Generic Guidance for Assisting in the Withdrawal of Emergency Countermeasures in Europe Following a Radiological Incident

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1 INTRODUCTION

This document provides generic guidance on the withdrawal of emergency countermeasures such as sheltering and evacuation following a radiological incident. This guidance has been produced with financial support from the European Commission as part of the integrated project, EURANOS. The overall aim of the project is to increase the coherence of emergency preparedness and management in Europe following accidental or deliberate releases of radionuclides to the environment. In order to achieve this aim, recovery handbooks have been produced for assisting in the management of contaminated food production systems and inhabited areas in Europe following a radiological emergency (Nisbet et al.; 2006; Brown et al.; 2007). These handbooks are unique in that they have been produced in collaboration with a wide range of stakeholders from 10 Member States. The generic handbook for inhabited areas includes management options for all phases of the response to a radiological incident. However, guidance on when to withdraw these options, particularly emergency countermeasures such as sheltering and evacuation, was not included in the handbook.

1.1 Development of the guidance

Research in a number of countries on the issues surrounding the withdrawal and management of emergency countermeasures has been used as a basis for developing this generic guidance document. It draws upon unpublished work carried out in the UK and France, new ICRP guidance (ICRP, 2007) and input from stakeholder panels in France, Germany, the UK and Belgium. The guidance should be considered as a living document that will be developed further in the future, both in its generic form and also as customised versions, by some Member States. Customisation at the local, regional or national level is necessary before the full potential of the guidance can be realised. A brief description on how the guidance may be customised is given in Section 3.

1.2 Scope and objectives of the guidance

This guidance document provides advice for the following situations:

- withdrawal of sheltering;
- withdrawal of evacuation;
- evacuation of sheltered populations.

The guidance deals specifically with the process of making decisions for withdrawal of emergency countermeasures during the response to a radiological incident, rather than with the management of these countermeasures. For this reason, the administration of stable iodine tablets to block uptake of radioactive iodine by the thyroid is not considered in this document. Iodine prophylaxis tends to be a one-off countermeasure which does not need to be lifted. The guidance is not directed at any particular type of radiological incident and does not explicitly consider the extent of off-site contamination.

The guidance is intended to be used as part of an approach which aims to involve all those concerned or potentially affected by the release of radioactivity to an inhabited environment. The document has been developed to meet several inter-related objectives:

i. to outline the many factors which influence the withdrawal of emergency countermeasures;

ii. to provide a decision aiding framework on when to withdraw emergency countermeasures.

In addition, it is hoped that dissemination of the guidance will help meet the following secondary objectives:

iii. to generate awareness of emergency preparedness;

iv. to promote constructive dialogue between all stakeholders in planning emergency countermeasures and their management;

v. to identify, under non-crisis conditions, specific problems that could arise, including the setting up of working groups to find practical solutions;

vi. to elaborate plans or frameworks at local, national or regional level to better prepare decision makers in the early and intermediate phases of accident response.

1.3 Audience

It is anticipated that the audience of this guidance on the withdrawal of emergency countermeasures will be those organisations and individuals involved in responding to a radiological incident. The organisations may vary depending on national arrangements for response to a radiological emergency. The types of people and organisations that may be involved could include:

- emergency response personnel (police force, ambulance and fire and rescue services);
- national authorities (including regulators), Government Departments and Central Agencies (with a national remit);
- site operators;
- local authorities;
- experts in radiation protection;
- other stakeholders who may be affected or concerned.

1.4 Application

The guidance is designed for several complementary applications:

- in the pre-emergency, preparation phase, under non-crisis conditions to engage stakeholders and involve them in the development of local, regional and national emergency plans and arrangements;
- in the post-accident phases, following customisation, as part of the decision-aiding process;
- for training purposes, for example during emergency exercises.

1.5 Context

The primary focus of any intervention following a radiological incident is to reduce the exposure of humans to radiation and to minimise the consequences to the health of people exposed. In the early, uncertain phase of an emergency, the objective of a protective strategy should be to avoid serious deterministic injuries and to keep the risk of stochastic health consequences as low as reasonably achievable. To accomplish this, there may be the need to act very quickly and without much specific knowledge of releases or exposures. Such automatic protective measures will, of necessity, follow procedures and processes planned in advance.

As an emergency exposure situation progresses and understanding of the exact circumstances increases, decisions will increasingly be based on actual data rather than on hypothetical scenarios, assumptions and model predictions. The decision to withdraw emergency countermeasures will need to appropriately reflect the prevailing circumstances of the emergency situation being addressed. Many different aspects must be taken into account when reaching such decisions. Radiological protection should be considered as only one part of the protection strategy; financial, social, psychological and other health related aspects must also be taken into account. It is also important to note that the withdrawal of emergency countermeasures doesn't necessarily mean that the incident is over and that normality has been resumed.

1.6 Phases of the response to a radiological incident

In the context of emergency preparedness and response, the International Commission on Radiological Protection (ICRP, 2007) defines the following phases: pre-emergency, early, intermediate and late. The first phase and, in many ways, the most important phase, is the pre-emergency phase, because during this phase the planning of an appropriate and effective response strategy is undertaken.

The early phase starts once it becomes apparent that an exposure or release is happening or is very likely to happen. Depending upon the emergency, it may be possible to distinguish within the early phase, a warning period, that is, a period when no exposure or release has actually started, but the strong likelihood of one occurring has been recognised, and a release or exposure period, during which exposures are actually occurring, and the initiating source of the release/exposure is not under control. It is during this phase that decisions to implement emergency countermeasures need to be taken promptly. Emergency plans must contain straightforward triggers for sheltering

and evacuation, requiring minimum discussion or delay. The early phase will normally last a few hours to a few days, possibly up to a week or even more, depending on the nature of the event (see Figure 1.1).

The intermediate phase begins when the source of the release or exposure has been brought under control, the airborne plume has moved out of the area, and there is no possibility of further release as a result of the implementation of measures that ensure the safety of the plant. During this phase decisions will usually be required on the withdrawal of emergency countermeasures that were imposed in the early phase. The implications and need for longer term recovery options including decontamination measures will need to be assessed, planned in detail and initiated if required. The intermediate phase may last from days to months, depending on the circumstances of the emergency exposure situation. It should also be recognised that even when the source of release has been brought under control it may take some time, perhaps days or even weeks before the responsible authorities are in a position to take a decision on the withdrawal of countermeasures, as the collation of data which can be used to inform such decisions may require some time.

For large-scale emergencies involving long-lived radionuclides, the level of contamination may require protective measures to be implemented over timescales of years (e.g. long-term food restrictions, invasive decontamination measures and relocation). If the purpose of these measures is to continue to reduce potential exposures to a level more acceptable for normal living, the management of the response continues to be that appropriate to an emergency exposure situation. This period is termed the late phase. The boundary between the intermediate and late phases is unlikely to be defined in terms of changes in the exposure pathways or decision timescales. Rather, the late phase will be characterised by the need to continue to manage the emergency exposure situation for a protracted period of time.

The transition from managing the situation as an emergency exposure situation to an existing exposure situation, if required, may take place at some point during the intermediate or late phases. It is not expected that this transition would occur during the early phase, although for small events it might follow it immediately without any intermediate phase. The appropriate time for making this transition is a decision that should be made by the responsible authorities, taking account of the characteristics of the actual situation. It should be noted, however, that for some emergency exposure situations affecting large areas, the management of the response may need to deal simultaneously with different phases over different geographical areas. Thus, a change to management as an existing exposure situation might not occur simultaneously at all locations. In planning for emergency response, it is therefore important to consider issues relevant to each of the phases, since it will not be known in advance exactly when this transition might occur.

The implementation of emergency countermeasures and their subsequent withdrawal take place during the early and intermediate phases of accident response (see Figure 1.1 below).

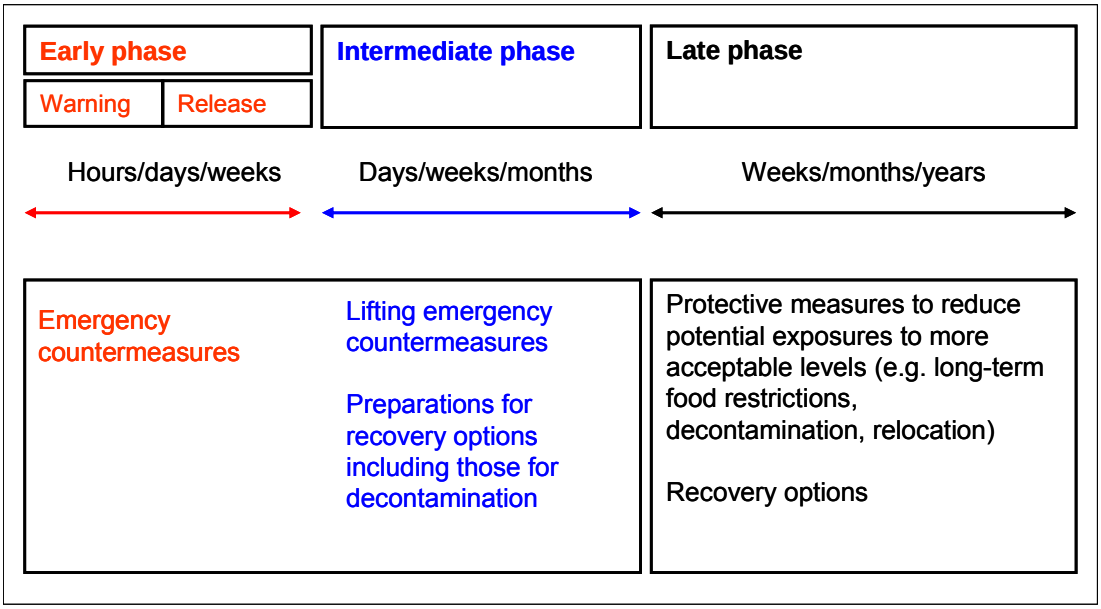

Figure 1.1 Phases of the response during an emergency exposure situation

1.7 Emergency countermeasures

In the event of a radiological incident involving the release of radionuclides into the environment, interventions to protect the population can be implemented. These include iodine prophylaxis, sheltering and evacuation. Of these, only sheltering and evacuation are considered further in the context of the withdrawal of emergency countermeasures. These emergency countermeasures are implemented in different ways throughout the European Union; in some countries emergency countermeasures are enforced by law, while in others they are simply recommended.

Sheltering offers protection from an airborne plume and/or deposited materials. It is not a long-term protective measure and whilst it is easy to implement, it cannot be carried out for long periods, typically for no longer than a day or so. From a radiological protection perspective, the protection afforded by sheltering decreases with time, as radionuclides increasingly filter into a building. Sheltering can also be used as a preparation for an evacuation. People in an area of potential risk can be instructed to go or stay inside and listen to further instruction (usually delivered via television or radio) while preparations for evacuation are being made. However, for very severe reactor accidents, sheltering in a typical home may not be sufficient to prevent deterministic injuries close to the facility. Sheltering is intended to be enforced until additional information can be obtained; therefore monitoring should be performed promptly anywhere it is implemented, to locate hotspots and evacuate people, provided that monitoring teams can access these areas without unjustified risks and that due consideration is given to the doses they may receive.

Evacuation is the rapid, temporary removal of people from an area to avoid or reduce short term radiation exposure in an emergency. It is most effective in terms of avoiding radiation exposure if it can be taken as a precautionary measure before there can be

any significant release of radioactive material. Evacuation is difficult to maintain for periods of more than about one week.

In the case of an accident at a nuclear installation, countermeasures such as sheltering and evacuation are implemented automatically as part of an overall plan executed in response to the emergency. Such plans are generally based on the division of the area surrounding the site into a number of sectors which extend to different distances from the site. Emergency countermeasures would not necessarily be put in place in all the sectors at the same time; the decision on where to implement the countermeasures would take account of the meteorological conditions at the time of the accident (e.g. wind direction) and the geographical features of the area surrounding the site. Emergency countermeasures would, if necessary, be accompanied by other protective measures aimed at reducing or preventing doses from ingestion. These measures may include restrictions on the consumption of locally grown food in the affected area and protection of local food and water supplies by, for example, covering open wells and sheltering animals and animal feed.

Datasheets containing detailed information on sheltering and evacuation are presented in Appendix A. They have been taken from the generic handbook for assisting in the management of contaminated inhabited areas (Brown et al., 2007)

1.8 Withdrawal of emergency countermeasures

1.8.1 Withdrawal of sheltering

Sheltering should be used for a limited period of time, as it is unlikely to be practicable to keep people sheltered in the area affected for more than a day or so. If the release has been short, depending on the monitoring information on contamination levels in the area after the release has stopped, it may be possible to withdraw sheltering relatively quickly and advise people that it is safe to go outdoors. Lifting of sheltering should be accompanied by advice to ventilate buildings. If the release is expected to continue for longer than a period considered acceptable by the responsible authorities, alternative measures should be taken into consideration in order to provide the necessary protection to the sheltered population. In this case sheltering may be lifted only to carry out an evacuation while the release is still taking place. This procedure will be referred to as *displacement* of the sheltered population.

1.8.2 Withdrawal of evacuation advice

Local residents, who have been displaced or evacuated during the early phase, may have to remain outside the area for several days or weeks, depending on the severity of the contamination in the affected area. Decisions concerning the withdrawal of the evacuation advice are taken during the early or intermediate phase following discussion between the public authorities and all of the stakeholders concerned.

1.8.3 Partial withdrawal of emergency countermeasures

There are situations where it may be appropriate to withdraw emergency countermeasures for some groups of people, whilst continuing to recommend they be left in place for other groups. This may be required because of local hotspots or due to the inhomogeneity of contamination. Whilst there may be a clear radiological justification for this approach to the withdrawal of protective measures, the potential for increased anxiety and misunderstanding of the revised advice needs to be recognised and addressed. Ideally there should be a physical gap (e.g. uninhabited space) between areas where countermeasures are still in force and areas where they are not. This would eliminate difficulties in communicating why one side of an invisible line is regarded as safe and the other is not.

Partial withdrawal of sheltering advice could allow a one-off reunion of separated family members. In particular, the reunion of children with parents is likely to reduce anxiety and facilitate the continuation of the countermeasure. Similarly for those requiring medical supplies it may be possible for emergency personnel to be made available to run errands on behalf of those sheltering. This would offer some reassurance to the sheltered population, but would require additional organisation and resources.

Providing for supervised re-entry into the evacuated area for limited periods, whether to collect belongings, to check the security of property or to attend to the needs of animals, may substantially reduce the pressure for an early withdrawal of the evacuation advice. However, the occasional re-entry into an evacuated area must be accompanied by prospective dose assessments with advice on likely risks which have been identified through a formal risk assessment.

Public acceptance of evacuation or sheltering decreases over time, especially when families are separated. Decision-makers could therefore be under pressure to withdraw emergency countermeasures as soon as it is feasible, even if reliable information on contamination levels is not available. In this case, emergency countermeasures could be lifted subject to a number of restrictions to limit potential exposure of the population in the contaminated area. Conditional withdrawal of emergency countermeasures can provide a trade-off between decisions based purely on radiological protection advice and considerations of the socio-psychological aspects that play an increasingly important role in an emergency as the situation evolves. The conditional withdrawal of an emergency countermeasure should be accompanied by a sound communication strategy aimed at keeping the population informed on how the situation develops. Table 1.1 provides a list of restrictions that could be imposed for conditional withdrawal of emergency countermeasures. It should be emphasised that this table only serves for illustration purposes and lists a limited number of possible relevant factors. The table should be developed further by Member States to take account of differences at national level.

Table 1.1 Possible restrictions recommended for conditional withdrawal of emergency countermeasures

Restrictions and recommendations	Relevant advice to consider
People prohibited from staying outdoors for prolonged period of times for non-essential activities. However, they could be allowed outside for short period of times (e.g. to buy food and medicines)	Advice on the meaning of 'prolonged' and 'short' period as well as non-essential activities
Access to areas where outdoor activities take place (e.g. playgrounds, sport complex) restricted temporarily, to allow for monitoring and possibly decontamination	Information on areas and buildings (e.g. schools, stations) that can be accessed and what restrictions are in place
Activities involving use of water bodies (e.g. bathing, swimming and fishing) temporarily prohibited	Advice on use of water in the house for drinking, bathing and cleaning
Consumption of vegetables and fruit grown on private allotment temporarily prohibited	General advice on what food can be eaten; general information on restrictions in place on food and drinking water
People advised to take off their shoes before entering their houses	Advice on measures to take for other items of clothing
'Self-help' and 'self-measurement' actions recommended to help increase public trust and confidence in decision making	General information on the status of emergency countermeasures and recovery plans

2 FACTORS INFLUENCING THE WITHDRAWAL OF EMERGENCY COUNTERMEASURES

The decision to withdraw sheltering and evacuation will need to reflect the prevailing circumstances of the emergency situation being addressed. Premature decisions to withdraw protective measures, before all the specific circumstances of the situation have been evaluated may result in further exposures, if the situation worsens unexpectedly. In general, emergency countermeasures will be withdrawn because they have achieved their desired effect, or their continued application will cause more harm than good (e.g. sheltering beyond a day or so becomes too disruptive). Many different aspects must be taken into account when reaching such decisions and as with all decisions regarding protective measure termination, it is important to involve, wherever possible, relevant stakeholders in discussions. While it will be difficult, if not impossible, to discuss decisions with sheltered populations, it will be essential to discuss decisions to return to evacuated areas with those who have been evacuated. Non-radiological (e.g. economic, social and psychological) consequences may become worse than the radiological consequences if there is a lack of pre-established guidance that is understandable to the public and officials.

Four main criteria that should be considered, before withdrawing emergency countermeasures, have been identified: administrative, radiological, technical and social. Some of these criteria have been further subdivided into different aspects for clarity. The criteria are as follows:

1. Administrative
    - Official confirmation that any release has stopped
2. Radiological
    - Radiological criteria and radiation protection advice
    - Adequacy of monitoring data
3. Technical
    - Availability of resources
4. Social
    - Social and psychological needs
    - Stakeholder dialogue
    - Communication strategy

Other criteria not listed above may become evident in specific situations. The relative importance placed by decision makers on each of these criteria could vary according to the nature and scale of the accident and also on socio-political, economic and cultural perspectives.

2.1 Administrative

2.1.1 Official confirmation that any release has stopped

Official confirmation through, for example, a written statement from the official authorities responsible for the safety of the installation (i.e. independent of the site operator), that the release has stopped, is unlikely to recur and that the plant has been brought under control is a necessary condition for the withdrawal of emergency countermeasures. It is important to note that the cessation of the release does not signify the end of the early phase. Both the site operator and the official authorities responsible for the safety of the plant have to be satisfied that the plant has been brought under control, and it is only when they can be sure that there will be no further releases that the early phase may be deemed over. Although the original fault with the installation may have been repaired, it may be necessary to release further activity to ensure complete safety of the plant. The completion of this chain of events may take some time. The official confirmation that any release has stopped may be used as a trigger for the intermediate phase to begin, although it is important to emphasise that it may be some time before the emergency countermeasures are withdrawn, since before the authorities can take such decisions the radiological impact of deposited activity needs to be measured (see Section 2.2.2) and doses to sheltered or evacuated populations need to be assessed (see Sections 2.2.1 and 2.2.3). Other factors may also be relevant for the switch to intermediate phase, such as the transfer of management control from authorities responsible for the emergency response to others (local authorities). On the basis of this and the other criteria listed above, sheltering can be withdrawn, to permit populations either to return to normal or to be displaced to a reception centre outside the contaminated area. Conversely, those already evacuated or displaced may be able to return home. In both situations the authorities can be confident that no further exposure of the population to the plume will occur.

2.2 Radiological

2.2.1 Radiological criteria

Radiological criteria that have been applied until now in planning the response to a nuclear emergency in the European Union are based on the recommendations of the International Commission on Radiological Protection (ICRP, 1991). The principles which form the basis of these recommendations are that the countermeasures should be introduced if they are expected to do more good than harm, taking account of social and economical factors (justification principle) and that the protection they afford to members of the public should be optimised (optimisation principle). However, ICRP does not recommend any specific limits to the dose the people may receive.

The ICRP has recently published a revised system of radiological protection (ICRP, 2007) which supersedes the 1991 recommendations. It will take several years before these recommendations become integrated into national legislation and policy. A major feature of the new recommendations is an emphasis on optimisation in an emergency situation through the use of reference levels. A reference level represents the level of dose or risk, above which it is judged to be inappropriate to plan to allow exposures to occur. It is recommended that member countries adopt the ICRP recommendations as

they see fit and use these reference levels as a basis for the management of emergency countermeasures. More information on reference levels and an example of how they might be used in an emergency exposure situation is given in Appendix B.

2.2.2 Adequacy of monitoring data

In the event of a radiological emergency, the aim of the monitoring and measurement strategy would ultimately be to produce a radiological map of the area affected. The results of any monitoring programme are likely to take days to weeks to acquire, according to the extent of the contamination and the characteristics of the environment. In principle, the planning of this detailed monitoring programme could be organised in the aftermath of the accident. However, whilst the details could not be planned in advance, greater efficiency would be achieved if top level planning in terms of coordination, access to resources, outline strategy, priorities and other matters were included as part of the emergency planning process. Monitoring would not only be required to perform radiological dose assessments for comparison with intervention and reference levels, but will also be important in stakeholder dialogue and communication processes. The monitoring process can be guided by information obtained by dispersion models. The use of dedicated software tools to visualise the measurement data is part of the monitoring strategy and can improve the efficiency of the monitoring process.

The Nuclear Energy Agency (NEA) has produced a simple framework for developing an appropriate monitoring and measurement strategy to best address a decision maker's needs at any point in time following the accident (NEA, 2000). The framework is based on a series of simple questions.

- Why (for what purpose) should emergency monitoring be performed?
- What (in terms of physical quantities to be measured) parameters should be monitored?
- When (with respect to the time-phases of an accident) should each parameter be monitored?
- Where (with respect to the accident site) should specific parameters be measured?

Using the NEA framework the following type of monitoring strategy presented in Table 2.1 would be appropriate to support decisions on withdrawing emergency countermeasures. The timescales for providing monitoring data to aid decisions on withdrawing advice on sheltering and evacuation are quite different because of the relatively short length of time that people can be expected to shelter. The type of monitoring that can be realistically undertaken for withdrawing each countermeasure is considered below.

Table 2.1 Example of NEA framework for monitoring applied to the management of emergency countermeasures

Questions	Response
Why monitoring should be carried out?	To give an early indication that the emergency has been brought under control and no further releases to the environment are detectable. To indicate that advice to shelter can be withdrawn – either because contamination in the environment is below a pre-determined trigger level or that it is so high as to warrant displacement of the sheltered population to reception centres outside the area. To indicate that additional decontamination measures need to be carried out within the contaminated area whilst evacuated or displaced populations are temporarily re-located outside the area. To indicate that contamination in the environment is such that evacuated populations can return home. To give overall reassurance to the public. To identify local hotspots. To validate model predictions.
What parameters should be measured?	Ambient dose rates. Activity concentrations in air. Ground deposition levels. Food, water and environmental contamination. Surface contamination.
When should each parameter be measured?	Early phase: ambient dose rates; activity concentrations in air. Intermediate phase: ground deposition levels; ambient doses rate; activity concentrations in air; food, water and environmental contamination; surface contamination. Late phase: ambient doses rate; food, water and environmental contamination; surface contamination.
Where should specific parameters be measured?	Around the site: airborne radionuclide concentrations; ambient dose rates. Location of measurements should consider wind direction and geographical features of the area. Within and adjacent to area subject to emergency countermeasures: activity concentrations in air ; dose rates ; ground deposition levels; food, water and environmental contamination; surface contamination. Selection of locations of measurements should take account of wind direction, geographical features of the area and relevance/importance of location. Several tens to several hundreds of km from site: food, water and environmental contamination. Selection of locations of measurements should take account of wind direction, geographical features of the area and relevance/importance of location.

2.2.2.1 Short-term monitoring to indicate that advice to shelter can be withdrawn

There is pressure whilst people are sheltering, especially when the release has stopped, to provide assessments of the likely radiological impact of the release to the sheltered population so that advice to shelter can be lifted. However, given the amount of time it takes to mobilise and deploy sampling and measurement teams, it will not be possible to have sufficient measurement results immediately after the release has stopped. A timeframe must be defined, therefore, to carry out a succinct and indicative rather than a complete and accurate assessment, while the population is still sheltering, of the contamination in the area, based on initial measurements of ambient dose rates and

surface contamination in different sectors of the area affected. A compromise should be found between the extent of detailed monitoring and the extension of sheltering beyond what may be considered a reasonable time. Dispersion models can be very helpful to select the different locations where monitoring should be carried out in this limited time.

2.2.2.2 Longer-term monitoring to indicate that evacuated or displaced populations can return home

In the longer term, radiological protection experts should obtain as much detailed monitoring information as possible on the radiological characterisation of the different types of environment. The area in question will be much larger than the area initially subject to sheltering and evacuation. These measurements should be at locations where people spend their time outside their homes (e.g. roads, gardens, shops, schools, nurseries, playgrounds). However, indoor measurements may be made to verify the assumption that contamination indoors is lower than outdoors. The monitoring strategy may also be planned according to educated assumptions of the contamination pattern into 'low', 'intermediate' and 'highly' contaminated areas (Morrey et al.; 2004). Ideally, the monitoring strategy may initially concentrate on characterising areas where contamination is expected to be low, with a view to an early return of evacuees, rather than obtaining detailed information on contamination levels in areas where it is not expected that evacuees would be allowed to return prior to the implementation of decontamination measures.

2.2.3 Radiation protection advice

Expert radiation protection advice will be required at all stages following a radiological emergency. The advice will extend beyond the use of reference levels discussed in the previous section and will also consider, for example, the requirements and timescales for the implementation of decontamination options. Key features of two types of radiological assessments considered in the context of withdrawing sheltering and returning evacuated or displaced populations to their homes are summarised in Table 2.2. Only radiological uncertainties are included in the table, even though other types of uncertainty exist which are common to both types of assessments (e.g. uncertainties in the models and in parameters used to calculate doses).

Table 2.2 Key features underpinning radiological protection advice

Item	Short-term advice	Long-term advice
Countermeasure in place	Sheltering	Evacuation/displacement
Type of measurements taken	Ambient dose rate; ground deposition levels; airborne radionuclide concentrations	Ground deposition levels; ambient dose rates; airborne radionuclide concentrations; food, water and environmental contamination; surface contamination
Number of measurements	Few	Large
Doses calculated	Effective dose in first week; specific organ doses if appropriate	Effective dose for adults and children on return to the area taking into account decontamination options carried out
Radiological uncertainties	High	Low
Consider reference levels	No	No
Advice if doses are high	Obligatory displacement for unknown duration. Consider decontamination	Obligatory extended period of evacuation or relocation. Consider decontamination
Advice if doses are low	Withdraw sheltering, remain in area and continue monitoring	Withdraw evacuation or displacement, return people to their homes
Stakeholder involvement	Very limited at first, but extensive after withdrawal of emergency countermeasures	Extensive

2.2.3.1 Short-term radiological assessment for withdrawal of sheltering

Before withdrawal of sheltering can take place, the stakeholders must have information on the short term radiological exposure which may result as a consequence of remaining in the contaminated area (e.g. in the first week or first month) and information on the contamination of the environment and foodstuffs. These data would allow a decision to be taken, after rapid consultation between the authorities and local officials, as to whether the population concerned may stay in the area or if they should be displaced to reception centres outside the contaminated area. Radiation protection experts would draw on their knowledge of accidental releases and would utilise measurements taken during the early phase and at the start of the intermediate phase. The area may be divided into a number of sectors for which specific dose calculations will be performed, depending on the specific characteristics at the time of the radiological release (weather conditions, demography). However, it is also important to be equitable and fair, and make sure that no social or cultural group is isolated as a result of this sectoring. The predictions are likely to be quite uncertain and, in the absence of reliable data, should be based on cautious scenarios to ensure that the radiological consequences are not underestimated. For example, effective doses received in the first week could be calculated without factoring in recovery options which may be implemented during this brief period. Radiation protection advice for the withdrawal of sheltering would then follow one of the two options described below.

- Where the authorities and local officials consider the short-term exposure might be significant, they may decide to displace the population when the sheltering order is withdrawn. The decision would need to take into account the number of people concerned and the capacity of the authorities to rapidly identify and equip reception centres or other places suitable for stays of several days to several weeks, depending on the number of people displaced and availability of hotels and other accommodation. A decision taken at this stage would not determine the duration of the displacement, which would be defined later, following a more in-depth consultation phase and taking into account additional recovery options that could be implemented. In some countries, France for example, the displacement at this stage would be obligatory rather than a recommendation (comparable to the imposition of emergency countermeasures during the early phase) because it aims to prevent the population from being exposed to what would be considered as serious levels of radiation during the first week or first month. Radiological protection advice may recommend that decontamination options are carried out in the contaminated area whilst people are away from their homes.
- Where the authorities consider the short-term exposure will not pose a significant risk for health, they may decide to allow the population to remain in the area in the short-term. When a full assessment is made of their longer-term exposure, the authorities, through a widescale consultation process, may justify subsequent displacement of the population, if long-term doses are predicted to be significant.

2.2.3.2 Longer-term radiological assessment – to remain or return to the contaminated area

In the days and weeks following withdrawal of sheltering, it is essential to establish a wide consultation process in order to discuss all possible options with full knowledge of the facts, including radiological risk provided by radiation protection experts.

For the people remaining when sheltering is withdrawn, it will be necessary to predict individual effective doses for different age groups taking into account recovery options which could still be implemented and which would have been agreed during the consultation.

For those displaced when the sheltering advice is withdrawn, it will be necessary to predict individual effective doses for different age groups after their possible return to the area, taking into account recovery options already implemented and those that have been agreed to be implemented during consultation. In some countries, if long-term exposure levels were extremely high, the authorities might consider it necessary to extend the displacement period as an obligation, not recommendation. In France, for example this extension would be granted if annual effective doses during the first few years following the accident were of the order of several tens of mSv. It has to be noted that such an obligation may not be carried out in other countries (e.g. United Kingdom).

2.2.3.3 Subsequent identification of those affected and assessment of doses

Whenever a population experiences trauma, there will be individuals who attribute subsequent ailments to the experience of that trauma. This situation is likely to be exacerbated following a radiological incident. In order both to provide reassurance to those whose increased risk from the accident is very small and to identify and treat appropriately those whose exposure to radiation during the accident is a matter of concern, it is important that records are kept of all those who believe themselves to have been in the area during the period of the release. Whole body monitoring and urine sampling and analysis may, for example, be offered to those who have been exposed (subject to a triage process, where numbers are high). The information collected on these individuals should be sufficient to enable a realistic estimation of their exposure and can be used to estimate the protection afforded by the countermeasures taken.

2.3 Technical

2.3.1 Availability of resources

The resources required for the withdrawal of sheltering principally focus on a mechanism to communicate with the sheltered population. Where sheltered populations have to be displaced to reception centres outside the area, additional resources in terms of manpower and transport are required. Specialist help may need to be provided when displacing people from hospitals, particularly disabled and elderly people. Local authorities would be expected to provide reception centres suitable for overnight accommodation and with facilities for the distribution of cooked food. Medical and counselling services may also be available to provide reassurance with the option to perform whole body monitoring.

The return of evacuated or displaced populations to their homes requires mechanisms to communicate with the evacuated population and additional resources in terms of manpower and transport to bring them home. There is likely to be an additional burden on medical and counselling services as members of the public present themselves for monitoring and to obtain information on their health status.

2.4 Social

2.4.1 Social and psychological needs

Sheltering, particularly for periods in excess of a day, can cause stress which can affect the health and well-being of sheltered populations. The situation becomes particularly difficult after dark, especially in bad weather situations. The following issues need to be recognised and addressed if possible:

- the legitimate desire of families to be together, especially if sheltering in different places;
- the distress caused by the advice to shelter, followed by the obligation to remain in shelter;
- the need to obtain foodstuffs and medical supplies;

- the possible need for medical attention;
- the need for farmers to look after animals (provision of feed, milking of dairy livestock);
- the need for children to play outside;
- the transaction of urgent business;
- inconvenience.

The evacuation or displacement of residents from their homes for periods of days or even weeks can also cause high levels of stress. Emergency evacuation is necessarily urgent and therefore affords little time for those affected to plan what to take with them. Futhermore, it places practical obstacles to the removal of pets and livestock. Concern for the security and lack of access to possessions and anxiety over animal welfare are likely to be major factors driving for early withdrawal of evacuation advice. In addition, economic pressure and the impact on local businesses and trade will be major causes for concern.

Situations in which partial withdrawal of sheltering and evacuation advice might be considered have already been described in Section 1.8.3.

2.4.2 Stakeholder dialogue

The stakeholder dialogue process consists of a consultation or dialogue with the people upon whom a radiological incident would have had a direct or perceived impact. The aim of such consultations would be to determine what courses of action would be the most acceptable. Emergency countermeasures are characterised by their prompt initiation. If they are to be effective, their implementation needs to be prescriptive through direct instructions established in advance, rather than determined on the basis of careful discussion between all stakeholders (e.g. representatives of people who could be asked to shelter or could be evacuated, national and local authorities, emergency services). Therefore, stakeholders need to be involved at the planning stage to help determine appropriate reference levels for emergency exposure situations and trigger levels for the implementation of emergency countermeasures. Once the immediate pressure of the early phase has diminished and the response has entered the intermediate phase, there will be more time available for the engagement of stakeholders (see Figure 2.1). Withdrawal of advice to shelter will probably be carried out without significant interaction with stakeholders because of the short timescales involved. In contrast, return of displaced or evacuated populations will almost certainly involve extensive consultation with stakeholders (see Section 2.4.3 below). For example, wherever possible, the willingness and preferences of the affected populations for returning home should be taken into account. For some people, it may be preferable to stay away from the area until all decontamination measures have been carried out. For others, it may be more important to return home in the knowledge that some remedial work may be necessary at a later date. In this way the social and psychological needs of individuals can be met and excessive levels of stress avoided.

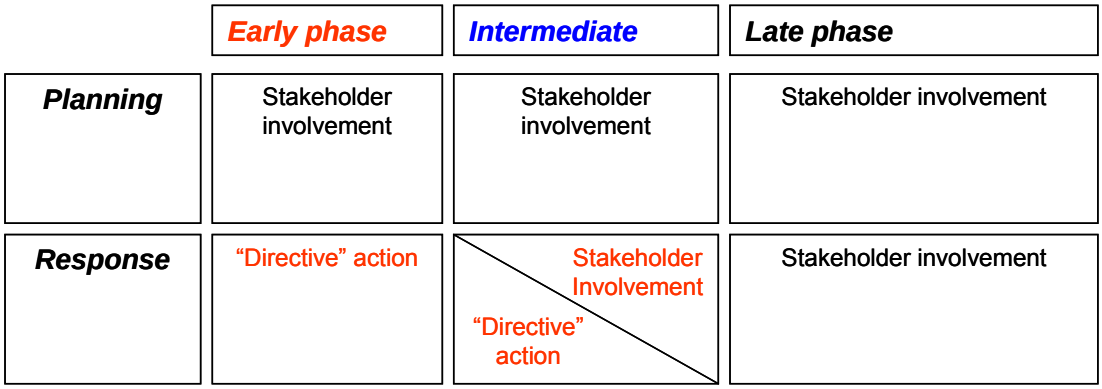

Figure 2.1 Stages at which stakeholder or directive action may be taken at different points in time following a radiological incident

2.4.3 Communication strategy

In situations involving radioactive contamination of the environment, information and communication issues are likely to be very important, whatever the scale of the release. The provision of information and how that information is communicated will have a significant influence on how the authorities tackle the situation, on the response of society to the event and on the overall success of the management strategy (Nisbet et al., 2006).

Knowledge will be limited in the early phase of an accident and, therefore, information should properly reflect such uncertainties and any advice given err on the side of caution. In most cases, people also need information and advice on what they can do personally to reduce exposure, particularly with respect to their children.

2.4.3.1 Developing a communication framework

Feedback from past radiological accidents has highlighted the importance of developing a framework for information and communication strategies under non-crisis conditions. This should be set up in the planning phase and be dynamic enough to fit in with the evolution of the situation over time. There are a few key points to consider:

- the development of a communication framework should ideally include stakeholder involvement due to the complexity of the issues, the wide range of people likely to be affected and uncertainties about characteristics of future accidents;
- the type of information disseminated should be tailored to meet the needs of a variety of people (i.e. those inside and outside the affected area, those involved in implementing actions, those affected by the actions, those who may come into contact with products or individuals from directly affected areas);
- the form of communication should be adapted to different levels of understanding, to reflect the circumstances under which people live and to address the specific issues at stake and problems being faced;

- at all stages of the response, authorities should not underestimate the constant need for information and the need to consult different stakeholders, including experts and lay people, to learn about the needs and expectations of communities, what they know and what they do not know and what the uncertainties are.

2.4.3.2 Communication in the early phase

Uncertainty is a key issue in the early phase of a nuclear accident. If communication can be established between those responsible for the protection of the public and those subject to emergency countermeasures, information can be provided on the actions being taken, likely timescales for decisions and the options that are being discussed. An example of a method to communicate with those most affected is via information centres set up in reception centres. These centres would provide support to people who have had to move away from their homes, either as a result of evacuation or displacement. In particular, it will be necessary to explain that the timescales for the withdrawal of advice to remain outside the contaminated area can only be decided after detailed monitoring and radiological assessments have been carried out and therefore it is important to provide these people with feedback on the progress of the monitoring programme.

2.4.3.3 Communication in the intermediate and late phases

In the intermediate and late phases, communication with stakeholders will be required for them to obtain a clear view of the new situation. In order to fulfil this requirement, public meetings may be held to allow views of stakeholders to be aired and taken into account in any subsequent actions proposed by the authorities. Ideally those advised to stop sheltering or return to their homes will be briefed on subsequent health monitoring programmes and how they can obtain information on their own health status. There may also be experts who can explain, in particular, the practicability of decontamination options for the inhabited areas and surrounding agricultural land and semi-natural environments. The recovery strategies should be able to address the expectations of the population and illustrate how populations may play their own role, notably by adapting their living and eating habits.

Public confidence will inevitably be shaken when an accident occurs. An open dialogue and discussion will be essential in building mutual understanding and a balanced view of the situation. It should not only involve representatives from the area subject to sheltering and evacuation, but also the elected officials and representatives of residents' associations from the surrounding area. People living and working in the surrounding areas may question whether or not they too should leave the area, especially if their neighbours had been displaced. The discussions should involve question and answer sessions with experts from central agencies, Government Departments and other organisations, especially with regard to the effectiveness of clean-up measures and the feasibility and schedule for their implementation.

3 SUPPORT FOR PLANNING AND CUSTOMISATION

The response to nuclear accidents is managed primarily at local level. The guidance provided in this document is generic and intended to be broadly applicable across Europe. However, there is a considerable diversity of climatic conditions, types of inhabited area, culture, infrastructure and regulatory frameworks within the European Union. Consequently, organisations at local, regional and national level need to develop their own guidance and plans for managing emergency countermeasures, according to their responsibilities and involvement. As these may be very different it is important that this generic guidance is customised according to the need of each country. The types of information and the level of detail required by different users will vary and need to be taken into account during the customisation process.

Customisation of the generic guidance for assisting in the withdrawal of emergency countermeasures is an essential part of planning in advance of an incident. The purpose of this section is to support this planning process by considering key topics such as requirements for information and outline arrangements prior to an emergency. Planning should be a co-ordinated activity between all relevant agencies. An essential component of the planning and customisation process is the involvement of stakeholders who should meet together to develop a common language and a shared understanding of the issues at stake at national, regional or local level. Various approaches for co-developing guidance with stakeholders can be used, including scenario based workshops and establishment of subgroups for more detailed planning on specific topics (e.g. monitoring, communication, welfare).

Table 3.1 provides a breakdown of topics covering data and information requirements that could usefully be gathered in advance of an accident. Table 3.2 gives a list of factors, in addition to the information requirements listed in Table 3.1 that might need to be considered when developing an outline strategy, focussed at the local level, for the withdrawal of emergency countermeasures in advance of an incident.

Table 3.1 Data and information requirements that could usefully be gathered in advance of an incident (based on Brown et al., 2007)

Topic	Comments
Population	Population distribution and size. Population groups (e.g. school children, religious groups, patients, prisoners, tourists). Population movements (e.g. commuters, students, holidaymakers). Time that the population spend outdoors (e.g. farmers versus office workers).
Type of buildings	Construction method (e.g. brick, wood). Configuration (e.g. multi-storey, terraced, semi-detached, detached). Location factors. Air exchange/ventilation.
Types of sub-areas/land use	For example: • industrial • recreational • public buildings • residential • food production. Also, critical facilities (factories, hospitals etc) and infrastructure (water treatment works, sewage treatment plants, roads, railways etc) that would need to be kept open in the event of a radiological emergency.
Background dose rates	Determine what typical background dose rates in the area are to aid monitoring and communication with the public.
Waste management	Authorised limits for incinerators, landfill sites, composting facilities etc. Number, type and capacities of facilities. Quantities of domestic refuse produced weekly, including garden waste. Ways to segregate contaminated garden waste from household domestic refuse. Normal practices for disposal of waste arising from the treatment of waste water and refuse (e.g. sewage sludge, incinerator ash, composted material). Disposal options for contaminated commercial goods that are unsaleable (not necessarily because they are highly contaminated). Siting of waste storage and disposal facilities. Legislation on construction of waste facilities.
Personnel to implement recovery options	List of available contractors and organisations that can be contacted for advice on techniques, equipment, staff protection and other matters.
Contacts	Lists of contacts in organisations that have a role in the event of a radiological emergency. Lists of contacts with local information. Lists of national, regional and local databases that provide useful background data and information on how to access them.

Topic	Comments
Available resources to implement recovery strategy	Local and regional availability of equipment and materials required for implementation of options (i.e. the quantity of equipment and materials that can be made available in a particular time period). Costs of resources: labour costs, cost of materials and equipment. Need to maintain any 'call-on' equipment for response purposes (e.g. fire tenders). Are skilled workers required to operate equipment? How many skilled workers are available? Would they work in contaminated areas?
Technical feasibility	Are decontamination techniques used in normal commercial operations or will the development of specific skills and methods be required? Identification of what training will be required to ensure that required levels of decontamination are achieved.
Impact of recovery options on economy and environment	What is the likely scale of the economic impact from implementing recovery options? What options may have a positive impact (e.g. make the environment cleaner or more attractive)? What options may have a negative impact on the environment?
Management of contaminated waste water from natural run-off	Understanding of drainage and sewage plant systems in local area. What happens to excess water that bypasses treatment (e.g. water following rain storms or floods)? What level of staff intervention is there during the sewage treatment process?
Acceptability of recovery options	This is likely to be influenced by the type of radiological emergency or incident, its size, how the response is handled, the cause of the emergency and other factors. However, public and other stakeholder views on the acceptability of the types of recovery options available could be sought to reduce the number of options to be considered in the event of a radiological emergency.
Relocation	Numbers of people in inhabited areas. Availability of and provision of resources for accommodation and housing. Availability of transport, private car ownership. Transport infrastructure (e.g. roads, railways).
Impact of geography and weather on recovery options	Availability of meteorological information, including weather forecasts Use of geographical information systems to provide information on soil types, topography and other relevant quantities.

Table 3.2 Factors and actions that might need to be considered when developing an outline strategy for withdrawal of emergency countermeasures (based on Nisbet et al., 2008; Brown et al., 2007)

Topic	Factors and actions to consider
Generic strategy	Ensure information requirements (see Table 3.1) are prioritised, actioned, achieved and maintained – it is important to have confidence that information is complete, reliable and up-to-date. Establish mechanisms for accessing information. Establish a monitoring programme. Consider how countermeasures implemented in the emergency phase will impact on overall recovery strategy. Consider employing a phased approach in which some contaminated areas are dealt with promptly, whereas other are treated later. Consider the role of self-help. Consider what the impact of different weather conditions and the geography of the area will have on the strategy and choice of recovery options. Produce and maintain a risk register for things that could go wrong in the development of the strategy (e.g. non-compliance, local population won't engage in dialogue). Identify drivers and barriers and establish which ones will make the biggest difference.
Recovery criteria	Identify appropriate criteria (radiological and non-radiological) to be used to determine the need for and scale of emergency and recovery countermeasures and to measure their success.
Recovery options	Identify practicable and acceptable recovery options in advance. Consider: • any constraints on the use of an option • impact of weather conditions (i.e. when will options not be practicable due to snow, frozen surfaces, thunderstorms and other weather conditions). Which countermeasure options might be applicable to the range of possible emergency scenarios? How might they be implemented? How will waste be managed? Customise data sheets for country specific information and use by different users.
Legislation	Radiological protection (e.g. workers and public). Waste management. Specific legislation at local, regional or national level which may apply (e.g. restriction placed on removal of trees). Compensation rights, including international agreements on compensation for radiological emergencies.
Training	Consider developing a training programme for the roles required to be performed (e.g. decision-makers, decontamination workers and civil protection personnel). Provision of information on the objectives of the recovery option to ensure that those implementing the option understand why it is being undertaken and how the objective can be achieved. Leaflets to provide instruction on how to implement options correctly and effectively for situations where major training exercises are not possible.
Communication	Develop a communication strategy with pre-prepared information. Establish audience, message and how it will be conveyed.
Roles and responsibilities	Identify the roles and responsibilities of those agencies that would undertake tasks in the emergency response. Identify leading agencies and legal responsibilities. Think about how available resources will be co-ordinated and moved to the affected area (e.g. the use of army, civil protection).

Topic	Factors and actions to consider
Role of local government and local agencies	Explore the best role for the local government and local agencies. Balance their level of experience in emergency and recovery response with the public confidence gained by them being involved early on and the advantage of their local knowledge.
Role of stakeholders	Identify existing stakeholder groups in the area (e.g. community groups). Investigate whether these could/would be prepared to provide feedback on possible strategies for the area. Consider processes that could be used to establish new stakeholder panels where no relevant groups exist.
Protection of workers	Agreement between regulatory bodies, radiological protection specialists and employers on which countermeasures are likely to require the use of respiratory protection equipment or protective clothing. This should take into account the nature and extent of contamination, the time since the radiological emergency started and whether people are still living in the area.

4 DATASHEETS FOR THE WITHDRAWAL OF EMERGENCY COUNTERMEASURES

It can be seen from Section 2 that there is a large amount of information that needs to be considered before a decision can be made on the withdrawal of emergency countermeasures. A datasheet template, similar in format to those used in the generic European handbooks for food production systems and inhabited areas (Nisbet et al.; 2006; Brown et al.; 2007), was used to systematically record information in a standardised format, taking into account most of the criteria that decision-makers might wish to consider when evaluating these countermeasures. The template structure which is presented in Table A.1 of Appendix A includes a short description of the countermeasure, its key attributes, constraints, radiological criteria, feasibility, requirements, costs, side effects, and a summary of practical experience of implementing the option.

The datasheets for the withdrawal of advice to shelter and withdrawal of advice to evacuate or displace are given in Table 4.1 and Table 4.2 respectively.

Table 4.1 Datasheet for withdrawal of advice to shelter

ID: 1 **Withdrawal of advice to shelter**	
Objective	To allow people the freedom to leave their place of shelter following passage of the plume or To displace people from their place of shelter due to either a prolonged release or a relatively high external doses from deposited radionuclides.
Other benefits	
Management option description	Sheltering should be used for a limited period of time, as it is unlikely to be practicable to keep people sheltered in the area affected for more than a day or so. If the release has been short, depending on the monitoring information on contamination levels in the area after the release has stopped, it may be possible to withdraw sheltering relatively quickly and advise people that it is safe to go outdoors. Lifting of sheltering should be accompanied by advice to ventilate buildings. If the release is expected to continue for longer than a period considered acceptable by the responsible authorities, alternative measures should be taken into consideration in order to provide the necessary protection to the sheltered population. In this case sheltering may be lifted only to carry out an evacuation while the release is still taking place i.e. displacement of the sheltered population.
Target population	People living in inhabited areas who have been advised to shelter because of the presence or expected future presence of radioactive contamination in the area.
Targeted radionuclides	All radionuclides.
Scale of application	As for sheltering, which for planning purposes is typically limited to a few kilometres around nuclear sites.
Timing of implementation	Withdrawal of sheltering is a matter of some urgency. Advice to withdraw sheltering will be given in either the early or intermediate phase.
Order of priority	Decision on withdrawing sheltering will normally be accorded the highest priority. However, pressures to withdraw this countermeasure precipitously should be resisted.
Constraints	
Legal constraints	
Environmental / technical constraints	Doses from exposure to radioactivity in the plume and the nature of the environment could hinder communication of advice to withdraw sheltering. These factors could also hinder the displacement of populations following the withdrawal of sheltering.
Social constraints	Sheltering may become increasingly stressful due to: • the legitimate desire of families to be together if sheltering in different places • the distress caused by the order to shelter, followed by the obligation to remain in shelter • the need to obtain foodstuffs and medical supplies • the possible need for medical attention • the need for farmers to look after animals (provision of feed, milking of dairy livestock) • the need for children to play outside • the transaction of urgent business • inconvenience

ID: 1	
Withdrawal of advice to shelter	
Radiological criteria	
Indicator	Estimation of effective doses received in the first week and in the first month. The predicted doses are likely to be quite uncertain and, in the absence of reliable data, should be based on cautious assumptions to ensure that the radiological consequences are not underestimated. For example, effective doses received in the first week could be calculated without factoring in recovery options which may be implemented during this brief period.
Technical data	Ambient dose rate, ground deposition, air concentrations, nature of emissions.
Reference levels	No specific reference levels are set to aid decision on withdrawal of sheltering. ICRP advises that a reference level for the overall residual effective dose incurred during an emergency exposure situation could be set in the band 20 mSv – 100 mSv.
Doses	
Additional doses	None, if advice is given over the local radio and TV. Where this is not possible, emergency personnel would have to enter the area to communicate with the sheltered population, thereby receiving an additional dose. For prolonged releases and releases that have stopped, where the advice to withdraw sheltering is followed by displacement of the population, additional doses would be received by the population when leaving the area, due to inhalation from the plume and resuspended activity and external exposure to deposited activity. Emergency personnel assisting with the displacement will also receive additional doses, which can be assessed by the wearing of personal dose rate meters.
Factors influencing effectiveness of procedure (technical)	Effectiveness of communication mechanism to deliver advice (e.g. siren, phone call, radio, television, door to door).
Factors influencing effectiveness of procedure (social)	Compliance of the public to be displaced after a period of sheltering. Trust of the public in the authorities.
Requirements	
Equipment	Monitoring equipment to provide measurement data on ambient dose rates, ground deposition levels and activity concentrations in air.
Utilities and infrastructure	Predictive models; mechanisms for sharing and sending monitoring data. Mechanisms to communicate with sheltered population; transport for population being displaced; reception centres suitable for overnight accommodation; medical and counselling services including personal monitoring.
Consumables	Prepared leaflets.

ID: 1	Withdrawal of advice to shelter
Skills	Staff familiar with sampling and monitoring procedures. Staff familiar with interpretation of data. Staff with skills in predictive modelling. Staff with skills in using communication equipment. Radiation protection specialists. Medical doctors and nurses. Counsellors.
Safety precautions	Personal Protective Equipment (PPE) may be required for people entering the area to displace sheltered populations. Personal dose rate monitors.
Communication	Ideally, a method of dialogue should be set up within emergency planning zones under non-crisis conditions. This should be developed through stakeholder involvement to find a consensus on the most acceptable mechanisms of communication. The implications of displacing sheltered populations for prolonged atmospheric releases or when ground contamination levels are high need to be considered by local populations and appropriate methods of disseminating this information made available.
Stakeholder involvement	Essential at the planning stage because withdrawal of advice to shelter will be carried out without much interaction with stakeholders, due to short timescales.
Intervention costs	
Equipment	The type of monitoring equipment will depend on which radionuclides are present and what measurements are being made (i.e. activity concentration in air, ambient doses rate, ground deposition). PPE and personal dose rate monitors may also be required.
Consumables	Printing of leaflets.
Labour	Standard labour rates for: • designing and printing of leaflets • carrying out monitoring and measurements • recording and reporting of results • transporting displaced populations • provision of medical and counselling services
Operator time	Time required to remove the countermeasure, according to size of affected population. Time required to displace sheltered populations. Time required to provide information, advice and guidance.
Factors influencing costs	Factors that may influence the cost of withdrawing advice to shelter include the size and accessibility of the target population and how many of the sheltered population subsequently need to be displaced. The form of communication used will influence costs associated with giving the advice to withdraw sheltering (e.g. press releases, television interviews, public meetings, leaflets, internet articles, telephone hot lines).
Side effects/impact	
Environmental impact	None.

ID: 1	
Withdrawal of advice to shelter	
Social impact	Partial withdrawal of sheltering advice could allow a one-off reunion of separated family members. In particular, the reunion of children with parents is likely to reduce anxiety and facilitate the prolonging of the countermeasure.
Practical experience	Sheltering and thereby withdrawal of sheltering for non-radiological incidents (e.g. chemical incidents).
Key references	Oudiz A, Dubian P, Cessac B, Maigne J-P (2005) Sheltering withdrawal after a nuclear accident. International conference on monitoring, assessments and uncertainties for nuclear and radiological emergency response. Rio de Janeiro, 21-25 November 2005
Version	1

Table 4.2 Datasheet for withdrawal of evacuation or displacement advice

ID: 2 **Withdrawal of Evacuation or Displacement Advice**	
Objective	To allow people to return to their homes.
Other benefits	
Management option description	Local residents, who have been displaced or evacuated during the early phase, may have to remain outside the area for several days or weeks, depending on the severity of the contamination in the affected area. Decisions concerning the withdrawal of the evacuation advice are taken during the intermediate phase following discussion between the public authorities and all of the stakeholders concerned.
Target population	People living in inhabited areas who have been evacuated or displaced because of the presence of radioactive contamination in the area.
Targeted radionuclides	All radionuclides.
Scale of application	As for evacuation and displacement of sheltered populations – for purposes of planning is typically limited to a few kilometres.
Timing of implementation	Early or intermediate phase – once the full pattern of environmental contamination has been assessed. Too rapid a relaxation of evacuation or displacement advice could result in unnecessary exposure of the population. Temporary supervised re-entry into the evacuated area for limited periods, whether to collect belongings, to check the security of property or to attend to the needs of animals, should be considered during the early phase.
Order of priority	Lowest priority. Those who have been evacuated are at no risk from exposure to radionuclides released during the accident. Therefore pressure for a rapid return to the evacuated area should be resisted. Consideration should not be given to lifting an evacuation notice before the situation involving those sheltering has been resolved. Higher priority should be given to temporary re-entry into the evacuated areas, as this measure may substantially reduce the pressure for an early withdrawal of the evacuation advice.
Constraints	
Legal constraints	
Environmental / technical constraints	An adequate monitoring programme in the area to provide reassurance that it is safe for people to return. Requirement to decontaminate some properties, communal areas etc. before people can return. Resources available for decontamination.
Social constraints	The lives of the evacuated community will be significantly disrupted, with consequences on families, jobs, education, finances and other matter. There will be concern about security and lack of access to personal possessions, anxiety over pets and livestock. Reception centres will not be well equipped with the amenities found in permanent residences. It will be unlikely that evacuees will accept reduced standards of living for extended periods of time. People may be reluctant to return to an area, particularly if schools were affected by contamination. People may need to move to hotels and other accommodation. Press may want to interview evacuees.

ID: 2	
Withdrawal of Evacuation or Displacement Advice	
Radiological criteria	
Indicator	Estimation of effective doses likely to be received by adults and young children during the first year following their return to the area and in subsequent years, taking account of any recovery options and decontamination measures.
Technical data	Ground deposition levels; ambient doses rate; activity concentrations in air; food, water and environmental contamination; surface contamination. Effectiveness of recovery and decontamination options.
Reference levels	No specific reference levels are set to aid decision on withdrawal of evacuation. ICRP advises that a reference level for the overall residual effective dose incurred during an existing exposure situation could be set in the band 1 mSv – 20 mSv.
Doses	
Additional doses	None.
Factors influencing effectiveness of procedure (technical)	
Factors influencing effectiveness of procedure (social)	Compliance of the public to return to live or work in the contaminated area or to send children to school in the contaminated area. Trust of public in the authorities.
Requirements	
Equipment	Monitoring equipment to provide measurement data on: ground deposition levels; ambient doses rate; radionuclide concentrations in air, food, water and other environmental media; surface contamination. Equipment to carry out recovery and decontamination measures.
Utilities and infrastructure	Predictive models. Mechanisms to communicate with evacuated population; transport for population returning to contaminated area; medical and counselling services including personal monitoring.
Consumables	Prepared leaflets.
Skills	Staff familiar with sampling and monitoring procedures. Staff familiar with interpretation of data. Staff with skills in predictive modelling. Staff with skills in using communication equipment. Radiation protection specialists. Medical doctors and nurses. Counsellors. Staff able to carry out decontamination of the area.
Safety precautions	Personal protective equipment (PPE) for those carrying out decontamination measures.

ID: 2 **Withdrawal of Evacuation or Displacement Advice**	
Communication	Ideally, a method of dialogue should be set up within emergency planning zones under non-crisis conditions. This should be developed through stakeholder involvement to find a consensus on the most acceptable mechanisms of communication. A method for communicating, quickly and efficiently, the status of the emergency and reasons for the new advice to those affected should be included in emergency plans. This communication method should be able to provide clarifications over time and answer questions. Both verbal and written communication with the evacuated population is necessary before allowing them to return. Communication to evacuated/displaced populations on health monitoring programmes.
Stakeholder involvement	Essential at the planning stage to establish the mechanisms that should be put in place. The return of evacuated populations will involve extensive communication with stakeholders.
Intervention costs	
Equipment	The type of monitoring equipment will depend on which radionuclides are present and what measurements are being made (ambient doses rate, ground deposition, activity concentrations in food, water and other environmental media; surface contamination). It may be necessary to carry out decontamination of properties and public places prior to the return of evaluated or displaced populations. In addition to the specific equipment required for these measures, PPE and personal dose rate monitors may also be required for those carrying out the work.
Consumables	Printing of leaflets.
Labour	Standard labour rates for: • design and print of leaflets • carry out monitoring and measurements • record and report of results • carry out decontamination measures • transport evacuated populations to their homes • provide medical and counselling services
Operator time	Time required to remove the countermeasure, according to size of affected population. Time required to return evacuated populations. Time required to provide information, advice and guidance .
Factors influencing costs	Factors that may influence the cost of withdrawal of evacuation/displacement advice include the size and accessibility of the target population. The form of communication used will influence costs associated with giving the advice to withdraw evacuation/displacement (e.g. press releases, television interviews, public meetings, leaflets, internet articles, telephone hot lines).
Side effects/impact	
Environmental impact	None.

ID: 2	
Withdrawal of Evacuation or Displacement Advice	
Social impact	Providing for supervised re-entry into the evacuated area for limited periods, whether to collect belongings, to check the security of property or to tend to the needs of animals, may substantially reduce the pressure for an early withdrawal of evacuation advice. The occasional re-entry into an evacuated area must be accompanied by prospective dose assessments on likely risks. People returning back to a contaminated area after withdrawal of evacuation may face economic difficulties. In some parts of Europe, people returning to a contaminated area may be stigmatised. Additional burden on medical and other local services following lifting of evacuation.
Practical experience	Experience from Ukraine and Belarus for radiological situations, also worldwide experience following evacuation from other hazards.
Key references	
Version	1

5 DECISION-AIDING CHECKLISTS

In the event of a radiological accident, decision-makers will need to be in a position to construct a strategy for managing the withdrawal of emergency countermeasures. For small-scale short duration releases, withdrawal of sheltering after a few hours may be a straightforward decision. For larger-scale, longer-duration releases involving several nuclides, a management strategy is likely to be more complex with the potential for displacing sheltered populations. A series of checklists have been developed in conjunction with stakeholders taking into account the main criteria that should be considered before a decision is taken to withdraw sheltering or evacuation advice. Each of these criteria has been broken down into the main factors to consider. Checklists are presented for withdrawal of sheltering (see Table 5.1), withdrawal of evacuation (see Table 5.2) and evacuation (displacement) of sheltered population (see Table 5.3). It should be stressed that following a radiological accident different emphasis may be placed on various factors depending on the specifics of the incident (e.g. time of day, special need of schools, hospitals or other vulnerable areas). Nevertheless, a risk assessment should be carried out where criteria have not been met or only partly met, to demonstrate that the impact is either low or the likelihood of it occurring is low.

Table 5.1 Checklist for withdrawal of sheltering (no displacement)

Criteria	Factors to consider	Considered?
Confirmation that plant has been made safe	Plume moved out of area and unlikely to return.	
	Incident at plant under control.	
	No further release likely.	
Adequacy of monitoring data	Availability of succinct and indicative measurements (activity concentrations in air, ambient dose rate, surface contamination).	
	Measurements available within and adjacent to the area.	
	Visualisation of monitoring data on suitable medium (e.g. maps).	
Radiological criteria	Estimation of total doses for comparison with reference levels of residual dose, if specified.	
	Comparison of contamination levels or ambient dose rates with an agreed set of trigger levels for the lifting of sheltering, if specified.	
	Comparison of contamination levels or ambient dose rates with an agreed set of triggers levels for evacuation (displacement) of sheltered populations.	
Radiological protection aspects	Resources to continue monitoring after withdrawal of sheltering	
	Options for further reducing exposures (e.g. decontamination of public places, roads, gardens, schools, playgrounds, restrictions on behaviours)	
Availability of resources	Mechanism for communicating with sheltered populations (e.g. helpline, local radio).	
Social and psychological needs	Reuniting of families.	
	Requirements for urgent medical supplies for existing medical conditions.	
	Requirements for urgent medical attention, not related to incident.	
	Requirements for farmers to tend to livestock.	
	Concern of affected people about impact of accident on their health.	
Stakeholder dialogue	Identify affected population and initiate dialogue with authorities as soon as possible.	
Communication strategy	Use any pre-established mechanisms (e.g. press releases prepared in advance, statements, leaflets).	

Table 5.2 Checklist for withdrawal of evacuation

Criteria	Factors to consider	Considered?
Confirmation that plant has been made safe	Plume moved out of area and unlikely to return.	
	No further release likely.	
Adequacy of monitoring data	Availability of widespread and indicative measurements (e.g. ambient dose rate, surface contamination).	
	Measurements available in a variety of environments (e.g. roads, gardens, schools, shops, playgrounds) focussing on places where people spend their time.	
	Account taken of implemented management options which will impact on predicted doses.	
	Availability of indoor measurements.	
	Visualisation of monitoring data on suitable medium (e.g. maps).	
	Focus first on characterising areas of expected low contamination, with a view to an early return of evacuees.	
Radiological criteria	Estimation of total doses for comparison with reference levels of residual dose, if specified. Take into account the impact of any management options (e.g. decontamination options) already implemented.	
	Comparison of contamination levels and ambient dose rates with an agreed set of triggers levels for lifting of evacuation, if specified.	
Radiological protection aspects	Resources to continue monitoring after withdrawal of evacuation.	
	Options for further reducing exposures (e.g. decontamination of public places, roads, gardens, schools, playgrounds, restrictions on behaviours)	
Availability of resources	Mechanisms for communicating with evacuated populations.	
	Resources for returning populations to their homes (i.e. manpower and transport).	
	Availability of accommodation should the population need to remain out of the area, temporarily or permanently.	
	Availability of medical and counselling services.	
Social and psychological needs	Reuniting owners with pets and livestock.	
	Arrangements for the care of livestock (e.g. milking of cattle).	
	Measures to ensure security of individuals' possessions.	
	Compensation for loss of earnings to local businesses and trade.	
Stakeholder dialogue	Engagement of relevant stakeholders for extensive consultation.	
	Inclusion of individuals from surrounding areas in	

Criteria	Factors to consider	Considered?
	stakeholder discussions.	
Communication strategy	Initially: communication with evacuees (e.g. via information centres, media broadcasts, helplines).	
	Intermediate and late phases: Availability of a method for stakeholders to air their views (e.g. public meetings).	
	Effectiveness of implemented management options based on expert opinions.	
	Information on how evacuees can help ('self-help' options).	

Table 5.3 Checklist for evacuation of sheltered populations (displacement)

Criteria	Factors to consider	Considered?
Confirmation that plant has been made safe	Plume moved out of area and unlikely to return.	
	No further release likely.	
Adequacy of monitoring data	Availability of succinct and indicative measurements (e.g. activity concentrations in air, ambient dose rate, surface contamination).	
	Measurements available within and adjacent to the area.	
Radiological criteria	Estimation of total doses for comparison with reference levels of residual dose, if specified.	
	Comparison of contamination levels or ambient dose rates with an agreed set of triggers levels for the lifting of sheltering, if specified.	
Radiological protection aspects	Resources to continue monitoring after displacement of population.	
	Estimation of exposures during displacement.	
	Options for further reducing exposures (e.g. decontamination of public places, roads, gardens, schools, playgrounds, restrictions on behaviours)	
Availability of resources	Mechanism for communicating with sheltered populations (e.g. helpline, local radio).	
	For sheltered population being displaced authorities need to consider: • Numbers of people affected • Transport available • Capacity to identify and equip reception centres • Provision of whole body monitoring and counselling	
Social and psychological needs	Concern over security of property.	
	Access to possessions.	
	Animal welfare.	
	Impact on local businesses.	
	Concern of affected people about impact of accident on their health.	
Stakeholder dialogue	Identify affected population and initiate dialogue with authorities as soon as possible.	
Communication strategy	Use any pre-established mechanisms (e.g. pre-prepared press releases, statements, leaflets).	
	Establish information centres.	

6 REFERENCES

Brown J, Mortimer K, Andersson K, Duranova T, Mrskova A, Hänninen R, Ikäheimonen T, Kirchner G, Bertsch V, Gallay F, Reales N (2007). Generic Handbook for Assisting in the Management of Inhabited Areas in Europe Following a Radiological Emergency. Available from http://www.euranos.fzk.de

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7 GLOSSARY

Term	Definition
Activity	The rate at which nuclear decays occur in a given amount of radioactive material. Unit: becquerel, Bq (1 Bq = 1 decay s^{-1})
Alpha (α) emitters	Radioactive materials for which the most hazardous type of radiation emitted is alpha particles (e.g. the radionuclide plutonium-239 is an alpha emitter)
Averted dose	The dose that would have been received if a *management option* had not been implemented
Beta (β) emitters	Radioactive materials for which the most hazardous type of radiation emitted is beta particles (e.g. the daughter of strontium-90 (yttrium-90) is a beta emitter)
Contamination/radioactive contamination	The deposition of radioactive material on the surfaces in *inhabited areas* or into drinking water sources and supplies
Countermeasure	See management option
Datasheet	A compilation of data and information about a *management option* designed to support decision-makers in the evaluation of an option and the impact of its implementation
Decision-makers	Persons or groups of people, who evaluate the various *management options* and decide on a recovery strategy or options within a recovery strategy. Decision-makers may include local councils and representatives, water and health authorities, police force and fire brigade, environment agencies, national authorities and radiation specialists
Decontamination	The removal of radioactive material from surfaces in *inhabited areas*
Deterministic effect (tissue reactions)	A radiation-induced health effect characterised by a severity which increases with dose above some clinical threshold, and above which threshold such effects are always observed. Examples of deterministic effects are nausea and radiation burns
Displacement	The evacuation of persons previously sheltering in an area following a *radiological incident*
Dose	General term used for a quantity of ionising radiation. Unless used in a specific context, it refers to the *effective dose*
Effective dose	A quantity used in radiological protection which incorporates the sensitivity of different types of living tissue to damage by different types of radiation received by a body. It is a measure of radiation exposure. Unit: Sv (Sievert)
Emergency phase	The time period during which urgent actions are required to protect people from short-term relatively high radiation exposures in the event of a radiological emergency or incident
Emergency countermeasures	Actions taken during the *emergency phase* with the aim of protecting people from short-term relatively high radiation exposures (e.g. evacuation, sheltering, administration of stable iodine tablets). Actions taken during the *emergency phase* with the aim of protecting people from short-term relatively high radiation exposures (e.g. evacuation, sheltering, taking stable iodine tablets)

Term	Definition
Gamma (γ) emitters	Radioactive materials for which the most hazardous type of radiation emitted is in the form of gamma rays, (e.g. the radionuclide cobalt-60 is a gamma emitter)
Inhabited areas	Places where people spend time (e.g. at home, at work and during recreation)
Intermediate phase	Begins when the source of the release or exposure has been brought under control and there is no possibility of further release as a result of the implementation of measures that ensure the safety of the plant. During this phase decisions may be required on the withdrawal of emergency countermeasures that were imposed in the early phase. This phase may last from days to months, depending on the circumstances of the emergency exposure situation
Intervention	A procedure that is undertaken to reduce exposure or the likelihood of exposure due to a de facto situation whose existence is not a matter of choice (e.g. a nuclear accident) or is not part of a controlled practice
Intervention level	The level of avertable dose at which specific protective action is taken in a situation of long-term exposure or an emergency
Late phase	The late phase of an emergency exposure situation usually exists for large scale accidents involving long-lived radionuclides which require recovery measures to be implemented over timescales of years so that exposures are reduced to a more acceptable level for normal living
Long-lived radionuclides	Defined for the EURANOS Handbooks as radionuclides with a *radioactive half-life* of more than three weeks.
Management option	An action, which is part of an intervention, intended to reduce or avert the contamination or likelihood of contamination. Previously called *countermeasure*
Normality/normal living	Situation where people can live and work in an area without the *radiological emergency* and its consequences being foremost in their minds
Pre-emergency phase countermeasures	Actions that should be considered in response to the threat of a release of radioactive material and implemented before the release starts (e.g. closing windows, doors and air ducts and controlling air exchange; covering, storing or sealing personal/precious objects). Such measures could influence indoor deposition and hence the subsequent importance of these surfaces in contributing to doses and the need for recovery options
Radiation	In the context of this document any radiation that produces ionisation in matter, such as alpha and beta particles, X-rays and gamma rays, and neutrons. Can cause damage to DNA in living cells. Non-ionising radiation, that is radiation that does not produce ionisation in matter, such as ultraviolet radiation, visible light and radio waves is not included
Radioactive half-life	The time taken for the *activity* of a radionuclide to fall to half its initial value due to its physical decay
Radioactivity	The property of radionuclides of spontaneously emitting *ionising* radiation as a result of atomic or nuclear changes
Radiological incident/ radiological emergency	Any event, accidental or otherwise, which involves a release of radioactivity into the environment

Term	Definition
Radionuclide	An unstable atomic nucleus that emits ionising radiation as a result of radioactive decay
Recovery (phase)	The time period during which activities focus on the restoration of normality for all affected populations. There are no exact boundaries between the emergency phase and the recovery phase. However, for the purposes of this guidance the recovery phase should be seen as starting after the incident has been contained and continuing until agreed recovery criteria have been met
Recovery strategy	The aim of a recovery strategy is the return to *normality*. It covers all aspects of the long-term management of the contaminated area and the implementation of specific management options. The development of the strategy should involve all stakeholders including members of the public.
Personal Protective Equipment (PPE)	Equipment (e.g. protective clothing, masks, etc.) designed to prevent or reduce the contamination of the skin and inhalation of radioactive material by individuals
Resuspension	Radioactive material deposited onto the ground can be resuspended into the air by wind or other disturbances. The subsequent inhalation of radioactivity is recognised as a potentially significant exposure pathway. Many factors influence resuspension, including climate, wind speed, time since deposition
Sievert, Sv	The SI derived unit of effective dose. Symbol: sievert, Sv ($1\ Sv = 1\ J\ kg^{-1}$)
Stakeholder	A person or group of persons with a direct or perceived interest or involvement in the recovery strategy
Stochastic effect	A radiation induced health effect characterised by a severity which does not depend on *dose* and for which no lower threshold exists. The probability of such an effect being observed is proportional to the dose. An example of a stochastic effect is cancer
Worker	An individual who is formally involved with the practical implementation of a recovery strategy. Exposures to workers must be controlled

Appendix A Datasheets for Sheltering and Evacuation

A1 THE DATASHEET TEMPLATE

There is a large amount of information available for the withdrawal of management options which needs to be considered before a decision can be made on the most appropriate options to select. A datasheet template, similar in format to those used in the recovery handbooks, was designed to systematically record information in a standardised format, taking into account most of the criteria that decision-makers might wish to consider when evaluating different options. The template includes a short description of the option, its key attributes, constraints, radiological criteria, feasibility, requirements, costs, side effects, and a summary of practical experience of implementing the option. Table A.1 presents the template with a brief summary of the information that appears under each heading. Tables A.2 and A.3 are the datasheets for sheltering and evacuation taken directly from the Generic Handbook for Assisting in the Management of Contaminated Inhabited Areas following a Radiological Emergency (Brown et al., 2007)

A2 REFERENCES

Brown J, K Mortimer, K Andersson, T Duranova, A Mrskova, R Hänninen, T Ikäheimonen, G Kirchner, V Bertsch, F Gallay, N Reales (2007) Generic Handbook for Assisting in the Management of Inhabited Areas in Europe Following a Radiological Emergency. Available from http://www.euranos.fzk.de

Table A.1 Datasheet template

ID: datasheet reference number	
Name of Action	
Objective	Primary aim of action
Other benefits	Secondary aims of the action, if any. For instance, the primary objective may be reduction of external dose, whereas an additional benefit may be a limited reduction in internal dose from food consumption
Action description	Short description of what the removal of the countermeasure entails and how to carry it out
Target population	Type of area or surface on which the management options will be implemented
Targeted radionuclides	
Scale of application	An indication of whether it is realistic or recommended for the management option to be applied on a small or large scale, i.e. the area size
Timing of implementation	Time relative to the accident or incident when the option is applied. It can be in the emergency or transition phase
Order of priority	Level of urgency for the removal of the countermeasure in question
Constraints	Provides information on the various types of restrictions that have to be considered before lifting the countermeasure
Legal constraints	Laws referring to, for example, protection of the environment, cultural heritage protection, liabilities for property damage, protection of workers
Environmental / technical constraints	Constraints of a physical or technical nature that prevent or restrict implementation
Social constraints	Constraints of a social nature which would prevent or restrict implementation
Radiological criteria	Provides information on the various radiological criteria necessary for making an informed decision on the lifting of countermeasures
Indicator	
Technical data	
Reference levels	
Doses	Provides information on how the removal of the countermeasure leads to changes in the distribution of dose to individuals and populations
Additional doses	Additional doses that could be received by workers involved in the removal of the countermeasure are included here. Potential exposure pathways are identified and a broad indication of dose-rates expressed as a multiplier of public doses is given
Factors influencing effectiveness of procedure (technical)	Technical factors that may, under different circumstances, influence the effectiveness of the method. An overview is given here of other factors that may influence the reduction in doses that could be observed (e.g. time of implementation)
Factors influencing effectiveness of procedure (social)	Social factors that may, under different circumstances, influence the effectiveness of the method (e.g. reliance on voluntary behaviour, population behaviour)

Requirements	Provides information on the equipment, infrastructure and skills needed to remove the countermeasure
Equipment	Primary equipment for removing the countermeasure
Utilities and infrastructure	Utilities required in connection with removing the countermeasure
Consumables	Consumables necessary to remove the countermeasure
Skills	Indication of the level of skilled worker required to remove the countermeasure
Safety precautions	Safety precautions that may be necessary before workers can remove the countermeasure
Communication	Distribution of information leaflets under non-crisis conditions, prepared press statements and other material
Stakeholder involvement	Identification of stakeholders under non-crisis conditions, interested groups, links to existing structures
Intervention costs	Provides information on the direct costs that may be incurred from the removal of the countermeasure
Equipment	Cost of the primary equipment
Consumables	Cost of the consumables
Labour	Cost of the labour
Operator time	Time required to remove the countermeasure, according to size of affected population. Includes number of people required to carry out action (i.e. team size)
Factors influencing costs	Factors that may influence the cost of removing the countermeasure (e.g. size and accessibility of target population), availability of equipment (e.g. coaches and consumables such as food within the contaminated area or elsewhere), wage level in the area, need to pay higher wages
Side effects/impact	Provides information on some other impacts of removing the countermeasure
Environmental impact	Impact that the removal of a countermeasure may have on the environment (e.g. with respect to pollution, land use)
Social impact	Removing a countermeasure may have other side effects (e.g. it may affect population behaviour, lead to loss of amenities)
Practical experience	Experience in the removal of countermeasures following an emergency. Some have only been tested on a limited scale, whilst others are standard practices
Key references	References to key publications leading to other sources of information
Version	The version number of the datasheet

Table A.2 Datasheet for sheltering

ID:	
Sheltering	
Objective	To reduce exposure from airborne radioactive material as the contaminated plume passes through inhabited areas. Sheltering will also reduce external doses from beta and gamma emitters on outdoor surfaces during the sheltering period
Other benefits	Sheltering a population in the contaminated area may aid the implementation of other management options
Management option description	Sheltering is the advice to a population to go indoors, remain indoors until further notice, close doors and windows and switch-off ventilation and air-conditioning systems. Sheltering may be triggered by dose criteria as part of the emergency plans for a nuclear establishment and is likely to be considered to protect people in the following circumstances: • an atmospheric release comprising mainly noble gases (i.e. where external irradiation from the plume is dominant); • where short term doses in the absence of management options are projected to be lower than those at which evacuation can be justified but high enough that some action to reduce short term doses is needed; • to avoid evacuation through the plume from a very large release; • in circumstances where evacuation is impractical; • as a pre-cursor to evacuation, so that it is easier to control evacuation The decision to withdraw sheltering will be influenced by: • duration: it is unlikely to be practicable to shelter a population for more than a day or so; • release status: partial withdrawal of sheltering (e.g. to re-unite families) or phased subsequent evacuation may be advised before formal advice is given that sheltering has been lifted, for example, before the incident site has been made safe; • availability of monitoring information on contamination levels (detailed monitoring in the sheltered area is likely to be the priority); • plans for a recovery strategy: decisions on any continuing protection of the sheltering population will need to be made Lifting of sheltering should be accompanied by advice to ventilate buildings Temporary sheltering may also be used while other recovery options are implemented to aid implementation and minimise any enhanced inhalation doses from resuspended material due to implementing other recovery options
Target population	People living in inhabited areas that are likely to be affected or are affected by radioactive contamination released into the environment
Targeted radionuclides	All radionuclides. Will give protection against high levels of short-lived radionuclides present in a release to atmosphere
Scale of application	Any. Around nuclear sites, pre-planning for sheltering (and other emergency management options) is typically limited to a few kilometres
Timing of implementation	Maximum benefit if people are sheltered before the contaminated plume reaches the area and sheltering continues until the release has stopped. However, can also continue to be beneficial after the release has stopped by reducing external doses from high levels of short-lived radionuclides deposited on the ground

Constraints	
Legal constraints	Requires appropriate level of approval prior to implementation. Human rights concerns
Environmental / technical constraints	The nature of the environment could hinder communication of the advice (to initiate sheltering or withdraw it)
Effectiveness	
Reduction in contamination on the surface	This option will not reduce contamination levels in the environment
Reduction in surface dose rates	
Reduction in resuspension	
Doses	
Averted doses	Averted doses are maximised if people are told to shelter before the plume arrives Some particulate material will be removed by filtration in cracks and pores in the building surfaces as air penetrates the building. However, air concentrations (and hence inhalation dose) of non-depositing material (e.g. noble gases) will not be reduced Indoor air concentrations (and inhalation doses during the period of sheltering) could typically be expected to be about a factor of 2 lower than those outdoors for iodine vapour and 1 μm particles and about a factor of 5 lower for 4 μm particles. The effectiveness will be greater for buildings with a lower natural air exchange rate. Further dose reductions can be achieved for non-depositing radionuclides (e.g. noble gases) by ventilating houses after the passage of the plume While sheltering, external doses from radioactive material deposited outdoors are significantly reduced. The impact of this reduction on the external doses received will depend on the longevity of the radionuclides in the environment. Sheltering can be particularly effective in reducing external doses if the release comprises short-lived radionuclides The reduction in external doses from outdoor contamination is dependent on the energy of the radionuclide emissions and the building structure and geometry. External gamma dose rates indoors from material deposited outdoors could typically be expected to be up to a factor of 10 lower than those outdoors for family homes. For multi-storey buildings, this factor could be as much as a factor of 100 lower. Cellars and basements offer very high protection. Beta particles of all energies will be stopped by most building construction materials. It should be noted that external doses will still be received from radionuclides deposited on indoor building surfaces and other objects and furnishings during sheltering. Some of the main factors affecting the dose reductions that could be achieved are: • The building construction, particularly the thickness of the walls and roofs and the building materials used • Location of people within a building (protection is better on the ground floor and in basements or cellars, and away from windows). • Timing of sheltering • Appropriate use of ventilation of the building • Aerosol size
Additional doses	Additional doses would be received by those overseeing implementation

	of sheltering and ensuring compliance if undertaken after the release has started
Factors influencing effectiveness of procedure (technical)	Speed of implementation and effectiveness of mechanism to deliver advice (e.g. siren, phone call, radio, television, door-to-door), ability to close down ventilation systems and shut windows and doors
Factors influencing effectiveness of procedure (social)	Compliance of public to shelter and to remain indoors if sheltering lasts more than a few hours Public's trust in authorities. Revisions of sheltering advice should be avoided (e.g. extent/duration). However, to maintain public confidence, it is likely to be more acceptable to implement sheltering over a larger area than may be justified on radiation protection grounds and then gradually reduce it than it is to have to increase it
Requirements	
Equipment	None
Utilities and infrastructure	Receptive political infrastructure Mechanisms to communicate with the sheltered population. For extended periods of sheltering, it may be necessary to visit the sheltered population to offer reassurance, food/drink and to reunite families. Medical and counselling services including personal monitoring.
Consumables	None
Skills	Excellent moderation and communication skills. Inhabitants would themselves, after having received advice, play a key role in implementation ('self-help')
Safety precautions	Personal protective equipment (PPE) may be required if people are entering the area to control the implementation of sheltering
Waste	
Amount and Type	No waste will be produced
Intervention costs	
Equipment	No specific costs
Consumables	No specific costs
Labour	Standard labour costs
Operator time	A large team of people could be required to issue advice, control sheltered area and support the sheltered population
Factors influencing costs	N/A
Side effects/impact	
Environmental impact	None
Social impact	Negative impacts include: • loss of economic output • panic/worry in population • claustrophobia/'cabin fever' • imposed situation; restriction of liberty • sheltered population could become designated 'victims' of the incident • designation of sheltered area affects economy (e.g. tourism, business), even if are not affected by plume or deposition • separation of families (e.g. children unable to return home to their

	families from school until sheltering is lifted) • may encourage people to self-evacuate leading to loss of control of the affected population Positive impacts include: • precautionary sheltering could engender public trust • the lifting of sheltering should be seen as a positive step, i.e. the first step in the recovery process
Practical experience	Sheltering is adopted for non-radiological incidents at a local level. There is very limited experience of sheltering large numbers of people
Key references	National Radiological Protection Board (1990). Board Statement on Emergency Reference Levels. Doc NRPB **1**(4), Chilton, UK
Version	

Table A.3 Datasheet for evacuation

ID:	
Evacuation	
Objective	To reduce exposure from airborne radioactive material as the contaminated plume passes through inhabited areas. Evacuation will also reduce external doses from beta and gamma emitters on outdoor surfaces during the evacuation period
Other benefits	The evacuation of the population from the contaminated area may aid the implementation of other management options
Management option description	Evacuation is the temporary removal of a population out of highly contaminated areas. Evacuation may be to an unaffected area or an area with much lower levels of contamination. Evacuation may be triggered by dose criteria as part of the emergency plans for a nuclear establishment and may be considered to protect people in the following circumstances: • As a precaution before any release of radioactivity occurs. This requires forewarning of the event and sufficient time to complete evacuation prior to the event, should it occur. • In scenarios where short term doses are projected to be large (of the order of a few tens of mSv or higher). • When uncertainty in the progression of an accident event is likely to justify evacuation. • After a release has occurred to prevent short-term, relatively high external doses from deposited radionuclides. Evacuation may also be considered after a release to facilitate the implementation of decontamination and other management options. Prior to evacuation, it is important to establish a criteria / strategy for returning the evacuated population. Too rapid a relaxation of evacuation, i.e. before the full pattern of environmental contamination has been assessed, could result in unnecessary exposure of the population. If a release occurs, the need to delay withdrawal of evacuation until a formal statement is given that the situation has been made safe, means that emergency plans should assume evacuation will last from several days up to perhaps a week or so
Target population	People living in inhabited areas that are likely to be affected or are affected by radioactive contamination released into the environment
Targeted radionuclides	All radionuclides. Will give protection against high levels of short-lived radionuclides present in a release to atmosphere
Scale of application	Any. However, it should be recognised that evacuation of large populations is difficult and requires a long time. Around nuclear sites, pre-planning for evacuation is typically limited to a few km
Timing of implementation	Maximum benefit if people are evacuated before the contaminated plume reaches the area and evacuation continues until the release has stopped and any high levels of short-lived radionuclides deposited on the ground have reduced
Constraints	
Legal constraints	Requires appropriate level of approval prior to implementation. Human rights concerns
Environmental/technical constraints	The nature of the environment and transport infrastructure could hinder the evacuation process. Temporary accommodation (e.g. evacuation centre, hotels, sports centres) would be required

Effectiveness	
Reduction in contamination on the surface	This option will not reduce contamination levels in the environment
Reduction in surface dose rates	
Reduction in resuspension	
Doses	
Averted doses	Doses will be averted during the period of evacuation. The averted dose will be influenced by the level of exposure at the location used for evacuation and the duration of evacuation.
Additional doses	Additional doses would be received by those overseeing implementation of evacuation, transporting the evacuees out of the contaminated area and those providing security for the evacuated area
Factors influencing effectiveness of procedure (technical)	Speed of implementation and effectiveness of mechanism to deliver advice, e.g. siren, phone call, radio, television, door-to-door. It should be noted that it can take several days to evacuate large numbers of people and this may significantly affect the effectiveness of the evacuation in reducing doses. Starting time of the evacuation. Availability of radiological data (monitoring strategy) and radiological assessments that will help to determine timing and scale of evacuation. Availability of geographic and demographic data. Availability of efficient, comprehensive and trusted communicators Size of area and population affected Ease of evacuation, e.g. does the area to be evacuated include hospitals, old people's homes, industrial processes? Weather (adverse conditions affect speed and safety of evacuation) The transport infrastructure, methods of transport and the time needed to evacuate different communities (villages, towns, districts) Evacuation route: evacuation through the plume will increase dose Effectiveness of pre-planning and decision making tools to identify appropriate evacuation area
Factors influencing effectiveness of procedure (social)	Compliance of public Public's trust in authorities Supervised visits to the evacuated area in order to retrieve possessions or deal with pets and animals may reduce the pressure for an early withdrawal of evacuation
Requirements	
Equipment	Organised transport (e.g. coaches) or self-evacuation by private vehicle. Road transport is likely to be available locally; however drivers may be unwilling to enter affected areas
Utilities and infrastructure	Mechanism for initiating management option: siren, phone call, radio, television, door-to-door Receptive political infrastructure Reception centre and/or accommodation. Prolonged evacuation requires the provision of more comfortable living conditions than many evacuation centres can provide Medical and counselling services for the evacuated population including personal monitoring Help line for worried relatives

	Defined evacuation routes (congestion will affect speed of evacuation; evacuation through an ongoing release will unnecessarily expose the evacuating population) Mechanism to collect details of all those evacuated, for subsequent dose estimation and decisions on health follow-up programmes Security provision for evacuated properties Mechanism for those affected to input into decisions on the recovery strategy Mechanism for direct verbal information and dialogue with the evacuees prior to their return to the area
Consumables	Food and drink, bedding, clothing, products for personal hygiene etc.
Skills	Expert moderation and organisational skills. Although inhabitants can evacuate themselves ('self-help'), strong organisation from authorities is essential to control it
Safety precautions	Personal protective equipment (PPE) may be required for people entering the area to control the implementation of evacuation and transport people out of the contaminated area
Waste	
Amount and Type	No waste will be produced
Intervention costs	
Equipment	Transport and accommodation costs
Consumables	Cost of consumables to support evacuated population
Labour	Standard labour costs
Operator time	A large team of people could be required to issue advice, control the evacuated area and support the evacuated population
Factors influencing costs	Size of evacuated population Duration of evacuation Effectiveness of pre-planning to aid efficiency of evacuation process
Side effects/impact	
Environmental impact	There may be a temporary change to land use
Social impact	Can cause major upheaval and worry for the affected population, particularly for old and sick people Moving of large numbers of people may lead to road traffic accidents and deaths Restriction of freedom Potentially high impact, in sense of building trust, but errors could lead to a loss of trust Evacuated persons could become designated 'victims' of incident Designation of 'The Evacuated Area' will affect economy of area (e.g. tourism, business – even if area not affected by plume or contamination) Community spirit may be heightened through the shared experience; therefore communities should be evacuated together (not split-up) Protection of important minority or cultural subgroups (e.g. reindeer herders) May encourage adjacent, unaffected populations to self-evacuate Additional burden on medical and other local services
Practical experience	Large numbers of people were evacuated from Pripyat and the surrounding exclusion zone after the Chernobyl accident in the former

	Soviet Union
Key references	International Atomic Energy Agency (1991). The International Chjernobyl Projet: An Overview. Report by an International Advisory Committee, IAEA, Vienna National Radiological Protection Board (1990). Board Statement on Emergency Reference Levels. Doc NRPB **1**(4), Chilton, UK
Version	

Appendix B Examples of the use of reference levels for the management of emergency countermeasures

The ICRP has recently published a revised System of Protection (ICRP, 2007) that supersedes the 1991 recommendations. A major feature of the new recommendations is an emphasis on overall optimisation of the response strategy in emergency response situations using reference levels. The reference level represents the level of dose or risk, above which it is judged to be inappropriate to plan to allow exposures to occur. ICRP recommends that during the planning for an emergency response, a reference level of typically between 20 to100 mSv of projected dose* should be selected. ICRP has also recommended an upper limit for emergency exposure situations of 100 mSv, acute or in one year. The reference level selected will act as a benchmark against which to judge the optimisation of the protection strategy applied. Expected residual doses† for the overall protection strategies are compared with the reference levels in initially assessing the suitability of the strategy.

Tables B.1 and B.2 give an indication of how reference levels may be used as part of the decision making process. However, the input of expert radiological protection advice is essential for putting reference levels in context (see Section 2.2.3), before decisions to withdraw emergency countermeasures can be taken.

Table B.1 Example use of reference levels for withdrawal of sheltering – based on short-term measurements‡

Predicted residual dose§	Action
< 20 mSv	The local population would be advised to remain in area after withdrawal of sheltering
20 - 100 mSv	The local population would be either advised to remain, or displaced. It is important to take account of the number of people concerned and the capability of local authorities to provide acceptable temporary accommodation as quickly as possible. Otherwise if the population remain, recovery measures should be implemented as soon as possible to optimise protection.
≈ 100 mSv	The population would be rapidly displaced
‡ Sheltering will have been withdrawn by the time long term measurements are available. § This is the integrated dose received by the population from the beginning of release calculated assuming that sheltering is withdrawn	

* The *projected dose* is the overall exposure, which is projected to occur as a result of the emergency exposure situation, should no protective actions be employed (ICRP, 2007).
† The *residual dose* is the dose that would result when a protection strategy is implemented (ICRP, 2007).

Table B.2 Example use of reference levels for withdrawal of evacuation or displacement – based on long-term measurements

Predicted residual dose[§]	Action
< 20 mSv	Individuals would be advised that it is safe to return to area
20 - 100 mSv	The population would either be advised that it is safe to return, or that the period of displacement/evacuation could be extended
≈ 100 mSv	A ban on returning to the area would be enforced and the affected population would be permanently re-housed.
[§] This is the integrated dose received by the population from the beginning of release calculated assuming that sheltering is withdrawn	

In general a reference level of 20 to 100 mSv per year will not be acceptable as a long-term benchmark for existing exposure situations, as exposures at these levels are generally unsustainable from social and political standpoints. As such, governments and regulatory authorities will at some point identify a new reference level which can be used to judge optimisation of protection strategies in the longer term post-accident rehabilitation phase. The International Atomic energy Agency (IAEA, 1994) and the European Commission (CEC, 1993) have also considered the radiological protection of a population in a post accident situation (i.e. temporary relocation should be considered for averted doses greater than 10 mSv/month).

B1 REFERENCES

Commission of the European Communities (CEC) (1993). Radiation protection principles for relocation and return of people in the event of accidental releases of radioactive materials. Radiation Protection 64, Doc X1-027/93, Luxembourg

International Atomic Energy Agency (IAEA) (1994). Intervention criteria in a nuclear or radiation emergency. Safety Series No. 109, IAEA, Vienna

International Commission on Radiological Protection (ICRP) (2007). Recommendations of the ICRP. ICRP Publication 103. Annals of ICRP Vol 37/2-3