclear power plant together with radiation monitoring results on site and in the vicinity, are considered necessary and sufficient to justify the implementation of short-term countermeasures.

In **Finland** and also in **Sweden**, the implementation of an evacuation of the inner part of the emergency planning zone (0-5 km) (0-15 km for Sweden) will be based on the plant situation and the risk of release. Other countermeasures (sheltering indoors, iodine prophylaxis, access control etc) in other parts of the emergency planning zone (5-20 km) (15-50 km in Sweden) or outside these zones will be decided according to the projected or actual radiation situation.

For **Germany,** the following information is required to justify the implementation of short-term countermeasures:

- current plant status and prediction of its development;
- dose (based on predictions and, to the extent possible, on measurements);
- release and environmental situation and
- meteorological situation.

In **Hungary** the decision on the implementation is based on the following information:

- evaluation of on-line data from the Hungarian nuclear power plant (in case of an accident therein);
- meteorological data;
- plume dispersion calculations;
- dose projections with recommended countermeasures;
- measured radiological data from the monitoring network.

In **Ireland,** an official notification of a potential/actual radioactive release to the environment, which could have radiological impact on the country, justifies the implementation of short-term countermeasures.

In **Japan**, the projected dose, the averted dose by protective measures, the timing of the release of radioactive materials or radiation to the environment, the economic costs accompanying the protective measures, the social disruption due the protective measures and the individual anxiety and disruption caused by the protective measures are considered while justifying the implementation of short-term countermeasures.

For **Luxembourg** the prognostics and diagnostics concerning the accident scenario (e.g. loss of safety barriers), the predicted source term, environmental measurements and advice of neighbouring states are elements for justifying the implementation of short-term countermeasures.

In **the Netherlands** the implementation of a countermeasure will be justified with a calculated projected dose greater than the intervention level, taking into account the estimated averted dose. Moreover, the abnormal or potentially abnormal plant condition and the time before release, and the ability of a safe implementation of the countermeasure are off importance. This includes, e.g. weather conditions and availability of transportation, but does not take into account the costs to implement the measure. Furthermore, psychological criteria may be considered in the decision process and political pressure could play a part.

As a basis the projected dose in stead of the averted dose is used because the estimation of the averted is full of wild guesses. However, the guessed averted dose is taking into account and should not be too low.

In **Norway**, prognoses and assessments of the avertable dose are considered necessary and sufficient to justify the implementation of short-term countermeasures.

In **Switzerland,** the potential threat caused by the emergency at the facility justifies the implementation of short-term countermeasures. Furthermore, psychological criteria may be considered in the decision process.

In the **United Kingdom,** abnormal or potentially abnormal plant/process conditions are sufficient criteria for the activation of the countermeasure plan. Real or potential changes in on-site and environmental conditions are also considered. Plant prognosis, weather conditions and radiological field measurements are sufficient information to justify the implementation of short-term countermeasures.

In the **United States**, abnormal or potentially abnormal plant conditions are sufficient criteria for the implementation of emergency response plans. Real or potential changes in on-site and off-site environmental conditions are also factored into the decision-making process. Degrading plant conditions, deteriorating weather and radiological field measurements are also sufficient to justify the implementation of short-term countermeasures.

Pre-established physical zones for the purpose of countermeasure implementation

Around nuclear installations, planning zones for the implementation of countermeasures are pre-established.

The planning zone for evacuation is, in general, in the order of 10 km around the nuclear installation, whereas in **Hungary** evacuation is considered up to 31 km around the nuclear power plant (see Table 4). The planning zones for sheltering and stable iodine are generally of the same size, and range from 10-20 km, larger than the evacuation zones. Choosing identical planning zones, indicates that sheltering and stable iodine are often implemented together. In **Hungary** the planning zone for sheltering may be extended up to 71 km.

In all cases, zone sizes are based on detailed analyses of possible accidents, their severity and consequences.

Table 4. Pre-established emergency planning zones

Country	**Zones**	**Reasons for the sizes**
Australia	*Zone 1:* 500 m pre-planned evacuation zone *Zone 2:* 2.2 km (dependant upon conditions) ANSTO exclusion zone – 1.6 km	Based on reference accident model used to assess the suitability of Australian ports for visits by nuclear powered warships
Canada	*Evacuation zone:* 7 km[1] *Sheltering zone:* 10 km *Iodine zone:* 10 km	Specific analysis made at the nuclear power plant Gentilly 2, to avoid deterministic effects for severe accidents and to reduce stochastic effects for design basis accidents
Czech Republic	*NPP Dukovany:* 10 km evacuation zone 20 km sheltering and stable iodine zone *NPP Temelin:* 5 km evacuation zone 13 km sheltering and stable iodine zone	Detailed analyses of possible sequences of severe accidents submitted by NPP
Finland	*Protective zone:* 5 km distance from the facility *Emergency planning zone:* Extending to about 20 km from the facility	Detailed analyses of consequences of severe accidents. The size of areas may differ in actual emergency situation due to, e.g. weather conditions
Germany	*Central Zone:* Surrounds the nuclear facility in a 2 km radius. *Intermediate Zone:* A circle with a radius of up to about 10 km around the NPP *Outer Zone:* A circle with a radius of up to about 25 km around the NPP	The size of the zones were chosen in the early years of commercial use of nuclear energy and later backed up by the German Risk Study Phase A.
Hungary	31 km sheltering zone where evacuation can be considered, 71 km where sheltering can be considered (for NPP)[2]	International practice and recommendations as well as practical considerations (ALARA principle, actual density of population)
Ireland		
Japan	8-10 km sheltering zone including evacuation zone (for nuclear power plants)	Potential release of radioactive material for an hypothetical accident postulated in nuclear safety review Furthermore past accidents (Tokaimura, TMI) were studied

1. Under revision. New proposal: 8 km for all three zones.
2. Currently under revision. In the revision the zones are proposed in conformity with the IAEA recommendations: PAZ (Precautionary action zone): 3 km; UPZ (Urgent protective action planning zone): 24 km; LPZ (Long-term protective action planning zone): 80 km.

<table>
<tr><td>Luxembourg</td><td colspan="3">Up to 25 km zone for iodine prophylaxis; for evacuation and sheltering case by case decision</td><td>Potential thyroid doses to infants and children</td></tr>
<tr><td rowspan="10">Netherlands</td><td colspan="3">Radius Implementation zone around the NPP:</td><td rowspan="10">Implementation zone: Zone asking for pre-established co-operation between local authorities in the area. Emergency preparedness in detail in these zones

Countermeasure zone: Based on the km where the countermeasure should be applied taking into account a PWR5 accident and the highest intervention levels</td></tr>
<tr><td><100 MWe:
5 km</td><td>100-500 MWe:
10 km</td><td>>500 MWe:
15 km</td></tr>
<tr><td colspan="3">Radius Countermeasure zones for the respective MWe, distance from the NPP:</td></tr>
<tr><td colspan="3">Evacuation</td></tr>
<tr><td>0</td><td>5</td><td>5</td></tr>
<tr><td colspan="3">Iodine prophylaxis</td></tr>
<tr><td>4</td><td>10</td><td>15</td></tr>
<tr><td colspan="3">Sheltering</td></tr>
<tr><td>7</td><td>20</td><td>30</td></tr>
<tr><td colspan="3">In a segment depending on the wind direction. For evacuation >100 MWe always also in a circle with 2 km radius</td></tr>
<tr><td>Norway</td><td colspan="3">For two research reactors, zones are being established according to the draft IAEA Safety Series on emergency planning and response</td><td>Local adjustments will be made, both geographical and related to the foreseen accident scenarios at the two reactors (depending on design)</td></tr>
<tr><td>Sweden</td><td colspan="3">Inner emergency zone: Up to 12-15 km in radius around the NPP

Indication zone: Up to approximately 50 km in radius around the NPP</td><td>Analyses of consequences of severe accidents. The size and the shape of the areas in which protective actions will be taken may differ in an actual emergency situation due to, e.g. weather conditions. The zones may also be divided into sectors</td></tr>
<tr><td>Switzerland</td><td colspan="3">Zone 1: Approximately 4 km in radius around the NPP (= sheltering zone)

Zone 2: Approximately 20 km in radius (= sheltering zone)</td><td>Zone 1: Possibility of deterministic effects for unprotected people.

Zone 2: Possibility of high doses, but below deterministic effects for unprotected people</td></tr>
<tr><td>United Kingdom</td><td colspan="3">1-3 km</td><td>Plant safety case and fault analyses</td></tr>
<tr><td>United States</td><td colspan="3">Inhalation Pathway Zone – 16 km

Ingestion Pathway Zone – 80 km</td><td>Potential for release of radioactive material for a hypothetical accident postulated in nuclear safety review</td></tr>
</table>

Phased implementation of countermeasures

Phased implementation of countermeasures is not foreseen in the emergency plan of **Canada** and **Norway**.

In **Australia,** and **Luxembourg** countermeasures are first implemented in the area close to the emergency followed by areas farther away.

In **Germany** and **Finland**, a phased implementation of countermeasures is foreseen, viz., close area followed by further expansion of the restricted area, specific population followed by general population and children in schools followed by general population.

In **Japan**, the specific population will be followed by general population.

In **the Netherlands** for evacuation phased implementation is based on projected doses (so normally firstly in the area close to the emergency). For other countermeasures the same as for the UK, but if possible besides schools also pregnant women (and their children). The **Swiss** emergency plan foresees a time-scaled phased implementation of countermeasures, prioritising schools, factories, etc followed by the general population.

In **Sweden**, phased implementation is not laid out in detail in the emergency plans, but different time frames for different countermeasures are important and self-evident, both for practical and protective reasons. In the inner emergency zone (up to approximately 15 km), early actions will be initiated depending on the actual situation in the NPP – based on pre-made analyses of the possible impact on the general public. Such countermeasures could be e.g. evacuation, information about iodine prophylaxis and sheltering of dairy animals. Countermeasures farther away from the NPP could possibly await some analyses and prognoses. It is also of great importance to synchronise the efforts in order not to expose the public to danger by doing things in the "wrong order".

In the **United Kingdom**, criteria such as close areas followed by farther areas and schools followed by general population are considered in the actual decision, but are not laid down in the emergency plan.

In the **United States**, countermeasures are first implemented in the area close to the site of the emergency followed by areas further away. For example, in response to an emergency at a nuclear power plant the countermeasures are implemented in a 360 degree circle around the plant site out to a distance of 3.2 km and then in the downwind direction out to 8 or 16 km. The resulting area resembles a keyhole.

4. EVACUATION

The term evacuation characterises rapid clearance of an area, organised or at least assisted by emergency personnel. In general, the duration of an evacuation does not exceed a time span of two weeks. Depending on the contamination of the residential area, it might be necessary to further extend evacuation, which is called temporary relocation or resettlement.

Evacuation reaches the highest protection against external and internal exposure, if undertaken and fully implemented in the pre-release phase. In case, the full implementation of an evacuation could reach the release phase, the decision for implementing evacuation or sheltering will be based on the dose averted.

Compared to other countermeasures such as iodine prophylaxis and sheltering, evacuation will certainly have the highest psychological, social and economic impact, and the decision process for its implementation should adequately take these factors into account.

The BSS mentions a generic optimised intervention level for temporary evacuation of 50 mSv of avertable dose in a period of no more than 1 week.

Intervention level, dose, integration time, operational intervention criteria

An overview on various intervention levels, doses, integration time and operational intervention criteria used to initiate evacuation is given in Table 5.

Most countries use an estimated or anticipated effective dose of 30 to 500 mSv as intervention level for the implementation of an evacuation. The integration time is normally one week, with the exception of **Switzerland**, where the integration period is the first year following the accident.

Canada, **Hungary, Ireland, Norway** and **Sweden**[1] use an intervention level of 50 mSv averted dose integrated over one week. **Australia** uses the same intervention level but gives no integration time. The **Czech Republic** uses an averted dose of 100 mSv as intervention level. **United Kingdom** uses an intervention level range of 30-300 Sv doses averted by the countermeasure.

The **Netherlands** uses several intervention levels based on the time of release and also levels to avoid deterministic effects. Normally evacuation will take place after cloud passage or before the release if there is enough time to finish the evacuation before the cloud passage. When very high doses could be expected the evacuation will be implemented during the cloud passage (direct evacuation).

1. Swedish intervention levels are generic, i.e. they are used in the planning process – not for decision making in the acute situation.

Table 5. Summary of evacuation criteria

Country	Intervention level [mSv]	Dose	Integration time	Operational intervention level
Australia	50	Averted dose		
Canada	50	Averted dose	7 days	To be developed.
Czech Republic	50-500 100	Effective dose Averted dose	 7 days	1 mSv/h ambient dose rate in plume and from deposition
Finland	50	Averted dose	7 days	1000 microSv/h*
Germany	100	Effective dose	External exposure in 7 days and effective dose commitment due to radionuclides inhaled during this period	Given for the inventory released, the time-integrated air concentration, soil contamination, time-dependent ambient dose rate (see annex 4)
Hungary	50	Effective averted dose	7 days	1 mSv/h, 4 h plume transition
Ireland	50	Averted effective dose	7 days or less	
Japan	50 500	Estimated effective dose Estimated equivalent dose		
Luxembourg	30-300	Anticipated effective dose	7 days	
Netherlands	4 000 1 000 5 000 3 000 1 000	Lung dose RBM dose Thyroid dose Skin dose Effective dose	Estimated for the first day (ext. and internal doses without foodstuffs)	Evacuation under all circumstances, i.e. also during the cloud ("direct evacuation")
	50-500 1 500 2 000	Effective dose Thyroid dose Lung dose	Estimated for the 1rst day (ext. and int. doses, without foodstuffs)	Before or after cloud passage, NOT during ("first day evacuation")
	50-250	Effective dose	Estimated for the first year (ext. and int. doses)	Evacuation within 14 days ("late evacuation")
Norway	50	Averted dose	7 days	
Sweden	50	Averted dose	7 days	To be investigated.
Switzerland **	100-500	Effective dose	The first year following the accident	Dose-rate >500 mikroSv/h after 24 h
United Kingdom	30-300	Sum of committed effective dose and external whole body dose, averted by c/m		Varies with site/operator
United States	10-50	Projected TEDE***	4 days	

* Caused by the contamination after passage of the plume.
** Evacuation is in Switzerland not a short-term countermeasure (for the plume phase) but only considered in the later phase.
*** TEDE denotes total effective dose equivalent, the sum of external dose equivalent and committed effective dose equivalent.

Operational intervention levels (OILs) are mentioned by six countries. Four of them give explicit values. An operational intervention level of 1 mSv/h is used by the **Czech Republic**, **Finland** and **Hungary**, whereas **Germany** uses different operational intervention levels for different starting-points. A list is given in Annex 2. **Canada** is going to develop operational intervention criteria for evacuation. In **Australia** and **Sweden**, the OILs are currently under review.

Criteria for ending the countermeasure

Criteria for ending an evacuation are in **Finland** the radiation situation, the movement of the radioactive cloud, the averted doses, operational intervention criteria and the contamination. In **Hungary**, a dose of 10 mSv in a month would be the ending criteria for evacuation**.** Almost the same is valid for **Canada.** Here, if the dose averted is less than 10 mSv in a month, an evacuation will be ended.

In **the Netherlands**, the evacuation ends either when the treat for a release is gone or the release was much smaller than could be expected. The return can take place when de effective dose in the first 50 year after the return will be between 50-250 mSv, depending on social, psychological and economical factors.

Switzerland's criteria for ending the countermeasure is the dose rate. A dose-rate <5 mikroSv/h means no further restrictions. A dose-rate <500 mikroSv/h means no evacuation but living in the area with restrictions.

In **Sweden**, detailed mapping of the contamination, and if needed, also decontamination have to be performed prior to any decision about returning to evacuated areas. If the evacuation was initiated by a threat of release in the near future, the countermeasure can be ended as soon as the threat is no longer present.

In the **United Kingdom**, a countermeasure comes to an end when there is no further threat of release and when there is adequate monitoring in the countermeasure area.

In the **United States**, a countermeasure is usually terminated when the threat to public no longer exceeds the appropriate protective action guide. However, other factors, such as plant and weather conditions, may be taken into consideration when making the decision to terminate the countermeasure.

Factors taken into account at the time of a nuclear accident when deciding an evacuation

Main factors considered when deciding an evacuation are, as summarised in Table 6, the release in progress, the averted dose, time delay for the countermeasure and weather conditions, as well as the expected dose without protection and the psychological impact on the public.

The answers given are in agreement with those given in Table 3, Chapter 4.2. It is, however, surprising that, in Table 3, only two countries mention the importance of weather conditions, whereas here, where the weather conditions are a part of the factors mentioned, nearly all find them very important.

Table 6. Considerations for recommending evacuation

Factors	Australia	Canada	Czech Republic	Finland	Germany	Hungary	Ireland	Japan	Luxembourg	Netherlands	Norway	Sweden	Switzerland	United Kingdom	United States
Averted dose	X	X	X	X		X	X	X	X	(X)	X	X	(X)	X	X
Expected dose without protection	X	X	X	X	X		X	X	X	X		X	X		X
Operational intervention criteria			X	X	X	X	X		X	X			X		
Weather conditions	X	X	X	X	X	X		X	X	X		X	X	X	X
Time of day	X	(X)	X		X			X	X	X		X	X		X
Release in progress	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Time delay for the counter-measure		X	X	X	X	X	X	X	X	X	X	X	X	X	X
Level of preparedness of the population	X		X			X							X	X	
Media impact	X		X												
Psychological impact on the public	X	(X)	X		X		X	X	X	X	X	X	X		
Phased implementation or targeted populations			X	X				X	X	X	X	X			X
Other		X[a]								X[b]	X[c]				

a. Ability to safely implement the countermeasure (federal level), residual dose (provincial level).

b. Number of people involved.

c. Economic impact, number of people involved.

The most important factors for **Australia** are the averted dose and the expected dose without protection. For **Ireland**, the averted dose is the only important factor. For **Hungary,** the averted dose indicated by the operational intervention level would be the most important factor. For the **Czech Republic,** the averted dose and the release in progress are the most important ones. For Norway, the averted dose and the number of people affected are the most important factors when deciding whether or not to implement evacuation.

In **the Netherlands** the projected dose in stead of the averted dose is the most important because the estimation of the averted is full of wild guesses. However, the estimated averted dose is taken into account and should not be too low.

When deciding whether or not to implement evacuation, the public health risk is the most important factor in **Finland** and in **Sweden** while for **Canada, Germany** and **Luxembourg**, expected dose is the most important one. Another important factor for **Canada** is the ability to safely implement the countermeasure.

In the **United Kingdom**, an alignment of the factors mentioned above with the predetermined intervention options is important when deciding whether or not to implement a countermeasure.

From the factors considered above, the operational intervention criteria is most important in **Switzerland** when deciding on whether to implement an evacuation.

Experience with evacuation

For an actual or potential radiological emergency

Japan experienced an evacuation during a radiological emergency. The size of the evacuated population was about 150, and the affected area was within 350 m radius of the plant.

As a result of a non-radiological emergency

Australia experienced evacuation during Cyclone Tracy in 1974. About 40 000 persons evacuated from Darwin Flood. Bush fires require evacuation of local or regional areas on occasion. As a result of these, Emergency Management Australia was formed.

In **Canada,** the largest evacuation was of the City of Mississauga, Ontario (1979), due to a serious train derailment and threat of chlorine release. A multi-stage evacuation occurred as the order spread to an increasingly large area. The size of the evacuated population ultimately reached about 250 000. Other, smaller, evacuations for floods, forest fires and tornadoes.

The evacuation zone is normally restricted and the number of evacuees generally smaller than 1 000. In the Saguenay flood of 1996, 16 000 persons were evacuated from different zones. When there was black ice, in 1998, no evacuation was necessary, but 17 800 people went to emergency service stations.

In 1997, floods affected nearly a third of the area of the **Czech Republic**. At that time, all villages, some parts of towns, facilities, hospitals, schools and offices amounting to some ten thousand people were evacuated. An evacuation was also carried out when there was a threat of an oil-well explosion.

These experiences were used for the preparation of the EPZ external emergency plan of the NPP Temelin, and are currently used during the revision of the EPZ external emergency plan of the NPP Dukovany. They are also used for the development of external district emergency plans and plans for chemical facilities, for which serious accidents cannot be excluded.

On 5 November 1994, in Ludwigshafen **(Germany)**, an evacuation was necessary during the de-activation of two bombs from the second world war. For the first bomb 10 000 inhabitants and for the second bomb 15 000 inhabitants were evacuated, both within a radius of 1.8 km.

In **Hungary**, some 10 000 people in an area of 100 km^2 were evacuated. This experience was applied to the nuclear emergency planning and preparations.

In **Ireland**, a small population was evacuated due to local floods.

In **Japan**, volcanic eruption forced temporary evacuation of the whole population of the island of Izuoshima, Tokyo Prefecture, which amounts to about 9 500.

In 1995, the threat of floods from the so-called large rivers caused the evacuation of 210 000 people and about 50 000 animals (mostly cows and pigs) in an area of ca. 1 000 km2 in the centre of **the Netherlands**. This evacuation was performed very smoothly and only a few people refused to go. This mostly due to the great help of the media, who informed the public as good as possible without exaggeration or trivialising the situation, but showing on television and in the journals the situation (the high water threatening the dykes) from moment to moment. In the end, most dykes didn't break, but some did or were broken on purpose to relieve the other dykes.

During a fire at the Lillestrøm railway station, the centre of Lillestrøm (**Norway**) was evacuated (i.e. small society, order of magnitude: 1 000 persons). Evacuation has been implemented also in connection with avalanches (small number of people affected).

In 1991, a railway accident occurred in Säckingen (**Switzerland**), where several wagons loaded with fuel caught fire. About 200 people around the accident site had to be evacuated. In 1994, another railway accident during transportation of fuel occurred in Affoltern, near Zürich. In this case 120 persons had to be evacuated. After an accident involving hazardous chemicals in the main railway station area in Lausanne in 1994, an evacuation was ordered for the area around the accident site. About 1 000 people were affected. However, this evacuation took place after the accident, as a precautionary measure, during the removal of the damaged wagons and the recovering of the hazardous material. The time for evacuation was not critical and the evacuation was performed without any problems. Parts of this non-nuclear experience, especially in the field of communication, was applied to the Swiss nuclear emergency planning.

A bomb incident at Aintree Racecourse, in the **United Kingdom**, led to the evacuation of 80 000 people from an area of 1.1 km^2. The autumn 2 000 floods caused the evacuation of 11 000 people from numerous locations throughout England and Wales. A major gas leak occurred in the Tower Hamlets, London. Approximately 200 people were evacuated from residential tower block and an Evacuee/Rest Centre was opened; but only 30 evacuees were received as the majority chose to stay with family or friends during the emergency. Lessons learned from these events: the information was used to improve local emergency plans and to assist with the preparation of a guidance document on mass evacuation. The experiences were not applied to the nuclear emergency planning and preparations.

The **United States** has experienced numerous evacuations in response to hurricanes, floods, and accidents involving the release or potential release of hazardous materials. The number of people evacuated range from a few dozen to tens of thousands depending on the size of the hurricane, the amount of flooding expected, or the quantity and type of hazardous material involved in the accident.

Real evacuation as part of an exercise

The port area in Queensland (**Australia**) was evacuated during an exercise. Problems with communications and responsibilities were identified.

Federal organisations in **Canada** suggested the implementation of a real evacuation as part of provincial exercises, but the provincial organisations in Québec rejected the idea.

In the **Czech Republic**, evacuation was exercised in practice during the verification of the emergency plans in areas potentially or actually affected by radiological, chemical or natural emergencies and accidents. Knowledge and experience from these exercises were used to improve the activities of decision makers and exercise participants.

Japan carried out evacuation exercises. People living within a few kilometres radius around a nuclear power plant moved to a gathering spot, from where they were transported by public buses provided by the local government to a safe area. The evacuation was successfully conducted according to the exercise scenario.

Sweden has carried out evacuations during nuclear emergency exercises at several occasions. The lessons learned have been implemented into current emergency plans.

The **United Kingdom** carried out a real evacuation during an exercise. No details are given in the questionnaire.

Practical aspects

In **Australia**, an evacuation will be implemented, as a planned operation, only after nuclear release and contamination, based on measured level of release. Response specifies individual cars with police/state emergency service assistance to others. For children and nursing homes there will be special considerations.

In **Finland**, precautionary evacuation would be carried out only in the vicinities of domestic NPPs. The decision is based on plant conditions and the time available for the evacuation. People living in the protective zone, extending to a five kilometres distance from the facility, are planned to be evacuated before a release. In the case where release starts very rapidly, inhabitants would shelter indoors until the release ends. Outside the protective zone, evacuation will be based on the actual contamination level and only implemented after nuclear release and contamination. Evacuation is executed as a planned operation by organised transport and by individual cars. In the Archipelago, the evacuation is executed by organised transport (coast guard) or by individual boats in a protective zone of 5 km distance from the NPP.

As no nuclear power plant exists in **Ireland**, and the nearest one is 100 km across the Irish Sea, it is not envisaged that a situation requiring evacuation would result from an accident at a nuclear power plant. A situation could arise where small-scale, temporary, evacuation may be required due to a radiological accident other than a nuclear power plant abroad.

In **Canada,** the **Czech Republic**, **Germany**, **Hungary**, **Luxembourg**, **Japan, the Netherlands** and the **United Kingdom,** an evacuation will be done as a planned operation before or after a release. Evacuation will be carried out as a planned operation by organised transport or by individual cars. However, it is also seen as a spontaneous reaction of the population in some countries; for example **Hungary, the Netherlands** or **Switzerland**. In **The Netherlands** and the **United Kingdom**, field measurements are used to select between an evacuation and sheltering. No differences are made for different groups within the population, except in **Finland**, where this may be necessary after the passage of a radioactive plume when decontamination and other recovery operations are underway.

Evacuation in **the Netherlands** is foreseen either before or after release and contamination. During the plume phase, evacuation is only foreseen if deterministic effects could occur.

In **Norway**, evacuation is an initial countermeasure foreseen either before or after release or contamination. Evacuation will be implemented as a planned operation using organised transport and individual cars. Special considerations in the implementation of the countermeasure will be given to certain groups within the population, e.g. children in kindergartens close to the research reactors.

In **Sweden**, people living in the inner emergency zone may be evacuated as a preventive action in case of a threat of release. The decision must be based on plant conditions and the time available for the evacuation. It is not obvious that people in the direct vicinity – up to a few kilometres – of a NPP should be advised to shelter even if there is an ongoing release. A rapid evacuation by e.g. private cars could be advantageous even if the decontamination problem has to be taken into account. Outside the inner zone, evacuation will be based on predictions of the contamination, taking e.g. weather conditions into account, or the actual contamination level. The authorities will focus their efforts on actively helping people who are unable to leave the area by themselves, and on supporting activities that helps the rest of the public to evacuate by e.g. private cars. In this context, correct and timely informing the public is of vital importance.

Evacuation in **Switzerland** is only foreseen after release, as in **Switzerland**, enough shelters are available to protect every citizen, at least in the area around the nuclear power plants. The duration of an evacuation can be several weeks to three months.

In the **United Kingdom**, it is considered not practicable to alert a particular population group without alerting the others. It is wise to include all members of a community in emergency plans, accepting that the implementation of a countermeasure may not be optimum for some members, rather than deliberately excluding some members because of their location or age. However, where certain population groups which are likely to be more at risk can be readily contacted (e.g. schools), priority can be given to informing such groups about the implementation of a countermeasure.

In the **United States**, evacuation is a planned countermeasure for protection of the public in the vicinity of most, if not all, nuclear facilities. Evacuation is also considered for emergencies involving other radioactive sources, depending on the projected dose to a member of the general public and other emergency conditions. In the case of nuclear facilities, the decision to evacuate is normally based on whether or not plant conditions are stable or deteriorating, the number of engineered safety features that are still functioning, the time available for evacuation and other factors that may have an impact on the effectiveness of the evacuation as a countermeasure. In the event the release starts very rapidly, inhabitants may be directed to shelter indoors until directed to evacuate. Although state and local officials have developed evacuation plans for the populations surrounding nuclear facilities, there is concern that the public will react to the emergency by spontaneously evacuating the area using their own vehicles. Depending on the magnitude of such an evacuation, this could result in increased traffic congestion and reduce the effectiveness of the evacuation in reducing individual exposures.

5. SHELTERING

A simple protective measure for mitigating the impact of a passing radioactive cloud is to advise people to stay indoors, preferably in cellars and closed rooms. In order to be informed about the development of the situation, people are asked to listen to the radio or other media. This counter-measure may be combined with the intake of iodine tablets.

Staying indoors will reduce the whole-body dose due to external gamma radiation. A substantial reduction of the inhalation dose can be achieved by closing windows, outer doors, and ventilation systems. The shielding from external radiation depends strongly on the type of building, the building material and the surrounding buildings.

Long-term sheltering, however, may cause social, medical and hygiene problems, except in specially designed facilities. For a sheltering period of 24 hours or longer, food and medical care for shelter occupants has to be considered.

According to the BSS, the generic optimised intervention level for sheltering is 10 mSv of avertable dose in a period of no more than 2 days.

Intervention level, dose, integration time, operational intervention criteria

Variation in intervention levels used for sheltering is smaller than for other countermeasures (see Table 7).

Australia, the **Czech Republic**, **Hungary, Ireland**, **Norway** and **Sweden** use an intervention level of 10 mSv averted dose with an integration time of one or two days. **Australia** gives no integration time. **Canada** uses 5 mSv averted dose in 1 day. In the United Kingdom, the intervention is based on a range of 3-30 mSv of committed effective dose and external whole body dose averted by the countermeasure.

Intervention levels based on effective dose range from 3-50 mSv, using integration times from 2 days to one week.

As an exemption, **Switzerland** differentiates between staying indoors based on an intervention level of 1-10 mSv effective dose in the plume phase and staying in cellars based on an intervention level of 10-100 mSv effective dose. The reason is that nearly every house in Switzerland is equipped with a shelter.

Another exemption is the **Netherlands**: sheltering means staying indoors, doors and windows closed. An integration time of only 6 hours is taken, because after that time the concentration indoors will be higher than outdoors. The level is between 5 and 50 mSv effective dose. It is foreseen that, if relevant, it will be announced that the sheltering is only necessary for children.

Operational intervention levels were introduced in six countries. The **Czech Republic**, **Finland** and **Hungary** use an ambient dose rate varying from 0.1 mSv/h to 1 mSv/h. A list of varying operational intervention levels exist in **Germany** (see Annex 3).

Canada developed operational intervention criteria for sheltering, in **Australia** these criteria are currently under review.

Table 7. Summary of sheltering criteria

Country	Intervention level [mSv]	Dose	Integration time	Operational intervention level
Australia	10	Averted dose		
Canada	5	Averted dose	1 day	To be developed
Czech Republic	5-50 10	Effective dose Averted dose	2 days	1 mSv/h ambient dose rate in plume and ambient dose rate from deposition
Finland	10	Averted dose	2 days	100 microSv/h
Germany	10	Effective dose	External exposure in 7 days and effective dose commitment due to radionuclides inhaled during this period	They exist for the released activity in the surrounding area, the released activity in the remote area, the time-integrated air concentration, and soil contamination (see Annex 5)
Hungary	10	Effective averted dose	In 2 days	0.2 mSv/h, 4 h plume transition
Ireland	10	Averted effective dose	In 2 days or less	
Japan	10-50 100-500	Estimated effective dose Estimated equivalent dose		
Luxembourg	3-25	Anticipated effective dose	7 days	
Netherlands	5-50	Estimated effective. dose	6 hours	Probably, the level of action will always be around the 5 mSv
Norway	10	Averted dose	2 days	
Sweden	10	Averted dose	2 days	
Switzerland	1-10 (staying indoors) 10-100 (staying in cellars)	Effective dose	Dose from the plume	Source term estimation from dose-rate inside the containment
United Kingdom	3-30	Sum of committed effective dose & external whole body dose, averted by c/m		Varies with site/operator
United States	10-50 (100 for special groups)	Projected TEDE*	4 days	

* TEDE denotes total effective dose equivalent, the sum of external dose equivalent and committed effective dose equivalent.

Criteria for ending the countermeasure

In **Canada,** sheltering ends when the dose is less than 5 mSv in one day. Sheltering of up to 1-2 days would be the maximum. In **Switzerland,** the decision to end sheltering is based on the dose rate, however no explicit value is given. In **Hungary** and **Sweden**, time is a criterion for ending sheltering, ending latest after two days. In **Finland,** the radiation situation, movement of the radioactive cloud, averted doses, operational intervention criteria and contamination, are criteria for ending sheltering. In the **Netherlands**, it will be advised to open doors and windows after about 6 hours if not the cloud is still passing and the concentration outdoors is higher than indoors.

Factors taken into account at the time of a nuclear accident when deciding sheltering

The main factors taken into account (see Table 8) are the same as for evacuation: release in progress, the averted dose, the expected dose without protection, weather conditions and the time delay for the countermeasure. Contrary to evacuation, the level of preparedness of the population plays a minor role in the case of sheltering.

Table 8. Considerations for recommending sheltering

	Countries														
Factors	Australia	Canada	Czech Republic	Finland	Germany	Hungary	Ireland	Japan	Luxembourg	Netherlands	Norway	Sweden	Switzerland	United Kingdom	United States
Averted dose	X	X	X	X		X	X	X	X	(X)	X	X	(X)	X	X
Expected dose without protection	X	X	X	X	X		X	X	X	X		X	X		X
Operational intervention criteria			X	X	X	X	X		X				X		
Weather conditions	X	X		X	X			X	X	X	X		X	X	X
Time of day		(X)			X		X	X	X	X	X				X
Release in progress	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Time delay for the counter-measure	X	X	X	X		X		X	X	X	X	X		X	X
Level of preparedness of the population			X												
Media impact	X		X												
Psychological impact on the public	X	(X)	X				X	X	X	X	X		X		
Phased implementation or targeted populations			X	X	X			X	X	X	X		–		X
Other		X[a]									X[b]		–		

a. Ability to safely implement the countermeasure (federal level), residual dose (provincial level).

b. Economic impact, number of people, time of year.

For **Switzerland,** the operational intervention criteria are the most important factors when deciding whether or not to implement sheltering. For **Hungary**, the averted dose (indicated by the operational intervention level when measured) is the most important criteria for the implementation of sheltering. For **Canada, the Netherlands** and **Germany,** the expected dose without protection is most important. For **Canada,** the ability to safely implement the countermeasure is also an important criterion. In **the Netherlands**, sheltering for children and adults is advised at different dose levels to allow adults to go outdoors for work and for food supply. Public health risk is considered most important for **Finland**. For the **Czech Republic**, the expected dose in EPZ and the averted dose are the important criteria. For **Norway**, the averted dose together with the time of the day and the year are the most important factors. In **Sweden**, the public health risk is the most important factor, and consequently the averted dose together with the expected dose without protection is most important.

Experience with sheltering

For an actual or potential radiological emergency

Japan sheltered about 310 000 people within 10 km radius of the plant during a radiological emergency.

The **United Kingdom** experienced sheltering for an actual or potential radiological emergency. No detailed information was given in the questionnaire.

Sheltering, in the **United States** is the usual advice in the event of a chemical spill or threat. Sheltering usually requires that people stay indoors, close windows and doors, stay tuned to the radio or television for further instructions, etc.

As a result of a non-radiological emergency

Several thousands, affected by a petrochemical release, were sheltered in Melbourne City, **Australia**. As a result of this, EMA (Emergency Management Australia) was built.

A sheltering order was given in Laval, Quebec, **Canada** in response to a fire at a paint manufacturer's in which paint drums exploded and paint particles were dispersed **to the environment**. "Stay-in" advice (a form of sheltering) has been given for asthmatics and elderly people in some cities during periods with high pollution.

Some small chemical accidents occurred in the **Czech Republic**. The population of the affected area, of ten to hundred meters, was warned in time and sheltered. This experience was applied namely for warning systems and notifying the public.

In **Finland**, only very limited areas have been sheltered. In **Germany**, only local areas around chemical installations experienced sheltering. In **Ireland**, a small population near the accident site was sheltered.

In **the Netherlands**, there is many experience on a limited scale: e.g. some streets or one quarter of a city, in cases that toxic materials are released due to fire or otherwise. During the passage of the plume a dose reduction of 3 and after the plume (with doors and windows open) a reduction of 90% is assumed.

Norway has sheltering experiences in connection with storms and risk of avalanches in the northwestern part of Norway.

In the areas around the chemical industry in **Switzerland** the alarm signal is occasionally sounded. This means that the population has to stay indoors and listen to the radio. Normally only a couple of blocks around the concerned facility are affected, i.e. several hundred to a couple of thousand people. But this experience was not applied to the nuclear emergency planning.

Sheltering, in the **United Kingdom** is the usual advice in the event of a chemical spill or threat; this requires that the people stay indoors and close windows and doors, etc.

In **Sweden**, limited areas have been sheltered in the event of big fires, accidents at chemical plants or other chemical spill outs.

Real sheltering as part of an exercise

In the **Czech Republic,** sheltering is exercised to verify the emergency plans both internal and external). Experiences are used to improve the activities of decision makers and exercise participants.

Real sheltering was tested in **Finland** during two exercises, where people stayed in civil defence shelters for 3 days.

In **Japan** sheltering was implemented within several kilometres of the outer area of an evacuation zone for the people around a nuclear power plant. It was conducted successfully according to the exercise scenario.

Sheltering as an initial countermeasure

For almost all countries, sheltering is implemented as the initial countermeasure, as it is easy communicate and to implement. During sheltering, population can easily be located in case of the additional implementation of iodine prophylaxis.

In Arpansa and Tasmania, **Australia**, sheltering is used as an initial countermeasure, but in Queensland and Northern Territory this is not possible as housing is not suitable for providing adequate radiological shelters.

In **Ireland**, due to the distance from the nearest nuclear power plant, sheltering would be the most likely countermeasure to be implemented in the event of an atmospheric release.

In **Luxembourg**, as a non-nuclear country, evacuation of the population is considered rather improbable. For this reason, sheltering and the distribution of KI tablets are seen as the more likely option.

In **the Netherlands**, sheltering will be the countermeasure **of first choice**, unless the doses justify evacuation. Even so, for iodine prophlaxis, the doses are calculated assuming sheltering, **so** three times lower doses during the sheltering time.

As **Norway** has no nuclear power reactors, sheltering will be the initial countermeasure in case of a far-field accident.

In **Switzerland**, almost all houses have shelters with a high shielding factor. Sheltering is, in general, combined with KI administration as initial countermeasure.

Countermeasures accompanying or following sheltering

In most cases, sheltering is combined with the donation of stable iodine tablets.

In **Finland**, sheltering is combined with intake of stable iodine, access control and protection of livestock production. If the radiological situation would require sheltering for more than one or two days, people will be evacuated.

Application for different groups within the population

Sheltering is always applicable for the entire population living in the affected area.

In **Finland**, there is a recommendation, especially for children, to avoid going outdoors as a "lighter" countermeasure.

Criteria used when selecting between sheltering and evacuation

The averted dose, projected dose, and ability to carry out the countermeasure safely (taking into consideration weather, release time, etc) are the criteria when deciding between sheltering and evacuation in **Canada**. Sheltering will be the preferred option as long as it is uncertain whether intervention levels as given in the "Plan des mesures d'urgence nucléaire externe à la centrale nucléaire Gentilly 2" will be reached, if there is not sufficient time to evacuate all potentially affected people, or if weather conditions are atrocious (snow storm, black ice, etc) making evacuation dangerous.

In the **Czech Republic**, the actual safety status of the NPP, actual meteorological conditions, time and the dose in case of venting are criteria for the deciding between sheltering and evacuation.

In **Finland**, criteria are based on the threat analysis made by STUK. Sheltering is an appropriate measure outside the planning zone; evacuation will be carried out in the area five-kilometres around the facility. Apart from the situation on-site, the decisions will be based on weather conditions and the time of release.

The decision between sheltering and evacuation will, in **Germany**, be based on the projected dose if no countermeasure is implemented and the time necessary to implement the countermeasure.

In **Hungary**, the decision between sheltering and evacuation is in theory based on the averted dose, but will in practice be taken on the basis of operational intervention levels, e.g. measured dose rates.

The averted dose, feasibility and hardship imposed are criteria used in **Ireland** when selecting between the two countermeasures.

In **Japan**, the decision between sheltering and evacuation depends on intervention levels only.

In **Luxembourg**, the predicted dose, weather conditions, time of day, as well as the release in progress, are criteria when selecting between sheltering and evacuation.

In **the Netherlands**, the choice is made mainly on predicted projected doses, but also on assumed averted and residual doses.

In **Norway**, the decision between the implementation of sheltering or evacuation will be based on the averted dose and the number of people involved.

As there are enough shelters in **Switzerland** for every citizen, at least in the area around their nuclear power plants, the countermeasure “staying in shelters” is the initial preventive countermeasure.

In **Sweden**, the decision is based on several factors, e.g. weather conditions, averted and predicted dose, time of release (if not already on-going) and distance to the affected NPP.

In **United Kingdom**, field measurements are used for deciding between sheltering and evacuation.

In the **United States**, the decision between sheltering and evacuation is based on the projected dose, weather conditions, presence of competing disasters, local physical factors that may impede evacuation, and mobility of special population groups.

6. USE OF STABLE IODINE

The intake of specific stable iodine compounds, for example potassium iodine or potassium iodine, is effective in reducing the uptake of radioactive ^{131}I and other radioiodines in the thyroid gland (iodine prophylaxis).

According to the WHO Guidelines for Iodine Prophylaxis Following Nuclear Accidents from 1989, the uptake of radioiodine by the thyroid is effectively blocked by a recommended administration of 100 mg stable iodine, corresponding to 130 mg potassium iodide or 170 mg potassium iodide. For pregnant women and children aged 3-12, the dose should be reduced to 50 mg stable iodine, for children younger than 3 years to 25 mg. Neonates are particularly sensitive to the effects of iodine excess, especially in iodine deficiency areas. Therefore, the administered amount for neonates should preferably not exceed 12.5 mg.

The maximum benefit from stable iodine is clearly obtained by taking tablets before exposure to radioiodine, or as soon as possible afterwards. Administration a few hours after exposure from to radioiodine can reduce the thyroid activity by a factor of up to 2. Little reduction in thyroid radiation dose would be achieved if administration of stable iodine is delayed beyond 6 hours and the protective action is of no value 12 hours after radioiodine exposure.

Although its effectiveness decreases with time, a single administration of stable iodine is effective for up to a few days, but this varies depending upon the natural dietary intake. If exposure to radioiodine continues beyond 2 days, further administration of stable iodine may be required.

Administration of stable iodine will rarely be used as a stand-alone protective action. It will normally be recommended in conjunction with sheltering or evacuation. Administration of stable iodine should be considered when inhalation of radioiodine is a major exposure pathway. In situations where uncontaminated food supplies are readily available, it is more appropriate to reduce doses from ingestion radioiodine by imposing restrictions on the production and consumption of foodstuffs.

According to the BSS, the generic optimised intervention value for iodine prophylaxis is 100 mGy of avertable committed absorbed dose to the thyroid due to radioiodine.

Intervention level, dose, integration time, operational intervention criteria

Intervention levels, type of dose, integration time and the operational intervention criteria used to initiate the countermeasure "use of stable iodine" are summarised in Table 9.

Australia, Canada, Hungary, **Ireland** and **Norway** use 100 mGy or rather mSv averted thyroid dose as an intervention level for this countermeasure (see Table 9). This value is comparable to the value of 100 mGy of avertable committed absorbed dose to the thyroid due to radioiodine laid down in the International Basic Safety Standards.

Four countries **(Czech Republic, Luxembourg, United Kingdom**, and **Switzerland)** use an intervention level range, based on the two-tier concept. **United Kingdom** and **Switzerland** use the same values for their intervention level range (30-300 mSv), but the values belong to different doses. Whereas **Switzerland** uses the anticipated thyroid dose, **United Kingdom** uses the committed thyroid dose averted by the countermeasure. Furthermore, the intervention level range from **Switzerland** is combined with an integration time of the first year following an accident.

Luxembourg uses an intervention level range from 30-250 mSv only for children.

The Netherlands uses an intervention level of 500 mSv thyroid dose for children and 1 000 mSv for adults. These levels are relatively high following the advice of endocrinologists – well-known thyroid experts – who claim that the intake of stable iodine is not without risks as thyroiditis could follow. Moreover, it is still not known whether or not people will become sensitive to iodine, getting allergic reactions the next time they are exposed to iodine (e.g. in medicine). The Polish experience does not solve that problem (yet). The intervention levels are nevertheless currently under discussion, because of the decrease in the intervention levels abroad.

The **Czech Republic** gives two different intervention level ranges: one for the effective dose (5-50 mSv) and one for the averted thyroid dose (50-500 mSv).

The intervention levels used by **Germany** for this countermeasure are originally based on 1989 WHO Guidelines for Iodine Prophylaxis following Nuclear Accidents. As Germany is an iodine deficient area, the recommended WHO values were adopted to these conditions. In addition, the experience of Chernobyl, especially with regard to childhood thyroid cancer, was taken into consideration when developing intervention levels. The result is that Germany has two different intervention levels: the lower intervention level (50 mSv) applies to children up to 12 and pregnant women, and the higher intervention level (250 mSv) applies to adults up to the age of 45. As an appropriate integration time for the calculation of the anticipated thyroid organ dose through radioactive radioiodine inhaled, 7 days were selected, including dose equivalent commitment. If, in case of long-lasting releases, the passage of the radioactive cloud takes longer than 7 days, the integration time is prolonged accordingly.

Finland has already adopted new intervention levels for iodine prophylaxis based on a WHO publication from 1999. Intake of iodine tablets is recommended for children under 18, if the averted dose to the thyroid is 10 mGy. For adults, the intervention level is 100 mGy.

Sweden has adopted the 1999 WHO recommendations on dosage. For people older than 40 years the use of iodine prophylaxis is not recommended due to the limited risk of developing thyroid cancer. The generic intervention level is 100 mGy to the thyroid gland (children), but recommendations will follow when the predicted averted dose may exceed 10 mGy.

Japan has no predetermined intervention level for the use of iodine tablets. For Japanese experts, it depends on the amount of radioactive iodine and the anticipated dose to the thyroid. The complex procedure of determining the intervention level is postponed to the case of an event and done by the judgement of experts. In case the event requires immediate action, there is no preliminary intervention level at hand.

Four countries have operational intervention criteria for the use of stable iodine. The **Czech Republic** already uses, and **Hungar**y will probably introduce a default criteria of 0.1 mSv/h ambient dose rate in the plume, as recommended by the IAEA in TECDOC-955.

Table 9. Summary of stable iodine criteria

Country	Intervention level	Dose	Integration time	Operational intervention criteria
Australia	100 mGy	Averted dose		[1]
Canada	100 mSv[2]	Thyroid organ dose (averted dose)		[3]
Czech Republic	5-50 mSv 50-500 mSv	Effective dose Organ dose (averted)		0.1 mSv/h[4]
Finland	10 mGy (for children under 18) 100 mGy (for adults)	Averted dose to the thyroid		10 µSv/h (for children under 18) 100µSv/h (for adults)
Germany	50 mSv (for children up to 12 and pregnant women) 250 mSv (for adults up to age of 45)	Thyroid organ dose (anticipated)	Radioactive iodine inhaled over a period of 7 days including dose equivalent commitment	Criteria are given for: • released activity of iodine at the source and • time integrated air concentration (see Annex 6)
Hungary	100 mGy	Thyroid organ dose (averted)		0.1 mSv/h; 4 h plume transition[5]
Ireland	100 mSv	Anticipated averted thyroid dose		Thyroid dose from radioiodines
Japan	Where a large amount of radioactive iodine is released and a high thyroid dose is anticipated, stable iodine prophylaxis could be taken according to the judgement of experts			
Luxembourg	30-250 mSv	Anticipated organ dose, children		
Netherlands	250 mSv children (<17) and pregnant women 1000 mSv adults	Projected Thyroid dose	1 day	
Norway	100 mGy	Averted dose		
Sweden	10-100 mGy for children	Averted dose to the thyroid		
Switzerland	30-300 mSv	Organ dose (anticipated dose)	Inhalation dose integrated over time of plume passage	Source term estimation
United Kingdom	30-300 mSv	Committed thyroid dose, averted by countermeasure		Varies with site/operator
United States	≥5 Gy (for adults over 40 yrs) ≥100 mGy (Adults 18-40 yrs) ≥50 mGy (for pregnant/lactating women) Adults 12-18 yrs Children 3-12 yrs Children 1 month-3 yrs Birth through 1 month	Committed dose equivalent to thyroid		

1. Under review at present.
2. Health Canada's Federal Recommendation. The province of Quebec has other intervention levels: ≥50 mSv (0-20 years), ≥100 mSv (20-40 years).
3. To be developed.
4. The default value of several ten mSv/h will be used, depending on real course and conditions of radio-nuclides release; for calculation the averted dose of 100 mSv from inhalation was used as basis assumption, and various accident sequences for WWER-213 reactor were calculated to assess the possible consequences for country specific conditions.
5. To be included into the National Nuclear Emergency Plan being revised, not yet accepted.

Finland uses also 0.1 mSv/h ambient dose rate in the plume to initiate the intake of tablets for adults. For the protection of children, a dose rate of 10 µSv/h will initiate the countermeasure.

Germany uses as operational intervention criteria for the decision on the intake of iodine tablets the released activity of iodine at the source and the time integrated air concentration, calculated for different times after shut-down of the reactor and for different distances from the source. Detailed values are given in Annex 4.

In the **United Kingdom,** the operational intervention criteria vary with the site and the operator. Therefore no examples are given.

Canada will be developing operational intervention criteria for this countermeasure. In **Australia,** these criteria are currently under review.

The decision to end the countermeasure is in all countries based on whether potential and real radiation exposures had fallen sufficiently, estimated for example via the activity in the air, the movement of the radioactive cloud, etc. Explicit criteria such as an operational intervention criteria were not mentioned.

Form of stable iodine used, iodine dosage, ingestion frequency, duration

In nearly all countries stable iodine is give in form of KI tablets (see Table 10). The KI content of a tablet varies from 65 mg KI to 100 mg KI and even 130 mg KI. In the ***United Kingdom***, potassium iodate (KIO_3) tablets are used, containing 50 mg equivalent mass of stable iodine.

Australia, **Finland**, **Germany**, **Ireland, Norway,** the **United Kingdom** and **Switzerland** adopted the WHO recommendations regarding the single iodine dosage according to the different age groups of the population. Whereas:

- **Canada** adopted the dosage for the different age groups, but not every province adopted the single administration.
- **Sweden** may recommend an additional KI dose within 48 hrs if the release is still on-going.
- The **Czech Republic** recommends the same dosage for the different age groups, but over a time period of 48 hours.
- **Hungary** makes no distinction between the age groups and recommends a twice-daily dosage of 65 mg mass of KI for each person for a duration of 10 days.
- **Japan** uses a dosage of 50 mg mass of KI for children and infants. The dosage would be given for a maximum period of ten days, with less than 1 g KI in total.
- **Luxembourg** adopted WHO’s envisaged dosage, with a single dose for neonates and pregnant women. Infants, children and adults would get the recommended dosage twice within two days.

For territories with low dietary iodine levels, there are no differences in terms of dose, duration or frequency.

United Kingdom prefers a single administration of stable iodine tablets. Instead of ordering a second administration, an evacuation would be the preferred action.

Table 10. Dosage criteria for stable iodine

Country	Population[1]	Dosage (mg)		Frequency	Duration
		Mass of KI	Mass of iodine		
Australia	Infants Children Adults Pregnant women Emergency Workers		25-50 50 100 100 100	Single dose Single dose Single dose Single dose 1 per day	 10 days
Canada	Neonates Infants Children Adults		12.5[2] 25[2] 50[2] 100[2]	[3]	[3]
Czech Republic	Infants Children Adults Pregnant women Others	32 65 130 130 130		24 h 16 mg 24 h 32.5 mg 24 h 65 mg 24 h	48 h 48 h 48 h max. 2x
Finland	Neonates Infants Children Adults Pregnant women	16 32.5 65 130 130		[4]	24 h
Germany	Neonates Infants Children Adults Pregnant women	12.5 25 50 100 50		Normally single dose. In exceptional cases taking an additional tablet may be recommended	The intake for neonates should be confined to one day
Hungary	Infants[5] Children[5] Adults[6] Pregnant women[5]	65		Twice daily	10 days

1. Neonates: birth-1 month.
   Infants: 1 month-3 years.
   Children: 3-12 years.
   Adults: include adolescents aged 13-16 years.
2. Federal recommendation follows the 1989 WHO Guidelines. Varies by province.
3. Varies by province. In New Brunswick, the frequency is 1 dose per 24 hr (except for newborns, where a single dose is advised), until instructed to stop. At the federal level, a protracted dose is generally not advised.
4. If needed, authorities give an order for another dosage after 24 h.
5. ½ or ¼ may be administered depending on age or in case of iodine sensitivity.
6. Adults below 40 years.

Ireland	Neonates Infants Children Adults Pregnant women		12.5 (1/4 tablet) 25 (1/2 tablet) 50 (1 tablet) 100 (2 tablets) 100 (2 tablets)		One day
Japan	Infants Children Adults Pregnant women	50 100 100 100		50 mg/day 100 mg/day 100 mg/day 100 mg/day	Max. 10 days; Less than 1 g (total)
Luxembourg	Neonates Infants Children Adults Pregnant women		12.5 25 50 100 100	1	Only 1 dose 2 days 2 days 2 days Only 1 dose
Netherlands	0-4 year 5-16 year >16 year Pregnant women	KIO_3	25 50 100 100	Normally single dose. In exceptional cases taking an additional tablet may be recommended	Only during the passage of the plume. Normally, "clean" food can be supplied
Norway	Neonates Infants Children Adults Pregnant women	16 32.5 65 130 130		[4]	24 h
Sweden	0-1 month Infants <3 yrs Children <12 yrs Adults <40 yrs Pregnant women	16 32.5 65 130 130		Normally single dose. In the case of a prolonged release, an additional dose may be recommended	
Switzerland	Neonates Infants Children Adults Pregnant women	16.2 32.5 65 130 130		Single dose Single dose Per day Per day Per day	Only one time Only one time [7] [1] Max. 2 days
United Kingdom	Neonates Infants Children Adults (including pregnant and lactating women)		12.5 25 50 100	Single administration only, preferred	Single administration provides protection for 24 hours
United States	Birth through 1 month 1 month through 3 yrs Children 3-12 yrs Adults 12-18 yrs Adults over 18 yrs Pregnant/lactating women	16 32 65 130			Until risk of significant exposure to radio-iodine by either inhalation or ingestion no longer exists

7. The duration depends on the actual situation.

Assumed shelf life of stable iodine tablets

A summary of the assumed shelf life for pre-distributed tablets (KI) is given in Table 11.

In **Switzerland,** the assumed shelf life for pre-distributed tablets (KI) is eight years. Stockpiled tablets are periodically controlled after these eight years. In **Luxembourg,** the producer of the stable iodine tablets (KI) guarantees a shelf life of ten years. In **Australia,** tablets are controlled after five years and, depending on the result, the shelf life might be extended. In **Ireland,** the manufacturer gives an expiry date of five years, whereas tests indicate that the expiry date could be extended to 10-15 years as long as tablets are stored correctly. **Hungary**, the **Czech Republic**, **Canada** and **Finland** also have an expiry date of five years for the tablets. **Germany** has an expiry date of 10-15 years under favourable storage conditions (cool and dry) for stable iodine tablets.

In the **United Kingdom** the assumed shelf life of the tablets (KIO_3) is three years, in **the Netherlands** it is 5 years.

In **Sweden**, iodine tablets are pre-distributed to the households within the inner emergency zone (up to about 15 km from the NPP). Every 5 years new tablets are distributed. The expiry date could be extended up to 10 years or longer, depending on storage, but the 5 year cycle was chosen in order to ensure the availability by compensating for possible loss or misplacing of tablets by the public.

In the **United States**, the Federal policy on the use of KI for protection of the general public from radioiodine has been recently revised. As such, there is not much experience with the long-term storage of KI. The current assumed shelf life for KI tablets is 5-7 years. As experience with long-term storage is gained, the expiration date could be extended.

Table 11. Stable iodine tablets shelf life

Country	**Assumed shelf life for stable iodine tablets [years]**	
	KI	**KIO_3**
Australia	5[8]	
Canada	5	
Czech Republic	5	
Finland	5	
Germany	10-15	
Hungary	5	
Ireland		5
Japan		
Luxembourg	10	
Netherlands		Check every 5 years
Norway	5	
Sweden	5	
Switzerland	8	
United Kingdom		3

8. After five years the tablets are controlled and depending on the result, the shelf life might be extended.

Precautions with regard to side effects caused from a high dose of stable iodine

Information about possible side effects are given in special leaflets (**Sweden, Switzerland, Germany, United Kingdom, Ireland, Finland,** the **Czech Republic**) or calendars which are distributed to all families within the emergency planning zone before an emergency.

In **Germany**, people aged over 45 are recommended not to take iodine tablets as, owing to the general iodine deficiency in Germany, early forms of thyroid over-activity (so-called functional autonomy or "hot nodules") are common in people aged over 45. The risk of taking iodine tablets (deterioration in the metabolic situation) outweighs the radiation risk due to radioactive iodine, which is very low in this age group.

In **Luxembourg**, individuals who may suffer severe side effects from a high dose of stable iodine, or known to have thyroid disease, are invited to consult their doctors in advance. Furthermore, information on risks and side effects is also given during emergency situations.

In the **United States**, the mechanism for providing information about the possible side effects from taking stable iodine has not yet been developed. The use of special leaflets, calendars, or other forms of instruction may be used by those states that decide to stockpile KI for the protection of the general public around nuclear power plants.

Distribution logistics and availability

With the exception of the **Austria, Canada,** and **United Kingdom**, stable iodine tablets are commercially available at pharmacies. In **Luxembourg**, tablets are only available for children not older than four years.

In **Australia**, the tablets will be distributed in an emergency situation only. The tablets are not commercially available, e.g. at pharmacies, but are stockpiled by the police and local and national authorities. In case of an emergency, they will be distributed to the residences of the population and to pre-designated locations.

In **Canada**, the provinces are responsible for the decision to distribute stable iodine. There are various policies, some provinces decided to pre-distribute the iodine tablets to residences, other provinces make them available at pre-designated locations. Within a radius of about 8 km around Gentilly 2 nuclear power plant, for example, iodine tablets will be pre-distributed to some 12 500 persons (inhabitants and workers). In New Brunswick, 3 500 people living within 20 km radius around Pt. Lepreau NPP received stable iodine tablets. Pills are also provided in quantity to police departments, public health offices, schools and local facilities. Additional supplies are stockpiled at the generating station and at the off-site emergency centre in Lepreau, New Brunswick. In Canada, iodine tablets are not commercially available at pharmacies.

The **Czech Republic** has the most widespread pre-distribution of stable iodine tablets to residences, businesses, pharmacies, schools and other locations. Around the nuclear power plant Dukovany, about 110 000 people living in the emergency planning zone have already received the tablets. Around the Temelin nuclear power plant, about 40 000 people living in the emergency planning zone received the tablets. People may also buy stable iodine tablets in designated pharmacies.

In **Finland**, tablets are pre-distributed to residences surrounding (5 km) nuclear power plants. The tablets are also pre-distributed to companies near the nuclear power plant. Stable iodine tablets are pre-distributed to about 1 150 people living around Loviisa NPP (50 permanent inhabitants and about 400 holiday homes with a maximum of 1 100 inhabitants) and 1 370 people surrounding Olkiluoto NPP (70 permanent inhabitants and about 450 holiday homes with a maximum of 1 300 inhabitants). In case of an emergency, tablets will also be distributed by emergency services at pre-designated locations and at public shelters.

In others parts of **Finland**, iodine tablets are also made widely available, e.g. in schools and nurseries. In addition, tablets are commercially available at pharmacies.

In **Germany**, stable iodine tablets are currently stockpiled in schools, public shelters, pharmacies and at local authorities. In case of an emergency they will be distributed at pre-designated locations or, with the help of emergency services, directly to the residences of the population.

The **German** Radiological Protection Commission (SSK) recommended a pre-distribution of tablets to households within a radius of up to 5 km around a nuclear power plant; this will be carried out as soon as iodine tablets containing 130 mg KI are commercially available in Germany. In addition there will be three national stockpiles storing stable iodine tablets for children up to 12 and for pregnant women, in case of an emergency outside a radius of 25 km around the nuclear power plants. Tablets are also commercially available at pharmacies.

In **Hungary**, tablets are stored at pharmacies and will be distributed at pre-designated locations during an emergency. Tablets will be distributed to every household in **Ireland**. In **Japan**, the tablets are stockpiled by local authorities and distributed at public shelters during an emergency.

In **Luxembourg**, stable iodine tablets will be commercially available in pharmacies for children of up to five years only. For other population groups, the tablets are stockpiled at schools and other pre-designated locations (e.g. local and national authorities).

In **the Netherlands**, stable iodine tablets are stockpiled in a central depository. They are also available around Borssele in Health Service Centres.

In **Norway**, stable iodine will distributed by the emergency services at designated locations. The distribution system is being revised. In Northern Norway, tablets will be available for all relevant groups and distributed through local authorities (from schools, hospitals etc). For the rest of the country, national authorities keep a central storage (few tablets). Around the research reactors, the operator has supplied some tablets (stored at the plant and by the police). This system for distribution might be changed.

In **Sweden**, iodine tablets are pre-distributed to all households within the inner emergency zone around the four NPP. This procedure is repeated every 5 years. There is also central storage of tablets for additional distribution. Larger workplaces, schools and hospitals have also received tablets.

In **Switzerland**, iodine tablets are pre-distributed about 4 km (zone 1) around the nuclear power plants. Depending on the location of the NPP, between 3 000 and 30 000 tablets are pre-distributed to residences of the population, to places of business, local authorities and pharmacies. Up to a distance of 20 km (zone 2) around nuclear power plants, tablets need not be distributed if the population can get them within the first two hours of an emergency. In this case, the public in general must go and fetch their tablets at specially designated locations. The solution chosen depends on the decision taken by the local authority. Currently, discussions are underway to change the legal basis to allow for a pre-distribution in zone 2 as well. In addition, a national central stockpile is available from where tablets can quickly be transported by helicopters to any location in Switzerland. Stable iodine tablets are also available commercially from pharmacies.

In general, there is no pre-distribution of potassium **iodate** tablets in the **United Kingdom**. However, the local health authority together with the operator, the police and the local government takes the decision for a pre-distribution in certain areas. Around Sellafield and Hinkley Point, the population density is low and residences are widespread around the sites. The local authorities therefore decided to pre-distribute tablets in an area of 1-3 km around the sites. Apart from that, tablets are stockpiled in schools, places of business, public shelter, and local authorities. Potassium **iodate** tablets are not accessible by the general public, e.g. cannot be purchased at pharmacies. They will only be distributed as part of the agreed emergency response arrangements after decision of the relevant Directors of Public Health.

In the **United States**, the distribution of KI for the general public is the responsibility of State and local officials. Because the Federal policy addressing the use of KI by the general public was only recently changed, there is not much experience with the logistics associated with the distribution and storage of KI on a large scale. However, each State that desires to stockpile KI for the population living in the vicinity of a nuclear power plant will have to develop a distribution plan that will be reviewed by the Federal government. In the United States, KI is available over the counter. But, most pharmacies do not keep it in stock and thus it is not readily available to the general public in large quantities.

Costs

The cost for the tablets in **Australia** is split between the local and the national authority, whereas in **Japan,** only the local authority pays for them. In **Ireland** and **Hungary,** the national authority pays for the tablets. In the **United Kingdom**, **Luxembourg**, **Germany**, **Canada** and the **Czech Republic,** the nuclear power plant operator pays for the tablets.

In **Finland,** the national and the local authority, as well as companies pay for the stable iodine tablets. Iodine tablets for residences in protective zones (0-5 km) around nuclear power plants are paid by the nuclear power companies.

In **the Netherlands**, the Ministry of Health pays for the tablets.

In **Norway**, the operator and the national authority pay for the stable iodine tablets, but this might be changed in future. Individual members of the public can purchase iodine tablets, if they wish.

In **Switzerland** the operator pays for the costs of the iodine tablets needed for zone 1 (4-5 km around nuclear power plants) and zone 2 (4-20 km around nuclear power plants), as well as for half of the tablets needed for the rest of the national territory. The rest is covered by the national authority.

In **Sweden**, the operators of nuclear power plants pay emergency fees to the state, and this money is used by the national authorities to pay for the tablets and the distribution.

In the **United States**, the Nuclear Regulatory Commission has agreed to pay for the initial supply of KI for each State that desires to stockpile KI for the general public living in the vicinity of a nuclear power plant. However, it has not committed to paying for additional KI as it reaches the end of its shelf life.

Combination of the countermeasure "use of stable iodine" with other countermeasures

The distribution and use of stable iodine tablets is, generally, not seen as an isolated countermeasure. Most countries consider the administration of stable iodine in combination with sheltering or evacuation to be the most effective countermeasure strategy. **Hungary** would also use the distribution of stable iodine as a stand-alone countermeasure. **Finland** would use the distribution of stable iodine tablets as an isolated countermeasure for infants and children under 18 years.

Experiences with the distribution of stable iodine tablets

During an emergency in the **United Kingdom,** stable iodine tablets have been distributed to site staff only. No significant effects from the countermeasure were observed. During an exercise, "simulated" stable iodine tablets were distributed to site staff only.

Australia, has distributed "simulated" stable iodine tablets during an exercise. It was observed that, for legal reasons, the police was reluctant to issue medication.

In **Hungary,** also, "simulated" stable iodine tablets have been distributed during an exercise. The main results were that:

- more education and information was needed;
- non-residents did not understand the reason for the distribution; and
- storage places should be nearer to the villages involved.

In **the Netherlands** some years ago the population around the NPP Borssele got house-to-house mailing that they could get stable iodine tablet at certain points in their villages to store these in their homes as pre-distribution. The interest was almost zero.

7. INFORMATION OF THE POPULATION AROUND A NUCLEAR POWER PLANT

Educational programmes on nuclear energy and its associated risks

Australia has an educational programme via local liaison committees, pamphlets and shop fronts, which includes visits to research reactors and nuclear-powered warships. The Commonwealth government, the state and ANSTO are responsible for these programmes.

In **Canada**, there are fact-sheets, instructional videos, public information centres and tours to the nuclear facilities. The nuclear utilities, provincial emergency measures organisations and the Federal Regulator are responsible for these educational programmes.

The **Czech Republic** has prepared an educational programme at two levels: For elementary schools, as part of the science education, and for state administration specialists, as part of the Civil Protection education programme. The Ministry of Schools, Youth and Sports and the Ministry of Interior (GŘ HZS) are responsible for these programmes.

Finland's educational programme includes:

- description and effects of nuclear and radiological accidents (at nuclear power plants, nuclear powered ships and satellites, transportation of nuclear material, nuclear waste or radioactive material, etc);
- health effects;
- emergency preparedness of authorities for these accidents; and
- tasks of authorities in nuclear or radiological emergencies and accidents.

These educational programmes are developed by the rescues authorities and STUK.

Japan's high school curricula contain nuclear energy and nuclear power generating studies. More than ten universities have nuclear engineering faculties.

The issue of educating and informing the public about radiation – its risks and benefits – is one of the most important tasks for the **Swedish** Radiation Protection Authority (SSI). Information can be found on public web sites, in leaflets and brochures. The national authorities also take part in information campaigns in the society. Educational material on radiation and radiation protection in general may be downloaded from the Internet to be used in public schools on all levels from the age of 6, up to 19 years.

Specific information issued to populations around nuclear power plants

Information prior to an emergency

In general, information prior to an emergency is delivered to the population via brochures, leaflets and in some cases calendars. Although, net based information might gain increased importance, it was mentioned only by two countries.

Australia delivers a pamphlet. Additional information is available at libraries. The Internet is used increasingly to supplement information. Specific presentations or courses, paid by the government, are available for emergency workers. The decision to give the courses is taken locally or nationally.

In the **Czech Republic**, the whole population and each family in the emergency planning zone receive information leaflets, and calendars containing basic information on how to behave in case of a radiological emergency.

In **Canada**, brochures are distributed to the population within a radius of 16 km around the nuclear power plant Gentilly 2. In addition, specific courses are organised by district councils in co-operation with the utility. While the district councils pay for the courses, the utility pays the experts. The decision to give these courses is laid down in the governmental order No. 11/1999 Coll.

In **Finland**, the licensee (NPP), in co-operation with the local rescue authorities, is responsible for providing information in advance. The information is distributed to the public in the emergency planning zone and includes basic information about radioactivity, examples of various hazard situations and their effects on the population and the environment, planned measures to alert, protect and help the population, instruction for action and so on. The information material is regularly updated. There are also courses given by the local authorities, civil organisations and the power plant operators. The decision to perform courses is taken on a local level.

In **Germany**, leaflets are distributed to the population surrounding the nuclear power plant up to a distance of 10 km. These brochures comprise information about radioactivity (basic concept: e.g. Bq, Sv, acticity, comparison of natural and artificial radioactivity), effects of radiation on man and on the environment etc.

In **Hungary**, every inhabitant in the 30 km region around the power plant receives useful information on siren alert signals and suggested action for various emergency situations. Besides this, the information is printed on calendars and distributed. Occasionally, there are specific presentations or courses, for which the Paks nuclear power plant pays. The decision for these courses is taken at a local level.

In **Japan**, information on specific features of nuclear emergency short-term counter-measures, involving local residents and others, is delivered via brochures to neighbouring residents.

Luxembourg uses an information leaflet, which is distributed to all households. The brochure and a short description of the emergency plan are also available on the Internet.

In **the Netherlands**, the whole Dutch population got house-to-house leaflets to inform them how to act in the case of chemical, nuclear or other accidents. A number was given were to ask for more specific information e.g. about nuclear accidents and iodine prophylaxis.

Leaflets about nuclear accidents and iodine prophylaxis were actively spread under the population around nuclear power plants up to about 20 km distance.

Regarding potential nuclear emergencies and planned responses, **Switzerland** issued specific information to the population around nuclear power plants. In a brochure about radioactivity, a special chapter deals with nuclear emergencies, describing briefly and understandable the potential threat of operating a nuclear power plant, emergency preparedness, planned countermeasures and what people are expected to do in an emergency situation. This brochure is distributed to households in Zone 1 (4 km radius) and to communities in zone 2 (20 km radius). People in zone 2 may receive a brochure on request. Some cantons have prepared documents and leaflets containing more detailed site-specific information for the local population around the nuclear power plants.

In **Sweden**, information is distributed to the public in the inner emergency zone, in connection to the distribution of iodine tablets. It includes basic information about radioactivity, examples of various hazard situations and their effects on the population and the environment. It also includes information on planned measures to alert, protect and help the population together with instructions on how to act in the case of an alarm. The information material is regularly updated.

In the **United Kingdom**, calendars are distributed to the local residence and itinerant workers.

In the **United States**, the licensee, in co-operation with local officials, usually provides information about the nuclear power plant in advance. The information is distributed to the public in the 16 km emergency planning zone (inhalation pathway zone) and includes basic information about the plant, the effect of the plant on the environment and the population, and measures to alert and protect the public in the event of an emergency. The information is updated regularly.

Information in case of an accident

In case of an accident, the potentially affected population will be alarmed and informed by sirens, vehicles with loud speakers, radio and television, and only in one country by going from door to door.

Australia

The population will be informed via radio and TV. Targeted telephone areas are under development.

Canada

Local media and local authorities, such as the fire brigade, will inform the population by going from door-to-door.

The legal basis for it is laid down in article 373 of the “Loi sur les services de santé et les services sociaux” of the Ministry of Health.

Czech Republic

Warning will be done by electronic sirens, information will be given through emergency broadcasting, radio and TV. The legal basis for public information is laid out in Acts No 18/1997 Coll. (Atomic Act), No. 239/2000 Coll. (on Integrated Rescue System), No. 240/2000 Coll. (Crisis Act) and the Governmental Order No. 11/1999 Coll.

Finland

Sirens and vehicles with loud speakers alert the population around a nuclear power plant. They are kept informed by radio and television.

The legal basis for this information comprises the protective measures in a radiation situation and information to the Public (Order of the Ministry of the Interior 1/97), the Council of the State Decision 397/1991 concerning the NPP and the Decree of Radiation and Nuclear Authority (STUK) 1515/1991 concerning STUK.

Germany

The potentially affected population will be warned by siren signals (one-minute wailing sound, meaning "turn on radios and listen to the announcements") or other suitable means (e.g. public address announcements), followed by co-ordinated media information. Media information will be rapidly and repeatedly given as official announcements on radio, television or videotext.

Civil defence sirens have generally been removed by federal order. In some Länder, however, the sirens were retained and modernised for use in the area of the intermediate zone around nuclear installations, or in the vicinity of installations with high danger potential.

The legal basis is given in Section 51 para. 2 of the Radiological Protection Ordinance in accordance with the requirements of EU directive 89/618/EURATOM.

Hungary

The population is alerted via sirens, which gives the signal to listen to national radio or TV broadcasts. The legal basis is stipulated in Act LXXIV, 1999 on the management of catastrophes and in the related Governmental Decrees governing the execution of the Act.

Japan

The public will be informed by local radio, public information cars and mass media, based on the Law for Nuclear Emergency Preparedness, and the Basic Plan for Emergency Preparedness.

Luxembourg

For information in case of an accident, sirens, radio and television messages, and mobile loud speakers for individuals who cannot be reached by sirens, are used. The Council Directive of 27 November 1989, on informing the general public about health protection measures to be applied and steps to be taken in the event of a radiological emergency, is the legal basis, as well as the "Règlement grand-ducal du 11 août 1996 concernant l'information de la population sur les measures de protection sanitaires applicables et sur le comportement à adopter en cas d'urgence radiologique".

The Netherlands

The population is alerted via sirens and in some areas with mobile loud speakers for individuals who cannot be reached by sirens, which gives the signal to listen to national radio or TV broadcasts.

Norway

The Crisis Committee has a responsibility to submit information to the public in an emergency situation.

Switzerland

Sirens followed by instructions and information on the radio alert the population.

The radio stations are obliged to broadcast information on behalf of the authorities. An amendment of the law is underway to take into account the recent development in the field of privatisation and an open market.

Sweden

Outdoor sirens and RDS (Radio Data System) receivers for in-door warning in all homes within the inner zone. The public is also informed on public and commercial radio “Urgent Message to the Public”. Public websites on the local, regional and central levels will be used during an accident. This way of informing the public is very important and effective. Concern has to be taken to co-ordinate all information on all levels in the society.

United Kingdom

The population is informed via the media and through emergency services. The legal basis is stipulated in the Public Information for Radiation Emergencies Regulations (PIRER).

United States

The population around the nuclear power plant is alerted by a series of sirens. When the sirens are sounded, the public is to turn to their radios and televisions and listen for instructions from the Emergency Alert System.

8. COUNTERMEASURES FOR SPECIAL GROUPS

Emergency workers

Australia

The dose limit for occupational exposure of police, fire service and defence services is 20 mSv effective dose. For rescue operations, the dose limit is 500 mSv (value currently under revision). As additional countermeasures for emergency workers, stable iodine tablets, personal dosimetry, protective clothing and breathing apparatus are planned.

The State Emergency Service, hospitals, and the bureau of meteorology are other special groups where specific short-term countermeasures would be implemented. Hospitals are prepared for emergencies.

Canada

Criteria and countermeasures for emergency workers are currently under development. They will be in line with internationally agreed criteria.

Czech Republic

The criteria for emergency workers are laid down in Regulation of SUJB No. 184/1997 Coll. Details are not given in the completed questionnaire.

Finland

Dose limits are given in the radiation decree. These limits are valid unless there is a serious reason to deviate. The emergency workers are divided into three groups:

Type of countermeasures to be implemented by emergency workers	Dose limits
Immediate measures in accident situations (measures needed to restrict the radiation hazard and bring the radiation source under control in an accident situation).	It is possible to exceed the normal criteria for radiation workers (50 mSv/year). Still the measures shall be taken in such a way that the radiation exposure due to the situation is kept as low as possible. Workers and volunteers shall be appropriately trained and aware of the potential health risks of radiation exposure. Monitoring of exposure and medical surveillance shall be organised. The effective dose shall not exceed 0.5 Sv or the skin dose 5 Sv if the measure is not a life saving operation.
Mitigation of consequences (warning people about the dangers, measures connected with access controls, etc).	Dose limits of radiation workers are followed.
Other measures.	Emergency workers are regarded equal to members of the general public. If the dose is higher than that of the public, additional advice will be given to reduce exposure.

Germany

According to a recommendation of the German Radiation Protection Commission, a dose of 250 mSv may only be exceeded in exceptional cases, such as to rescue persons or to prevent a serious increase of damage, given that a radiation protection expert has assessed this exposure as being necessary and justified. The dose of 1 Sv, however, must never be exceeded. While taking early action to protect the population, the whole body doses of emergency workers should by all means be kept below 100 mSv. In connection with cordoning off measures, a level of 5 mSv is valid and, for the protection of material assets, a dose level of 15 mSv.

For members of the public, fire brigades, police, and medical rescue services breathing equipment, contamination protection and iodine tablets are foreseen as countermeasures. The radiation exposure must be monitored and recorded. The personnel has to be informed about expected exposure and potential health consequences.

Hungary

The limits for occupational exposed personal, set by a ministerial decree, are:

- 100 mSv effective dose in 5 years, 50 mSv in one year;
- 150 mSv for the eye;
- 500 $mSv/cm^2/y$ for the skin; and
- 500 mSv/y for the limbs.

Recommendations for emergency workers are not yet approved. Following the IAEA recommendation, they will be set at:

- 250 mSv for life saving or core damage prevention;
- 50 mSv for preventing serious injury, high collective dose, catastrophe; and
- 25 mSv for short-term recovery, urgent protective actions, sampling, etc.

In all cases, the implementation of thyroid blocking is assumed. If this is not the case, the above-mentioned values shall be divided by 5.

Ireland

There are no countermeasures for special groups.

Japan

The effective dose limit for emergency workers is 50 mSv in general, and 100 mSv for life saving.

Luxembourg

There is a reference level of 50 mSv effective dose for general intervention and 250 mSv effective dose for life-saving actions.

For civil defence, police and fire brigades, respiratory protection, protective clothing and dose meters are foreseen as countermeasures.

The Netherlands

For all emergency work (in general).	50 mSv[a]
Protecting goods, support and/or performing about measurements, evacuation, iodine-prophylaxe and secure public etc.	100 mSv[a]
Saving big economical interests, however voluntarily and after being informed about the risks.	250 mSv[a]
Saving lives or avoiding high risks for populations and individuals, however on a voluntarily basis and being informed about the risks.	750 mSv[a, b]

a. These levels are effective doses and meant for non-pregnant workers, during the first 24 hours after an emergency.

b. This value is only meant as a guidance level, in special situations it can be exceeded.

Norway

Dosimetric criteria for special groups can be found in the “Nordic Intervention Criteria for Nuclear or Radiological Emergencies – Recommendations”.

Switzerland

Generally, the dose limit for emergency workers is set to 50 mSv effective dose for the first year after the accident. For life saving actions, the dose limit is 250 mSv effective dose for a time period of one year after the accident.

Sweden

Generally, the dose limit for radiation workers is 50 mSv/year or 100 mSv accumulated over 5 consecutive years. These limits may be exceeded in the case of an emergency. A “guide-line” dose limit is 100 mSv, and this should be exceeded only by volunteers in life-saving efforts. Still, measures shall be taken so that the radiation exposure is kept as low as possible. Workers and volunteers shall be appropriately trained and aware of the potential health risks of radiation exposure. Monitoring of exposure and medical surveillance shall be organised.

United Kingdom

Three categories of workers are known:

- those involved in urgent actions at the scene of a serious accident – avoid exposures that would result in serious deterministic injuries;
- those implementing emergency countermeasures – generally keep below one-off exposure to worker annual dose limit;
- those involved in recovery operations – full ICRP system of dose limitation.

United States

The dose limit for occupational exposure of emergency workers is 50 mSv. However, this limit can be exceeded for workers performing the following emergency services. The following Table provides the recommended dose limits for various emergency actions and the conditions which apply.

Dose Limit TEDE (Sv)	Activity	Condition
0.10	Protecting valuable property	Lower dose not practicable
0.25	Life saving or protection of large populations	Lower dose not practicable
>0.25	Life saving or protection of large populations	Only on a voluntary basis to person fully aware of the risks involved

Workers performing services during emergencies should limit dose to the lens of the eye to three times the listed value and doses to any other organ (including skin and body extremities) to ten times the listed value. These limits apply to all doses from an incident, except those received in unrestricted areas as members of the public during the intermediate phase of the incident.

Table 12. Dose limits for emergency workers

Country	Emergency workers/Effective dose [mSv]	
	General limit	Limit for life saving actions
Australia	20	500*
Canada		
Czech Republic		
Finland	50/year	500
Germany	100[a, b]	250
Hungary		250***
Ireland		
Japan	50	100
Luxembourg	50	250
Netherlands	50, 100 or 250[c]	750 or higher
Sweden	50/year or 100/5 years	100[d]
Switzerland	50**	250**
United Kingdom		

* Under review.

** Time period of one year after the accident.

*** Not yet approved.

a. For the fire brigade 100 mSv per assignment.

b. For the police 100 mSv per year.

c. See text.

d. This limit may be exceeded by volunteers if they are well informed about the radiation risk (see text above).

As general countermeasures for emergency workers, dosimetric measurements to allow effective control of the exposure, iodine prophylaxis and protective clothing, and in the Netherlands respiratory protection for special actions are foreseen.

Other special groups identified for the implementation of short-term countermeasures are police, civil defence, drivers of public transportation, coastguards, military and others.

Warning of farmers, hospitals or others

Czech Republic

For notification and warning of inhabitants and facilities in the EPZ, emergency plans foresee the use of the Integrated Rescue System.

Finland

There are special plans for early warning of farmers, hospitals or others needing extra-time to prepare for evacuation and sheltering. Protective clothing and iodine tablets are foreseen for farmers, social workers (home-aid for old people), workers at waterworks and electricity workers etc.

Switzerland

Hospitals, schools, public institutions and large enterprises are informed at an early stage in order to be prepared for the implementation of sheltering when the order is given by national authorities.

9. HARMONISATION OF THE COUNTERMEASURES

Australia

Due to the fact that emergencies at visiting nuclear powered warships are assumed to be restricted to one state, there is no harmonisation with other states or countries. Reference is made to ARPANSA's "Reference Accident" for assessment of suitability of ports visited. Emergency Management Australia is responsible for maintaining cross-border co-operation and co-ordination.

Furthermore, some states have systems to register and monitor people who will be affected by countermeasures for the purpose of determining costs, but not for appropriate compensation. Plans are exercised every two years.

Canada

Federal recommendations for countermeasures/intervention levels must be harmonised with the Provinces. The federal emergency management and information exchange arrangements are harmonised with the United States.

The Province Québec has harmonised agreements regarding the transmission of an alarm with Ontario and New Brunswick. There will also be an exchange of liaison personnel.

In case of an emergency at a nuclear power plant near the border, there will be co-operation between Canada and the United States at a federal level, as well as between the respective Canadian Province and US State.

At the federal level, co-ordination and co-operation are carried out in accordance with the Canada-United States Joint Radiological Emergency Response Plan, maintained by the Office for Critical Infrastructure Protection and Emergency Preparedness for Canada, the Federal Emergency Management Agency, and the Department of Health and Human Services for the US.

Czech Republic

In case of an emergency at the nuclear power plant Dukovany, there is a co-operation with the provincial warning central of **Lower Austria**. The Regional Office in Brno and the Czech Government are responsible for maintaining this co-operation.

Finland

There was co-operation between rescue authorities when the emergency plans of the emergency planning zone Loviisa and Rauma area were revised.

Furthermore the Nordic countries (**Sweden, Norway, Denmark, Iceland** and **Finland**) have long co-operated in the field of harmonisation, and joint policy papers have been issued on e.g. concentration of radionuclides in foodstuffs. A document on joint Nordic intervention criteria for nuclear or radiological emergencies was issued in 2001.

In case of an accident near the border, information from the accident country would be sufficient for the implementation of harmonised countermeasures.

Germany

Alert measures, means of communication, information of the public and the implementation of countermeasures, especially the use of iodine tablets because of different dosages used across borders, was harmonised between neighbouring Länder and with France, Switzerland and the Netherlands. Further attempts are underway to harmonise the intervention levels for countermeasures, as well as starting points for the implementation of the countermeasures.

The authorities responsible for maintaining this cross-border co-operation and co-ordination are the local and regional competent Länder authorities, such as the chief administrative office of the district Waldshut, the Regierungspräsidium Freiburg and the Ministry of Environment and Traffic of Baden-Württemberg. At a federal level, they are the Federal Ministry of the Environment, Nature Conservation and Nuclear Safety.

Hungary

In the framework of the IAEA RER/9/050 Harmonisation project, an attempt has been made to harmonise basic rules with neighbouring countries. For nuclear power plants near the border there is co-operation/co-ordination between emergency management in the emergency planning zones of the different countries. It is not regulated which organisations are responsible for maintaining co-operation and co-ordination across the borders. In practice, the power plants and Regulatory Bodies keep working relationships. Bilateral agreements on early exchange of information with the neighbouring countries are a good basis for this item.

Ireland and Japan

Because of geographical distance to neighbouring countries, harmonisation of countermeasures was not undertaken.

Luxembourg

There is close collaboration between the Radiation Protection department (Ministry of Health), the Civil Defence Organisation (Ministry of Interior) and local authorities of the German Länder (federal states) and French Départements.

The Netherlands

Harmonisation with other European countries and especially with the neighbour countries are not yet achieved, but is a major point of concern.

Norway

The Nordic countries (**Sweden, Norway, Denmark, Iceland** and **Finland**) have long co-operated in the field of harmonisation, and joint policy papers have been issued on e.g. concentration of radionuclides in foodstuffs. A document on joint "Nordic Intervention Criteria for Nuclear or Radiological Emergencies – Recommendations" was issued in 2001.

Switzerland

There is a close collaboration between Switzerland and Germany due to the fact that the Swiss nuclear power plant Leibstadt is located directly at the border to Germany. A second power plant is located about 8 km from the German border. Regarding the implementation of urgent countermeasures, both countries co-ordinated their emergency preparedness to the extent possible. In the past few years the long-term countermeasures have received more and more attention. Collaboration in these fields has therefore been intensified. In addition, Switzerland started collaborating with France.

A joint Swiss German commission is responsible for maintaining co-operation and co-ordination at federal and at local level.

In case of an accident occurring in a neighbouring country (region) near the border, information from the accident country is sufficient for the implementation of harmonised countermeasures. However, improvements to this information exchange is an ongoing task.

Sweden

The Nordic countries (**Sweden, Norway, Denmark, Iceland** and **Finland**) have long co-operated in the field of harmonisation, and joint policy papers have been issued on e.g. concentration of radionuclides in foodstuffs. A document on joint "Nordic Intervention Criteria for Nuclear or Radiological Emergencies – Recommendations" was issued in 2001.

In the **United Kingdom**, an attempt has been made to harmonise basic rules or specific emergency plans with neighbouring countries. Due to differences in regulations and other boundary conditions, real harmonisation on both sides of a national border may not be possible. But each side should know the concepts of the other and the reason for existing differences, and must be able to inform the public about this if different actions have to be implemented.

Within the **United States**, all Federal, State and local officials utilise the protective action guides (countermeasures) published by the Environmental Protection Agency. These guides are developed in co-operation with other Federal departments and agencies and endorsed by the Federal Radiological Preparedness Co-ordinating Committee. In the event of an emergency in either **Canada** or the **United States** that has a transboundary impact, there will be co-operation between **Canada** and the **United States** at the Federal level.

10. ECONOMIC CONSEQUENCES OF COUNTERMEASURES

Canada

Costs were not considered while developing the emergency plan and they do not have any influence on the decision to implement a countermeasure.

At the federal level, there is no mechanism for identifying all people in an affected area, although those using the Evacuation Reception Centres in the event of an evacuation order will be registered upon arrival. At the federal level, Canada's third-party nuclear liability legislation, the Nuclear Liability Act (NLA) does contain provisions for establishing dose registry and claim registration mechanisms under Part II of the Act. Part II is proclaimed when the Governor in Council deems that the operator's liability could exceed USD 75 million, or, as a result of extensive damages or injury, it is in the public interest to provide special measures for compensation. Under Part II, a Nuclear Damage Claims Commission would be established by the Governor in Council as a tribunal to hear and determine claims.

Under the present Act, the provisions and regulations for establishing dose registry and claim registration mechanisms under Part II would be developed following the occurrence of a nuclear incident. Proposed revisions to the NLA will take into consideration that both the rules and regulations governing the activities of the Nuclear Damage Claims Commission be established in draft form in advance of a nuclear incident.

Czech Republic

The costs for on-site countermeasures were considered when the internal emergency plan was developed. When developing the external emergency plan, costs had not been considered. Within the emergency planning zone, costs do have an influence on the decision to implement a countermeasure, but these attitudes are not yet fully processed. A system exists to register people who will be affected by countermeasures.

Finland

Costs of implementing various countermeasures are not considered in developing the emergency plan. The do not have any influence on the decision to implement a countermeasure. A system to register and monitor people who will be affected by countermeasures for the purpose of determining costs and appropriate compensation is in place.

Germany

Only the costs for KI tablets are considered in developing the emergency plan. In Germany people in emergency centres are monitored and registered, however not for the purpose of determining costs and appropriate compensation.

Hungary

Costs are only implicitly considered in developing the emergency plan.

Ireland

The decision to implement a countermeasure rests with a committee of government ministers. While costs would be considered, public health would be the major concern.

Japan

National and local governments bear the costs for implementing various countermeasures. Costs do not have any influence on the decision to implement countermeasures.

Luxembourg

Cost estimates may have an influence on the decision to implement a countermeasure. This depends on the countermeasure.

Norway

Costs of implementing various short-term countermeasures were considered while developing the emergency plan. Cost estimates do have an influence on the decision to implement a countermeasure. There is no national system to register and monitor people who will be affected by countermeasures for the purpose of determining costs and appropriate compensation.

United Kingdom

In developing its advice on intervention levels, NRPB took account of a wide range of consequences expected as a result of implementing each countermeasure, specifically the health risks and benefits, the monetary costs and the social consequences (such as reassurance, anxiety, disruption).

United Kingdom has a system to register and monitor people who will be affected by countermeasures.

Switzerland

Costs of implementing various short-term countermeasures are not considered while developing the emergency plan. Cost estimates do not have an influence on the decision to implement a short-term countermeasure. A system to register and monitor people who will be affected by countermeasures for the purpose of determining costs and appropriate compensation does not yet exist.

Sweden

A wide range of factors have been considered when developing the emergency plans, and cost for various short-term countermeasures is one of them. But, cost has no direct influence on the decision to implement a countermeasure. There is currently no national system to register and monitor people who will be affected by countermeasures for the purpose of determining costs and appropriate compensation.

United States

The economic consequences of some countermeasures were considered in the development of the associated action levels. For example, the cost of housing, lost wages, transportation and food were considered in the development of the action level for evacuation of the general public.

11. CONCLUSIONS AND PERSPECTIVES

Fourteen NEA member countries completed the questionnaire on short-term countermeasures, providing an updated overview of current practices and regulations regarding short-term countermeasures, as well as some insights into short-term countermeasure planning and implementation.

The information given in this report allows NEA member countries to compare national practices with other countries, and identify areas for further review and co-ordination. The information may also be used to understand the basis for decisions in various countries, and, if deemed necessary, as a basis for international harmonisation. This may help to explain to the public affected by an emergency why the decisions in neighbouring countries may vary.

Although regional and national differences can be observed, the regulations regarding the implementation of short-term countermeasures are, in general, in line with the IAEA recommendations.

In some countries, competencies and duties in connection with short-term countermeasures are shared between different levels, e.g. federal and regional levels such as Länder or Provinces.

Since the NEA Workshop, which was held in Stockholm, Sweden, in 1994, many countries have consolidated their implementation of short-term countermeasures. Objectives of countermeasures, dose limits for emergency workers, factors considered in developing emergency plans and the way of informing the general public remained in general unchanged. Regarding the iodine prophylaxis, many countries rely now on a pre-distribution of the tablets, whereas in 1994 central storage was still the preferred option. Regarding intervention levels, the majority of countries use now a single value abandoning the concept of a range. Operational intervention levels were introduced in a few countries, some of which participated in the IAEA programme on Regional Harmonisation on Emergency Preparedness.

Intervention levels for the decision on the implementation of sheltering are very similar in the countries regarded, whereas corresponding levels for evacuation and iodine prophylaxis show stronger variations. Some harmonisation may be desirable with a view to the public perception of the implementation of a countermeasure in neighbouring countries.

Regarding the criteria for ending a countermeasure, only a few countries have given fixed dose level below which the countermeasure would be ended. Canada, for example, has stipulated that in case of sheltering, the countermeasure would be ended when the dose be less than 5 mSv in one day. Other countries give more general criteria such as the radiation situation, movement of the cloud, contamination situation, end of the release, etc. This issue might be further discussed.

Two countries mentioned the importance of protecting livestock production as early phase countermeasure, i.e. sheltering cattle, protection of their drinking water and feeding stuffs, in order to prevent exposure in the later phase of an accident caused by ingestion of contaminated food. Future investigations should therefore include the implementation of agricultural short-term countermeasures, which were not yet covered in the questionnaire, e.g. shelter dairy cows, protect feedstuff stored outside, warning of the consumption of fresh harvested foodstuff.

This survey of national policies regarding short-term countermeasures should be regularly updated, e.g. every five years.

ABBREVIATIONS

ALARA	As low as reasonably achievable.
ANSTO	Australian Nuclear Science and Technology Organisation.
ARPANSA	Australian Radiation Protection and Nuclear Safety Agency.
CEZ	Czech Power Company.
EMA	Emergency Management Australia.
EPC	Emergency planning zone.
GCC	Governmental Co-ordination Commission.
GRHZS	Ministry of Interior of the Czech Republic – General Directorate of Fire Rescue Service.
HAEA	Hungarian Atomic Energy Authority.
HSE	Health & Safety Executive.
HSK	Hauptabteilung für die Sicherheit der Kernanlagen (Swiss Federal Nuclear Safety Inspectorate).
LAR	Leitender Ausschuss Radioaktivität.
NEOC	Nuclear Emergency Operation Centre (= Nationale Alarmzentrale, NAZ).
NHMRC	National Health and Medical Research Council (Australia).
NII	Nuclear Installations Inspectorate.
NPP	Nuclear power plant.
NRBC-Protection	Eidgenössische Kommission für AC-Schutz, KOMAC.
NRPA	Norwegian Radiation Protection Authority.
NRPB	National Radiological Protection Board.
OIL	Operational Intervention Level.
RPII	Radiological Protection Institute of Ireland.
RRSSS	Régie régionale de la santé et des services sociaux.
SSI	Swedish Radiation Protection Authority.
STUK	Radiation and Nuclear Safety Authority (Finland).
SUJB	State Office for Nuclear Safety.
WHO	World Health Organisation.

Annex 1

THE ORIGINAL QUESTIONNAIRE OF NEA

Background

In 1994, the NEA launched a questionnaire on short-time countermeasures distributed to the NEA member countries to establish an overview, at that time, on the current practices regarding short-term countermeasures. The answers received were analysed by Rosemary Hogan of the US NRC and discussed during the Workshop on "The Implementation of Short-term Countermeasures" held in Stockholm in June 1994.

Countries' practices regarding short-term countermeasures have since evolved and been modified. The Working Party therefore decided to modify the questionnaire and proposed its distribution with the aim of preparing an up-to-date overview on these practices.

At its 59th meeting, 5-7 March 2001, the NEA Committee on Radiation Protection and Public Health (CRPPH) approved the questionnaire and agreed to distribute it to the CRPPH members. The CRPPH members agreed to act as national co-ordinators to distribute the questions within their country, and to collect the answers to be sent back to the NEA secretariat.

The answers will be subsequently discussed by the Working Party on Nuclear Emergency Matters and will be published as an NEA report.

Action

Each CRPPH member is asked to

- **Distribute** the questionnaire to the relevant organisations in their country;
- **Collect** and **co-ordinate** the answers; and
- **Send** the completed questionnaire to the NEA secretariat not later than **1 June 2001**.

QUESTIONNAIRE ON SHORT TERM COUNTERMEASURES

0. Organisation

What organisations (type and jurisdictional level) were involved in completing this questionnaire?

1. General objectives and criteria for short-term countermeasures

1.1 What are the objectives of implementing short-term countermeasures in the case of a nuclear emergency?

1.2 Which urgent countermeasures for the general public are employed in your country?

	Near field accident	**Far field accident**
Evacuation		
Sheltering		
Stable iodine		
Other (specify)		

1.3 What intervention levels[1] and operational intervention criteria are used to initiate countermeasures?

	Intervention levels in mSv[1]	**Operational intervention criteria**
Evacuation		
Sheltering		
Stable iodine		
Other (specify)		

1.4 What criteria are used for ending countermeasures?

	Criteria for ending a countermeasure
Evacuation	
Sheltering	
Stable iodine	
Other(specify)	

1. Specify which dose is used: averted dose, anticipated dose, effective dose, organ dose, and give integration period (one day, one week?)

1.5 Is the International Basic Safety Standard for protection against ionising radiation and for the safety of radiation sources (IAEA safety series N° 115) a basis for the development of your intervention levels?

Yes ☐ No ☐

If not, on which bases did you develop your intervention levels?

2. National Organisation for Nuclear Accidents

2.1 What organisation(s)[2] developed the legal framework for these intervention levels?

2.2 What organisation(s)[1] makes recommendation concerning the implementation of countermeasures in case of a nuclear emergency?

2.3 What organisation(s)[1] has the authority to make the decision whether or not to implement countermeasures in case of a nuclear emergency?

3. Implementation of short-term countermeasures

3.1 Emergency plan

3.1.1 What organisation(s)[3] developed the general guidelines for the implementation of the emergency plan?

3.1.2 What organisation(s)[2] developed the procedures for the implementation of short-term countermeasures?

3.1.3 Which factors were considered in developing emergency plan guidelines (general rules)?

Public health risk	Yes ☐	No ☐
Time necessary for the implementation	Yes ☐	No ☐
Shielding qualities of average house	Yes ☐	No ☐
Availability of basement and shelters	Yes ☐	No ☐
Transportation availability	Yes ☐	No ☐
Public trauma	Yes ☐	No ☐
Night or day	Yes ☐	No ☐
Nuclear power plant near a border	Yes ☐	No ☐
Costs	Yes ☐	No ☐
Countermeasure applied to entire population	Yes ☐	No ☐
Other	Yes ☐	No ☐

2. Specify both the type of organisation and its jurisdictional level within the country, i.e. federal, state, etc.

3. Specify both the type of organisation and its jurisdictional level within the country, i.e. federal, state, etc.

3.1.4 Was there a public consultation before establishing countermeasure guidelines?

3.2 General points concerning the implementation of short-term countermeasures

3.2.1 What information or criteria are considered necessary and sufficient to justify the implementation of short-term countermeasures?

3.2.2 What physical zones are pre-established for the purposes of countermeasure implementation (ex: 5 km evacuation zone, 20 km sheltering zone)

3.2.3 What are the reasons for the sizes of these zones?

3.2.4 Has a phased implementation of countermeasures been considered in emergency plans, for example

Close area followed by further expansion of the restricted area	Yes ☐	No ☐
Specific population followed by general population	Yes ☐	No ☐
Schools followed by general population	Yes ☐	No ☐
Other (specify)	Yes ☐	No ☐

3.2.5 Which factors are likely to be taken into account at the time of a nuclear accident when selecting which countermeasures to implement?

	Evacuation	**Sheltering**	**Stable iodine**
Averted dose			
Expected dose without protection			
Operational intervention criteria			
Weather conditions			
Time of day			
Release in progress			
Time delay for the countermeasure			
Level of preparedness of the population			
Media impact			
Psychological impact on the public			
Phased implementation or targeted populations			
Other			

Answer “Yes” or “No”, give priorities if possible.

3.2.6 Among the above listed factors, which is the most important when deciding whether or not to implement a countermeasure?

Evacuation	
Sheltering	
Stable iodine	

3.3 Specific countermeasure: Evacuation

3.3.1 Has your country ever experienced evacuation for an actual or potential radiological emergency?

Yes ☐ No ☐

If so, what was the size of the population and of the area affected?

What was the impact on the evacuated population?

3.3.2 Has your country ever experienced evacuation as a result of non-radiological emergencies, such as a hurricane?

Yes ☐ No ☐

If so, what was the size of the population and of the area affected?

Did you apply this non-nuclear experience to your nuclear emergency planning and preparations?

3.3.3 Has your country ever implemented real evacuation as part of an exercise?

Yes ☐ No ☐

If yes, explain the results.

3.3.4 Do you foresee evacuation:

As your initial countermeasure	☐
Only before nuclear release and contamination	☐
Only after nuclear release and contamination	☐
Either before or after release and contamination	☐

Explain.

3.3.5 Is evacuation executed:

As a planned operation	Yes ☐	No ☐
As a spontaneous reaction of the population	Yes ☐	No ☐
By organised transport	Yes ☐	No ☐
By individual cars	Yes ☐	No ☐

Other.

3.3.6 Is evacuation applied differently for different groups within the population, such as children, pregnant women, etc?

3.4 Specific countermeasure: Sheltering

3.4.1 Has your country ever experienced sheltering for an actual or potential radiological emergency?

Yes ☐ No ☐

If so, what was the size of the population and of the area affected?

What was the impact on the sheltered population?

3.4.2 Has your country ever experienced sheltering as a result of non-radiological emergencies, such as chemical spill or threat?

Yes ☐ No ☐

If so, what was the size of the population and of the area affected?

Did you apply this non-nuclear experience to your nuclear emergency planning and preparations?

3.4.3 Has your country ever implemented real sheltering as part of an exercise?

Yes ☐ No ☐

If yes, explain the results.

3.4.4 Do you foresee sheltering as your initial countermeasure?

Yes ☐ No ☐

Explain.

3.4.5 What countermeasure(s) accompany or follow sheltering?

3.4.6 Is sheltering applied differently for different groups within the population, such as children, pregnant women, etc?

3.4.7 What criteria are used when selecting between sheltering and evacuation?

3.5 Specific countermeasure: Use of stable iodine

3.5.1 Has your country ever experienced stable iodine distribution for an actual or potential radiological emergency?

Yes ☐ No ☐

If so, what was the size of the population and of the area affected?

What was the health impact on the affected population?

3.5.2 Has your country ever implemented distribution of "simulated" stable iodine tablets (made of sugar for example) as part of an exercise?

Yes ☐ No ☐

If so, explain the results.

3.5.3 How is stable iodine distributed to individual members of the population?

At their residence before an emergency	Yes ☐	No ☐
At their businesses before an emergency	Yes ☐	No ☐
At their residence during an emergency	Yes ☐	No ☐
At a pharmacy or other location before an emergency	Yes ☐	No ☐
At a pre-designated location during the emergency	Yes ☐	No ☐
At a public shelter during the emergency	Yes ☐	No ☐
At a road control point during evacuation	Yes ☐	No ☐
By the emergency services	Yes ☐	No ☐
Others	Yes ☐	No ☐

3.5.4 Is there an area around nuclear power plant where stable iodine is pre-distributed to the population?

Yes	☐
No	☐
Depends on the nuclear power plant	☐
Other	☐

If so, what is the size of the area?

What is the average population around nuclear power plants with pre-distributed stable iodine?

3.5.5. Where is stable iodine stockpiled?

Home	☐
Schools	☐
Place of business	☐
Public shelter	☐
Pharmacies	☐
Local authorities	☐
National authorities	☐
Others	☐

3.5.6 Who pays for stable iodine

Individual member of the public if they want some	☐
Only individual member of the public	☐
Businesses	☐
Nuclear power plant	☐
Local authority	☐
National authority	☐
Others	☐

3.5.7 What form of stable iodine is used?

KI tablets	☐
KIO_3 tablets	☐
Others	☐

3.5.8 Are stable iodine tablets commercially available at pharmacies?

3.5.9 What iodine dose (mg), ingestion frequency and duration are recommended in case of a nuclear emergency in your country for various populations?

Population	Dose (mg)	Frequency	Duration
Infants			
Children			
Adults			
Pregnant women			
Others			

3.5.10 Do you recommend implementation differences, in term of dose (mg), duration or frequency, for territories with low dietary iodine levels?

Yes ☐ No ☐

If so, what are the recommendations?

3.5.11 Are any precautions taken for members of the public who may suffer severe side effects from a high dose of stable iodine or may have thyroid disease?

3.5.12 What is the assumed shelf life of the stable iodine tablets?

3.5.13 Is stable iodine used as an isolated countermeasure or only together with sheltering or evacuation?

Isolated	☐
With sheltering	☐
With evacuation	☐

4. Information for the population around a nuclear power plant

4.1 Does your country have educational programmes on nuclear energy and its associated risks?

Yes ☐ No ☐

What kind of educational programme has been or should be developed?

What type of organisation is responsible for these educational programs?

4.2 Is specific information issued to populations around nuclear power plants concerning possible nuclear emergencies and planned responses?

Yes ☐ No ☐

If so, what kind of information is delivered and for which population?

Are there specific presentations or courses?

Yes ☐ No ☐

If so, who gives the courses and who pays for them?

Is the decision to give courses made locally or nationally?

4.3 How is the population around a nuclear power plant educated concerning the possibility and manner of implementation of a countermeasure by the authorities?

4.4 In case of an accident, how is the population around a nuclear power plant alerted and kept informed concerning the practical implementation of countermeasures?

4.5 Is there a legal basis or obligation for the information of the public before or during an emergency?

Yes ☐ No ☐

If yes, specify.

5. Countermeasures for special groups

5.1 Are there established dosimetric criteria for emergency workers?

Yes ☐ No ☐

If yes, specify.

5.2 Are there different countermeasures planned (stable iodine, dosimetry, protective clothing…) for emergency workers who may need to be outside in an affected area?

Which countermeasures?	**For whom?**

5.3 Have other special groups been identified in your country for the implementation of short term countermeasures

Yes ☐ No ☐

If yes, specify.

5.4 Are there plans for early warning of farmers, hospitals or others needing extra-time to prepare for:

Evacuation Yes ☐ Non ☐

If so, explain.

Sheltering Yes ☐ No ☐

If so, explain.

5.5 Are there different countermeasures planned (stable iodine, dosimetry, protective clothing…) for farmers or other non-emergency workers who may need to be outside in an affected area?

Which countermeasures?	For whom?

6. Harmonisation of the countermeasures[4]

6.1 Has an attempt been made to harmonise basic rules or specific emergency plans with neighbouring countries (or states, provinces, Länder …)?

Yes ☐ No ☐

If so, which parts of the emergency plan are (will be) harmonised?

With which country (or region)?

6.2 For nuclear power plants near a border of a country (or states, provinces, Länder …), is there co-operation/co-ordination between emergency management in the emergency planning zones of both countries (or states, provinces, Länder …)?

Which organisations (type and jurisdictional level) are responsible for maintaining co-operation and co-ordination across such borders?

6.3 In case of an accident occurring in a neighbouring country (region), near the border, would information from the accident country (region) be sufficient for the implementation of harmonised countermeasures?

4. Due to differences in regulations and other boundary conditions real harmonisation on both sides of a national border may not always be possible, but each side should be aware of the concepts of the other in order to understand possible differences and communicate these to the public.

7. Economic consequences of countermeasures

7.1 Were costs of implementing various countermeasures, such as cost for transportation, housing, feeding, and maintaining KI stock or the value of human life (α value), considered in developing the emergency plan?

7.2 Do cost estimates have an influence on the decision to implement a countermeasure?

7.3 Does your country have a system to register and monitor people who will be affected by countermeasures for the purpose of determining costs and appropriate compensation?

Annex 2

ORGANISATIONS INVOLVED IN COMPLETING THE QUESTIONNAIRE

Table 1. Organisations involved in completing the questionnaire

Country	Organisations involved	Remarks
Australia	• ARPANSA • Emergency Management Australia • Various state regulators	Commonwealth Regulator and Advisory body Commonwealth emergency co-ordinating body
Canada	• Health Canada • Gouvernement du Québec • Ministère de la Sécurité publique, Direction générale de la sécurité civile et de la sécurité incendie, Ministère de la Santé et des Services sociaux, Régie régionale de la santé et des services sociaux (RRSSS)	
Czech Republic	• State Office for Nuclear Safety (SUJB) • CEZ (NPP Dukovany, NPP Temelin) • Ministry of Interior of the Czech Republic, General Directorate of Fire Rescue Service (GRHZS)	
Finland	• Radiation and Nuclear Safety Authority Finland, STUK • Local rescue authorities in municipalities (Loviisa and Rauma) where nuclear power plants are situated	STUK is the regulatory authority on the use of nuclear energy and radiation practices, the national warning point and the national competent authority for domestic nuclear accidents, radiological emergencies or accidents in foreign countries .
Germany	• Federal Ministry of the Environment, Nature Conservation and Nuclear Safety • Federal Office for Radiation Protection	Both federal organisations are responsible for precautionary countermeasures.
Hungary	• Hungarian Atomic Energy Authority (HAEA)	National regulatory body on nuclear safety
Ireland	• Radiological Protection Institute of Ireland (RPII)	National Competent Authority
Japan	• Science and Technology Policy Bureau • Ministry of Education, Culture, Science and Technology • Agency for Nuclear and Industrial Safety, Ministry of Economy, Trade and Industry	

Country	Organisations involved	Remarks
Luxembourg	• Radiation Protection Department	This Department is the competent body from the Ministry of Health charged with all technical aspects in relation to radiation protection.
Netherlands	• Dutch National Emergency Centre • Ministry of Environment and Internal Affairs in agreement with other ministries involved • National Institute of Health and the Environment (RIVM) for models and calculations	Policy (norms etc) is set by the Ministry of Environment, Division of Radiation, Nuclear and Bio Safety
Norway	• Norwegian Radiation Protection Authority (NRPA)	NRPA is the Secretariat for the nuclear emergency response organisation and the national competent authority on nuclear safety and radiation protection
Sweden	• Swedish Radiation Protection Authority	
Switzerland	• Swiss National Emergency Operations Centre. General Secretariat of the Department of Defence, Protection of the Population and Sports, federal level • Swiss Nuclear Safety Inspectorate HSK, federal level	
United Kingdom		
United States	• Environmental Protection Agency • Nuclear Regulatory Commission • Department of Health and Human Services • Department of Agriculture • Department of Energy	These are just a few of the organisations that have significant responsibilities in preparing for and responding to nuclear or radiological emergencies in the United States

Annex 3

NATIONAL ORGANISATIONS FOR NUCLEAR ACCIDENTS

The member countries were asked to specify both the type of organisation and its jurisdictional level within the country, i.e. federal, state, etc, in detail:

- What organisation(s) developed the legal framework for these intervention levels?
- What organisation(s) makes recommendation concerning the implementation of countermeasures in case of a nuclear emergency?
- What organisation(s) has the authority to make the decision whether or not to implement countermeasures in case of a nuclear emergency?

Australia

The Australian Radiation Protection and Nuclear Safety Agency (ARPANSA), the Commonwealth regulatory and advisory body, produces guidance documents, and the state governments are responsible for their implementation.

ARPANSA also recommends, through a working group convened by the nuclear codes committee, the implementation of countermeasures in case of a nuclear emergency. The State Government Radiation Health Department is also involved in this recommendation process.

Only the state authority, i.e. the relevant emergency organisation – usually the police – makes the decision on whether or not to implement countermeasures.

Canada

The primary legal responsibility for intervention lies within the Provincial governmental organisations responsible for emergency measures, with the exemption of areas which are under federal jurisdiction, such as protection of nuclear workers and food safety. Within the federal government the Canadian Nuclear Safety Commission is responsible for the protection of nuclear workers, Health Canada for food safety. There is no legal framework for intervention at the federal level. Recommended intervention levels are considered as guidelines.

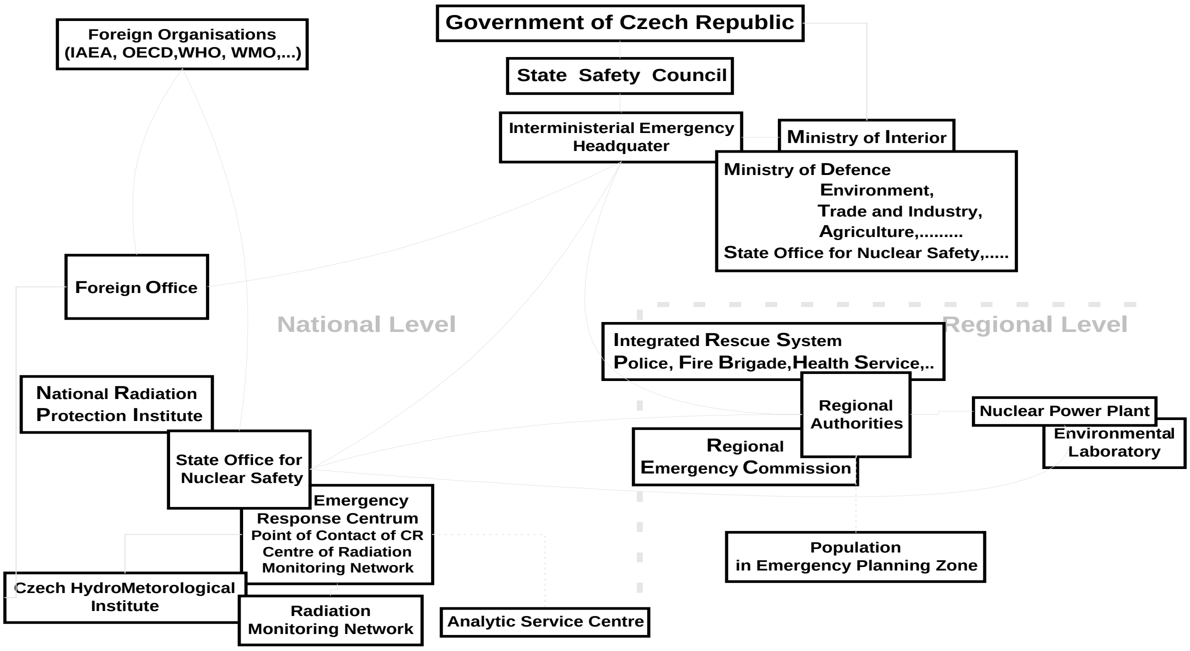
Recommendations concerning the implementation of countermeasures at provincial level, are made by provincial emergency measures organisations. At the federal level, recommendations are made by Health Canada and the Canadian Nuclear Safety Commission. The decision on whether or not to implement countermeasures is made by provincial emergency measures organisations at the provincial level and by the Minister of Health Canada, as lead minister for the Federal Nuclear Emergency Plan.

Czech Republic

The legal framework was developed by SUJB. Recommendations for implementing sheltering or stable iodine will be given by the Nuclear Power Plant and, for all other countermeasures, by SUJB.

The decision on whether to implement countermeasures will be taken either by the Regional (District) Office or the government. A graphical presentation of the Czech emergency response organisation is given in Figure 1.

Figure 1. The emergency response organisation of the Czech Republic



Finland

Legal frameworks for intervention levels are developed by STUK, the national competent authority for nuclear accidents or radiological emergencies.

In the very early phase of an accident in the domestic NPP, the licensee is responsible for giving recommendations to local authorities until STUK announces its readiness to take over the responsibility. In all other cases, STUK is responsible.

Depending on the severity of the hazard situation, decisions concerning safety operations are taken by the rescue authorities at municipal, provincial or governmental level. Other measures required by the situation shall be decided by the relevant administrative sectors. The rescue authority will be the general supervisor co-ordinating operations between the various authorities. The responsibilities are, briefly:

The Ministry of the Interior:

- Protective measures in severe hazards situations affecting widespread areas.
- Establishing a command centre with governmental authorities for co-ordinating activities.

The Ministry of Agriculture and Forestry:

- Orders and instructions concerning, e.g. milk, meat, crops, and forestry and agricultural products.

The Ministry of Trade and Industry:

- Energy management, storage of reserve supplies and foreign trade.

The National Food Agency:

- Supervision of purity of foodstuffs in processing and delivery and supervision of retail food.

The Ministry of Social Affairs and Health:

- General safety of public health and social security, also in radiation hazards.
- Orders concerning the monitoring and quality of drinking water.

The Ministry of Transport and Communication:

- Matters concerning traffic, transport and communication links.

The Ministry of Foreign Affairs:

- Communication to Finnish embassies abroad and to embassies of foreign countries in Finland.

The State Provincial Offices with other regional administrative authorities:

- Monitoring the accident situation, supervise rescue activities and direct the activities of their subordinate authorities.

The municipalities in the endangered area:

- Implementation of decisions and instructions pertaining to rescue activities and other areas of administration.
- Issue of information to the residents in their own area.
- Directing the activities and co-ordination in their own area.

Germany

The basis for the German intervention levels are laid down in the "Radiological Basis for decisions on Measures for the Protection of the Population against Accidental Releases of Radionuclides", which were approved by the Radiological Protection Commission (federal level) and the Länder Committee for Nuclear Energy – Executive Committee (federal states level).

The Federal Ministry of the Environment, Nature Conservation and Nuclear Safety, together with the Federal Ministries of Agriculture and Health, recommend the implementation of agricultural short-term countermeasures. The Länder Ministries of Interior have agreed on the "Basic Recommendations for Disaster Response in Areas Surrounding Nuclear Facilities" as a frame in which the Länder develop the emergency preparedness plans for the different utilities. In Germany, the responsibility for emergency response stays with the Länder.

The disaster response organisations of the Länder decide on and are responsible for the implementation of countermeasures. Depending on the Land, the competence can be distributed differently within these organisations. In some Länder, the county district magistrates and the district authorities, as a "lower level disaster response authority", are responsible while in other Länder, such competence is assigned to the regional government as intermediate authority.

Hungary

The Ministry for Public Health developed the legal framework, with the consent of the other ministries and national organisations involved in nuclear emergencies.

A Defence Committee – including the representatives of every involved ministry and national organisation – has been set up, to be called upon in case of a nuclear emergency. This Committee makes the recommendations.

A Governmental Co-ordination Commission (GCC) – including high ranking officials from the involved ministries and national organisations – is called together in case of any type of emergency. The Commission is headed by the Minister of Interior. In case of a nuclear emergency, the Director General of the Hungarian Atomic Energy Authority will be the Deputy Head. The GCC makes decisions concerning countermeasures.

Ireland

The legal framework for intervention levels was developed by the Radiological Protection Institute of Ireland (RPII), the national competent authority for matters relating to ionising radiation, in conjunction with the Department of Public Enterprise, the Governmental Department responsible for the National Emergency Plan for Nuclear Accidents.

Legislation relating to intervention levels is set out in Article 36 of the Irish Statutory Instrument 125 (SI 125) of 2000. This SI gives effect to Council Directive 96/29/EURATOM laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionising radiation.

RPII recommends the need for certain countermeasures to a committee of senior officials from key Government departments and national agencies. This Committee considers the practicalities of these recommendations and makes its recommendations to a committee of government ministers that in turn decides on whether to implement the countermeasure(s) or not.

Japan

Within the legal framework established by the Basic Law for Emergency Preparedness and the Special Law for Nuclear Emergency Preparedness, such technical and specific details as intervention levels are provided by the Guidelines on Emergency Preparedness for Nuclear Installations issued by the Nuclear Safety Commission.

In case of a nuclear emergency, the competent minister reports to the Prime Minister and recommends any necessary emergency response. The Prime Minister, as the head of Nuclear Emergency Response Headquarters, directs or recommends local governments to implement sheltering or evacuation of local residents, and directs other relevant organisations to take necessary measures, obtaining advice from the Nuclear Safety Commission.

Luxembourg

The Radiation Protection Department (Ministry of Health) and the Civil Defence Organisation (Ministry of Interior) developed the legal framework for intervention levels for nuclear accidents. These organisations also make the recommendation concerning the implementation of countermeasures in case of a nuclear emergency. Only the government or the different ministers may take the final decision whether or not to implement countermeasures.

Netherlands

The Ministry of the Environment (VROM) prepared the law and the "Plan for Emergency Preparedness" (NPK) in co-operation with the Ministry of Internal Affairs and consulting other relevant Ministries.

The Technical Advisory Group (TIG) recommends based on the dose and other calculations of the RIVM.

A "Policy Team" existing of representatives from the Ministries of Environment (VROM) and Internal Affairs and the Inspectorate for Nuclear Installations (KFD – VROM) and other relevant Ministries like the Ministries of Health, Agriculture and Traffic and Water works makes the final decisions.

Norway

The legal basis for the nuclear emergency preparedness is given in a Royal Decree dated 26 June 1998. The authority to implement countermeasures has through this decree been given to the Crisis Committee for nuclear accidents. No specific levels have been given.

Norwegian Radiation Protection Authority (NRPA) and other advisors with relevant competence in case of a nuclear accident will make recommendations to the Crisis Committee, which decide upon which countermeasures to implement.

The Crisis Committee for nuclear accidents has the authority to decide upon implementation of countermeasures. The legal basis for each countermeasure is covered by police legislation (evacuation etc) and food control legislation. Other countermeasures (iodine prophylaxis, sheltering, etc) will be implemented by advice only.

Switzerland

The Federal Commission on NRBC-Protection (Eidgenössische Kommission für AC-Schutz KOMAC) is in charge of elaborating procedures and criteria for countermeasures. This commission is composed of experts in the field of radiation protection and emergency preparedness.

The Swiss Federal Nuclear Safety Inspectorate (HSK) will assess the situation based on the plant status and provide advice regarding early countermeasures to the National Emergency Operations Centre (NEOC).

In urgent situations, the competence lies with the NEOC. Later, the countermeasures are elaborated by the Centre and submitted to the Radiation Emergency Management Board LAR. At this level, criteria other than dose or radiation protection are taken into account. Finally, the decisions are taken by the government.

Sweden

There are numerous laws and decrees formulating the legal framework that governs the emergency response to nuclear and radiological accidents. Sweden also follows several international conventions in this field. The Swedish Radiation Protection Authority has – as national competent authority – developed the guidelines for intervention levels.

The decisions regarding the implementation of countermeasures are taken by the county administrative boards, and they are responsible for the management and co-ordination of the rescue services in their counties. They also answer for the alarm and information to the public. In the case of a severe and extensive accident, the responsibility for the rescue services may be taken over by another authority, especially appointed by the government.

Central authorities give support, advice and recommendations to the county administrative boards, regarding e.g. countermeasures.

The Swedish Radiation Protection Authority gives advice on countermeasures aiming at minimizing the malicious effects of radiation. Other central authorities give advice within their area of competence, e.g. the National Food Administration give counselling on actions taken in order to protect the public from contaminated foodstuff. SSI co-ordinates the information and recommendations given by all central authorities.

United Kingdom

The National Radiological Protection Board (NRPB) has a statutory duty to recommend intervention levels. The Health Safety Inspectorate (HSE) and the Nuclear Installations Inspectorate (NII) have the statutory authority for developing the legal framework and approving emergency plans.

During the early stages of an emergency the operator makes recommendations concerning the implementation of countermeasures. This is then co-ordinated through the Government Technical Advisor and Regional Health Authority at the Local Emergency Centre where the Police co-ordinates measures to protect the public.

The police, in consultation with other interested agencies, will decide and co-ordinate what actions should be taken to protect the public.

United States

The primary responsibility for developing the legal framework for establishing intervention levels lies within several Federal governmental organisations. The Environmental Protection Agency (EPA) is responsible for establishing acceptable levels of radiation in the environment. The Food and Drug Administration (FDA) within the Department of Health and Human Services (HHS) has established intervention levels for food. The United States Department of Agriculture establishes intervention levels for crops and animal feeds. The establishment of these intervention levels is accomplished through the Federal Radiological Preparedness Co-ordinating Committee (FRPCC), an inter-agency workgroup consisting of 17 Federal departments and agencies with nuclear or radiological emergency response functions and capabilities.

In response to a nuclear or radiological emergency, recommendations for implementing countermeasures can come from a number of different sources. In most cases the recommendations come from the Lead Federal Agency (LFA) as established in the Federal Radiological Emergency Response Plan, the National Contingency Plan, or the Federal Response Plan. The designation of the

LFA is based on who owns, operates or regulates the radioactive material. The table below identifies the different LFAs for emergencies involving nuclear or radioactive material in the United States.

Regardless of which Federal department or agency is the LFA, only state or local governments, have the authority to make the decision on whether or not to implement the countermeasures. The state or local governments may implement the recommendations without any changes or may decide to implement more or less protective countermeasures based on their analysis of the situation and its unique characteristics.

Type of Emergency	**LFA**
1. Nuclear Facility	
a. Licensed by the Nuclear Regulatory Commission (NRC) or an Agreement State	NRC
b. Owned or Operated by the Department of Defense (DOD)	DOD
c. Owned or operated by the Department of Energy (DOE)	DOE
d. Not Licensed, Owned, or Operated by a Federal Agency	EPA
2. Transportation of Radioactive Materials	
a. Shipment of Materials by the NRC or an Agreement State	NRC
b. Materials Shipped by or for the DOD	DOD
c. Materials Shipped by or for DOE the	DOE
d. Shipment of Materials Not Licensed or Owned by a Federal Agency or an Agreement State	EPA
3. United States Satellites Containing DOD Radioactive Material	DOD
4. Other United States Satellites Containing Radioactive Material	NASA[1]
5. Impacts from Foreign Accidents or Unknown Sources of Radiation	EPA
6. Terrorist Use of Nuclear or Radioactive Material	
a. Crisis Management	FBI[2]
b. Consequence Management	FEMA[3]

1. National Aeronautic and Space Administration.
2. Federal Bureau of Investigation.
3. Federal Emergency Management Agency.

Annex 4

THE GERMAN OPERATIONAL INTERVENTION CRITERIA FOR THE COUNTERMEASURE “EVACUATION”

Table 1. Released activity which at a distance of 1 km from the source may lead to an effective dose of 100 mSv within 7 days, and the proportion of the partial doses to each other

Nuclide	Released activity (Bq)		Contribution of the exposure pathway to the effective dose (%)					
	Release		Gamma submersion	Inhalation	Gamma soil radiation	Gamma submersion	Inhalation	Gamma soil radiation
	Early (6 h after shut-down)	Late (120 h after shut-down)	Early release (6 h after shut-down of the reactor)			Late release (120 h after shut-down of the reactor)		
Dry deposition								
^{131}I*	7.4E+14	8.8E+14	2.7	69.2	28.1	1.1	87.2	11.8
^{131}I**	2.4E+15	3.0E+15	0.4	74.3	25.3	0.5	93.5	6.0
^{132}Te	4.6E+15	4.6E+15	0.4	42.3	57.2	0.4	42.3	57.2
^{137}Cs	2.6E+15	2.6E+15	0.4	85.4	14.2	0.4	85.4	14.2
Wet deposition (rainfall rate 1 mm/h)								
^{131}I*	3.2E+14	4.8E+14	1.2	30.3	68.5	0.6	46.8	52.6
^{131}I**	1.5E+15	2.8E+15	0.2	47.5	52.3	0.4	86.8	12.8
^{132}Te	8.0E+14	8.0E+14	0.1	7.2	92.7	0.1	7.2	92.7
^{137}Cs	1.2E+15	1.2E+15	0.2	38.6	61.2	0.2	38.6	61.2
Wet deposition (rainfall rate 5 mm/h)								
^{131}I*	1.3E+14	2.2E+14	0.5	12.3	87.3	0.3	21.1	78.6
^{131}I**	8.0E+14	2.4E+15	0.1	24.4	75.5	0.4	73.0	26.6
^{132}Te	2.4E+14	2.4E+14	0.0	2.3	97.7	0.0	2.3	97.7
^{137}Cs	4.8E+14	4.8E+14	0.1	15.9	84.1	0.1	15.9	84.1
Exposure pathway gamma submersion								
Noble gases	1.3E+18	6.0E+18	100.0			100.0		
^{133}Xe	5.8E+18	5.8E+18	100.0			100.0		

* Reference nuclide; ** Note, see p. 98.

Table 2. Released activity which at a distance of 5 000 m from the source may lead to an effective dose of 100 mSv within 7 days, and the proportion of the partial doses to each other

Nuclide	Released activity (Bq)		Contribution of the exposure pathway to the effective dose (%)					
	Release		Gamma submersion	Inhalation	Gamma soil radiation	Gamma submersion	Inhalation	Gamma soil radiation
	Early (6 h after shut-down)	Late (120 h after shut-down)	Early release (6 h after shut-down of the reactor)			Late release (120 h after shut-down of the reactor)		
Dry deposition								
^{131}I*	9.4E+15	1.1E+16	4.1	68.2	27.7	1.6	86.6	11.7
^{131}I**	3.2E+16	4.0E+16	0.6	74.1	25.3	0.7	93.2	6.0
^{132}Te	6.0E+16	6.0E+16	0.7	42.2	57.1	0.7	42.2	57.1
^{137}Cs	3.4E+16	3.4E+16	0.6	85.3	14.1	0.6	85.3	14.1
Wet deposition (rainfall rate 1 mm/h)								
^{131}I*	1.6E+15	2.6E+15	0.7	11.8	87.5	0.4	20.4	79.2
^{131}I**	1.0E+16	3.0E+16	0.2	23.7	76.1	0.6	72.1	27.3
^{132}Te	3.2E+15	3.2E+15	0.0	2.2	97.8	0.0	2.2	97.8
^{137}Cs	6.2E+15	6.2E+15	0.1	15.3	84.6	0.1	15.3	84.6
Wet deposition (rainfall rate 5 mm/h)								
^{131}I*	5.2E+14	9.0E+14	0.2	3.7	96.1	0.1	6.8	93.1
^{131}I**	3.6E+15	1.9E+16	0.1	8.5	91.4	0.4	45.3	54.4
^{132}Te	9.0E+14	9.0E+14	0.0	0.6	99.4	0.0	0.6	99.4
^{137}Cs	1.9E+15	1.9E+15	0.0	4.9	95.1	0.0	4.9	95.1
Exposure pathway gamma submersion								
Noble gases	1.1E+19	5.0E+19	100.0			100.0		
^{133}Xe	5.0E+19	5.0E+19	100.0			100.0		

* Reference nuclide, ** Note, see p. 98.

Note:

Exposure pathways:	Gamma submersion, inhalation, gamma soil radiation
Diffusion category:	D
Wind speed:	1 m/s at 10 m height
Building release:	Width 80 m, height 60 m, height of release 50 m
Soil correction factor:	Negligible, b = 1 (see Chapter 8)
Integration time for Gamma soil radiation:	7 days
Breathing rate:	$3.5 \cdot 10^{-4}$ m^3/s for normal activity
Inhalation dose, integration time:	50 years
Reference group:	Adults

Note: Information about the deviations as compared with the emission limits laid down in the criteria for alarming the disaster response authority [SSK 95] in Section 7.11.

** Due to deposition processes within the nuclear facility, radio-iodine forms change from iodine in aerosol form to organically-bound iodine if the release takes place after a delay. Due to the different velocities of dry and wet deposition on the soil for aerosol and organically-bound iodine, with increasing stay time of the fission products in the containment, higher releases of ^{131}I result in the same effective doses.

Table 3. Time-integrated air concentrations which may lead to an effective dose of 100 mSv within 7 days

Nuclide	Deposition	Time-integrated air concentration (Bq·h/m^3) Release	
		Early (6 h after shut-down of the reactor)	Late (120 h after shut-down of the reactor)
^{131}I*	dry	1.7E+06	2.7E+06
^{131}I**	dry	7.3E+06	9.2E+06
^{132}Te	dry	1.4E+07	1.4E+07
^{137}Cs	dry	7.9E+06	7.9E+06
^{131}I*	1 mm/h rain	3.0E+05	2.8E+06
^{131}I**	1 mm/h rain	2.2E+06	1.3E+07
^{132}Te	1 mm/h rain	5.1E+05	5.1E+05
^{137}Cs	1 mm/h rain	1.1E+06	1.1E+06
^{131}I*	5 mm/h rain	8.4E+04	9.9E+05
^{131}I**	5 mm/h rain	6.3E+05	5.1E+06
^{132}Te	5 mm/h rain	1.4E+05	1.4E+05
^{137}Cs	5 mm/h rain	3.3E+05	3.3E+05
Noble gases	none	2.8E+09	1.9E+10
^{133}Xe	none	1.9E+10	1.9E+10

***** Reference nuclide.

Exposure pathways:	Gamma submersion, inhalation, gamma soil radiation
Diffusion category:	D
Wind speed:	1 m/s at 10 m height
Rain formation height:	1 000 m
Soil correction factor:	Negligible, b = 1 (see Chapter 8)
Integration time for Gamma soil radiation:	7 days
Breathing rate:	$3.5 \cdot 10^{-4}$ m^3/s for normal activity
Inhalation dose, integration time:	50 years
Reference group:	Adults

****** Due to deposition processes within the nuclear facility, radio-iodine forms change from iodine in aerosol form to organically-bound iodine if the release takes place after a delay. Due to the different velocities of dry and wet deposition on the soil for aerosol and organically-bound iodine, with increasing stay time of the fission products in the containment, higher releases of ^{131}I result in the same effective doses.

Table 4. Soil contamination which may lead to an effective dose of 100 mSv within 7 days

Nuclide	Soil contamination (Bq/m^2)
^{131}I*	7.7E+07
^{131}I	6.0E+08
^{132}Te	1.3E+08
^{137}Cs	3.0E+08

***** Reference nuclide.

Exposure pathway:	Gamma soil radiation
Integration time:	7 days
Soil correction factor:	Negligible, b = 1 (see Chapter 8)
Reference group:	Adults

Annex 5

THE GERMAN OPERATIONAL INTERVENTION CRITERIA FOR THE COUNTERMEASURE "SHELTERING"

Table 1. Released activities which at a distance of 1 km from the source may lead to an effective dose of 10 mSv within 7 days

Nuclide	Released activity (Bq)/Time of release	
	Early (6 h after shut-down of the reactor)	Late (120 h after shut-down of the reactor)
Dry deposition		
^{131}I*	7.4E+13	8.8E+13
^{131}I	2.4E+14	3.0E+14
^{132}Te	4.6E+14	4.6E+14
^{137}Cs	2.6E+14	2.6E+14
Wet deposition (rainfall rate 1 mm/h)		
^{131}I*	3.2E+13	4.8E+13
^{131}I	1.5E+14	2.8E+14
^{132}Te	8.0E+13	8.0E+13
^{137}Cs	1.2E+14	1.2E+14
Wet deposition (rainfall rate 5 mm/h)		
^{131}I*	1.3E+13	2.2E+13
^{131}I	8.0E+13	2.4E+14
^{132}Te	2.4E+13	2.4E+13
^{137}Cs	4.8E+13	4.8E+13
Noble gases	1.3E+17	6.0E+17
^{133}Xe	5.8E+17	5.8E+17

***** Reference nuclide.

Exposure pathways:	Gamma submersion, inhalation, gamma soil radiation
Diffusion category:	D
Wind speed:	1 m/s at 10 m height
Building release:	Width 80 m, height 60 m, height of release 50 m
Soil correction factor:	Negligible, b = 1 (see Chapter 8)
Integration time for Gamma soil radiation:	7 days
Breathing rate:	$3.5 \cdot 10^{-4}$ m^3/s for normal activity
Inhalation dose, integration time:	50 years
Reference group:	Adults

The proportion of the partial doses corresponds to the values give in Table 4.1-1.

Note: Information about the deviations as compared with the emission limits laid down in the criteria for alarming the disaster response authority [SSK 95] in Section 7.11.

Table 2. Released activities which at a distance of 5 000 m from the source may lead to an effective dose of 10 mSv within 7 days

Nuclide	Released activity (Bq)/Time of release	
	Early (6 h after shut-down of the reactor)	Late (120 h after shut-down of the reactor)
Dry deposition		
^{131}I*	9.4E+14	1.1E+15
^{131}I	3.2E+15	4.0E+15
^{132}Te	6.0E+15	6.0E+15
^{137}Cs	3.4E+15	3.4E+15
Wet deposition (rainfall rate 1 mm/h)		
^{131}I*	1.6E+14	2.6E+14
^{131}I	1.0E+15	3.0E+15
^{132}Te	3.2E+14	3.2E+14
^{137}Cs	6.2E+14	6.2E+14
Wet deposition (rainfall rate 5 mm/h)		
^{131}I*	5.2E+13	9.0E+13
^{131}I	3.6E+14	1.9E+15
^{132}Te	9.0E+13	9.0E+13
^{137}Cs	1.9E+14	1.9E+14
Noble gases	1.1E+18	5.0E+18
^{133}Xe	5.0E+18	5.0E+18

***** Reference nuclide.

Exposure pathways:	Gamma submersion, inhalation, gamma soil radiation
Diffusion category:	D
Wind speed:	1 m/s at 10 m height
Building release:	Width 80 m, height 60 m, height of release 50 m
Soil correction factor:	Negligible, b = 1 (see Chapter 8)
Integration time for Gamma soil radiation:	7 days
Breathing rate:	$3.5 \cdot 10^{-4}$ m^3/s for normal activity
Inhalation dose, integration time:	50 years
Reference group:	Adults

The proportion of the partial doses corresponds to the values give in Table 4.1-1.

Note: Information about the deviations as compared with the emission limits laid down in the criteria for alarming the disaster response authority [SSK 95] in Section 7.11.

Table 3. Time-integrated air concentrations which may lead to an effective dose of 10 mSv within 7 days

Nuclide	Deposition	Time-integrated air concentration ($Bq \cdot h/m^3$)	
		Release	
		early (6 h after shut-down of the reactor)	late (120 h after shut-down of the reactor)
^{131}I*	dry	1.7E+05	2.7E+05
^{131}I	dry	7.3E+05	9.2E+05
^{132}Te	dry	1.4E+06	1.4E+06
^{137}Cs	dry	7.9E+05	7.9E+05
^{131}I*	1 mm/h rain	2.8E+04	1.7E+05
^{131}I	1 mm/h rain	1.9E+05	6.7E+05
^{132}Te	1 mm/h rain	5.2E+04	5.2E+04
^{137}Cs	1 mm/h rain	1.1E+05	1.1E+05
^{131}I*	5 mm/h rain	8.2E+03	8.2E+04
^{131}I	5 mm/h rain	6.1E+04	3.7E+05
^{132}Te	5 mm/h rain	1.4E+04	1.4E+04
^{137}Cs	5 mm/h rain	3.2E+04	3.2E+04
Noble gases	none	2.8E+08	1.9E+09
^{133}Xe	none	1.9E+09	1.9E+09

***** Reference nuclide.

Exposure pathways:	Gamma submersion, inhalation, gamma soil radiation
Soil correction factor:	Negligible, b = 1 (see Chapter 8)
Integration time for Gamma soil radiation:	7 days
Breathing rate:	$3.5 \cdot 10^{-4}$ m^3/s for normal activity
Inhalation dose, integration time:	50 years
Reference group:	Adults

Table 4. Released activities which at distances of 100 km and 300 km, respectively, may lead to an effective dose of 10 mSv within 7 days

Nuclide	Deposition	Released activity at the source (Bq)	
		Time of release	
		Early (6 h after shut-down of the reactor)	Late (120 h after shut-down of the reactor)
Distance source – receiving point: 100 km (receiving point along trajectory)			
^{131}I*	dry	3.2E+17	5.2E+17
^{131}I	dry	1.4E+18	1.8E+18
^{132}Te	dry	2.7E+18	2.7E+18
^{137}Cs	dry	1.5E+18	1.5E+18
^{131}I*	5 mm/h rain	1.6E+16	1.6E+17
^{131}I	5 mm/h rain	1.2E+17	7.1E+17
^{132}Te	5 mm/h rain	2.8E+16	2.8E+16
^{137}Cs	5 mm/h rain	6.1E+16	6.1E+16
^{133}Xe	none	3.5E+21	3.5E+21
Distance source – receiving point: 300 km (receiving point along trajectory)			
^{131}I*	dry	8.3E+17	1.4E+18
^{131}I	dry	3.6E+18	4.5E+18
^{132}Te	dry	6.9E+18	6.9E+18
^{137}Cs	dry	3.9E+18	3.9E+18
^{131}I*	5 mm/h rain	4.1E+16	4.0E+17
^{131}I	5 mm/h rain	3.0E+17	1.8E+18
^{132}Te	5 mm/h rain	7.1E+16	7.1E+16
^{137}Cs	5 mm/h rain	1.6E+17	1.6E+17
Noble gases	none	1.4E+21	9.2E+21
^{133}Xe	none	9.2E+21	9.2E+21

***** Reference nuclide.

Exposure pathways:	Gamma submersion, inhalation, gamma soil radiation
Remote area transport:	NRPB model
Wind speed:	10 m/s
Mixing layer height:	1000 m
Soil correction factor:	negligible, b = 1 (see Chapter 8)
Integration time for Gamma soil radiation:	7 days
Breathing rate:	$3.5 \cdot 10^{-4}$ m^3/s for normal activity
Inhalation dose integration time:	50 years
Reference group:	Adults

Note: The partly higher operational intervention levels (released activity) compared with the inventory (assumption: equilibrium core of a power reactor with approx. 3 700 MW_{th}) show that at distances of 300 km and more sheltering is no longer necessary.

Table 5. Soil contamination which may lead to an external radiation exposure of 10 mSv effective dose within 7 days

Nuclide	Soil contamination (Bq/m^2)
^{131}I*	7.7E+06
^{131}I	6.0E+07
^{132}Te	1.3E+07
^{137}Cs	3.0E+07

***** Reference nuclide.

Exposure pathways:	Gamma soil radiation
Integration time:	7 days
Soil correction factor:	Negligible, b = 1 (see Chapter 8)
Reference group:	Adults

Annex 6

THE GERMAN OPERATIONAL INTERVENTION CRITERIA FOR THE COUNTERMEASURE "STABLE IODINE"

Table 1. Time-integrated air concentrations of ^{131}I which may lead to a thyroid dose of 250 mSv (adults) and 50 mSv (children/pregnant women) due to inhalation

Nuclide	**Time-integrated air concentration (Bq·h/m^3)**			
	Early (6 h after shut-down)		Late (120 h after shut-down)	
	Adults (250 mSv)	**Children/Pregnant women[1] (50 mSv)**	**Adults (250 mSv)**	**Children/Pregnant women[1] (50 mSv**
^{131}I*	5.0E+05	4.8E+04	6.9E+05	6.6E+04
^{131}I	7.4E+05	7.0E+04	7.4E+05	7.0E+04

1. Calculation performed for children. Pregnant women should take iodine tablets as soon as the criterion for children has been reached.

Exposure pathways: Inhalation
Breathing rate: Adults $3.5 \cdot 10^{-4}$ m^3/s for normal activity
Children $9.05 \cdot 10^{-5}$ m^3/s for normal activity

Table 2. Released activities of ^{131}I which at a distance of 100 km and 300 km resp. may lead to a thyroid dose of 250 mSv (adults) and 50 mSv (children/pregnant women[1]) due to inhalation

Nuclide	Released activity at the source (Bq)			
	Early (6 h after shut-down)		**Late (120 h after shut-down)**	
	Reference group		Reference group	
	Adults (250 mSv)	Children/Pregnant women[1] (50 mSv)	Adults (250 mSv)	Children/Pregnant women[1] (50 mSv)
Distance source – receiving point: 100 km (along trajectory)				
^{131}I*	9.5E+17	9.2E+16	1.3E+18	1.3E+17
^{131}I	1.4E+18	1.3E+17	1.4E+18	1.3E+17
Distance source – receiving point: 300 km (along trajectory)				
^{131}I*	2.5E+18	2.4E+17	3.4E+18	3.3E+17
^{131}I	3.6E+18	3.4E+17	3.6E+18	3.4E+17

1. Calculation performed for children. Pregnant women should take iodine tablets as soon as the criterion for children has been reached.

Exposure pathways:	Inhalation
Breathing rate:	Adults $3.5 \cdot 10^{-4}$ m^3/s for normal activity
	Children $9.05 \cdot 10^{-5}$ m^3/s for normal activity
Release period:	12 hours
Average wind speed:	10 m/s
Mixing stratum height:	1 000 m height

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This report summarises information on national emergency preparedness and planning in NEA member countries for the implementation of short-term countermeasures such as evacuation, sheltering and iodine prophylaxis. The information presented may be used to better understand and to compare existing national approaches, procedures, practices and decisions, which may vary among countries due to different national habits, cultural specificity and societal needs. This report may also assist member countries interested in achieving international harmonisation of short-term countermeasures.

OECD Nuclear Energy Agency
Le Seine Saint-Germain – 12, boulevard des Îles
F-92130 Issy-les-Moulineaux, France
Tel.: +33 (0)1 45 24 10 15 – Fax: +33 (0)1 45 24 11 10
E-mail: nea@nea.fr – Internet: www.nea.fr

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