Protective Action Recommendations

For a

Radiological Dispersal Event
Including Improvised Nuclear Devices

Revision 9

Working Group

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Purpose

With the current concern that a radiological event of large magnitude could occur at a location that does not routinely deal with radioactive material, recommendations for the protective actions to be taken must be developed and distributed long before the event happens. To this end, the Department of Health set up a working group consisting of staff from the Department and from the U.S. Environmental Protection Agency. The purpose was to create guidelines for protective actions that would be appropriate for nearly any expected scenario. The guidelines will be distributed to response agencies and held for wider distribution should an event occur. Three phases of the event were identified. This document addresses Protective Action Recommendations (PAR) for two of those phases. The first set of PARs apply when there is a threat of a radiological event or immediately after it has happened. The second set applies after an event has occurred and a radiation hazard has been identified. This set is divided into those given directly to the public and those given to the first responders and local response agencies. *In any event it is generally best to assume radioactive material is involved until measurements show otherwise.*

In an actual event, as it proceeds and more information is obtained, additional PARs will be developed addressing the more precise needs that become known. Until then, the protective actions described in this document should provide protection of the public with regards to radiological issues.

Introduction

The basis for the decisions and recommendations includes the following assumptions:

- We are only addressing radiological concerns and issues.
- We are dealing with a dirty bomb, not a nuclear detonation.
- We are assuming there is radioactive material in the area. These recommendations will be protective until we find out if that is true or not.
- Calculations have shown us that in these situations the immediate dose levels are not likely to be life threatening outside of the blast area.
- The dose and activity trigger levels (Protective Action Guides) developed for emergency response at nuclear power plants and used for relocation and food control can be applied for these events. In most of the affected areas, dose levels will be much less than the trigger levels and relocation will be unnecessary.
- We are providing information to city, county, and regional agencies and first responders who will be making the first decisions.
- To assure public safety, in most cases, it is unlikely that protective actions will be needed beyond 1 mile from the epicenter of the event.

Three phases were defined for development of PARs:

Phase I — Applies immediately and continues until we know more about the event, e.g. having the results from a sample, an instrument reading, and/or a Multi-Channel Analyzer reading (for gamma-emitting radionuclides). These can help us know what the isotope(s) are and what the dose level is. We can then refine the PARs.

Identifying dose levels and radionuclides is vital so getting a sample and/or instrument readings is of utmost importance.

Phase II — Event is over in terms of explosion or initial distribution of radioactive material. The radiation hazard has been identified. This is the beginning of the recovery process.

Phase III — Cleanup and full recovery. Food control restrictions if necessary following procedures similar to those developed for use after a nuclear power plant event.

Protective Action Recommendations (PAR)

Protective action recommendations should be applied to locations and individuals within 1 mile from event until further information is gathered.

Phase I

An explosion or other event has occurred, e.g. a dirty bomb:

PAR_1 — Recognize other threats, such as fire or explosion that immediately impact life, may take precedence over radiation.

PAR_2 — Don't deny or delay needed medical attention.

PAR_3 — Shelter-in-place. This means to stay inside a building, close the windows, turn off ventilation or turn it on re-circulation if possible. Duct tape and plastic are not necessary unless windows are broken. They could make the building too air tight.

Sheltering-in-place is a temporary measure and normally will last less than 24 hours. During that time safe paths of egress will be determined so people can then leave the area in as safe a manner as possible.

PAR_4 — Contamination is not a medical emergency and does not require a visit to the hospital or emergency room. Only seek medical

attention if you have an injury or medical emergency. Contaminated individuals can go to Public Assistance Centers for aid.

PAR_5 Move away from explosion, for instance to opposite side of building and stay away from windows in case of broken glass.

PAR_6 Listen to the news, via TV or radio – Tune in to your local emergency broadcasting station (Emergency Alert System) for further instructions.

First Responders Only:

PAR_7 Take a sample as soon as possible and send it to the State Public Health Lab. The Lab should recognize that there might be multiple hazards, including chemical, biological or radiological.

Phase II

Once event has happened and a radiation hazard has been identified:

PARS 1-7 apply to this phase as well.

Public Recommendations

PAR_8 If you think you have been contaminated, remove outer layer of clothes, bag them and then take a shower using lukewarm water and plenty of soap. Do not scrub skin.

PAR_9 Public Assistance Centers will be setup as needed and you will be informed by radio/TV of their locations.

PAR_{10} Do not retrieve vehicles or personal effects that are near the blast scene, especially if they are coated with visible dust from the blast.

PAR_{11} Do not eat or drink anything that was near the scene, especially items that are not packaged (i.e. fresh fruit, water from open containers, etc.) or food from a home garden.

PAR_{12} When you reenter your home or workplace after evacuation and if there may be contamination, wear gloves and booties. Remove them when you are back in the clean zone.

PAR_{13} It is recommended that those who live within the Relocation Area leave their homes until cleanup can be done. If you live outside

the Relocation Area, or if there is no Relocation Area, you need not leave. However, there may still be some contamination in the area and there are several simple things you can do to protect yourself and your family. These include:

- Hosing off car, roof of house, driveway, and sidewalks
- Washing homegrown vegetables to remove all dirt. Any contamination will be removed as well.
- Removing shoes when entering house.

Recommendations to Local Governments/Emergency Responders

PAR_{14} Keep fighting fires.

PAR_{15} Be aware radiation is involved – USE YOUR METERS.

PAR_{16} Prepare an assistance center for eventual possible evacuation, decontamination and people or individuals going into area (e.g. daycare, pets, etc) and coming back out.

PAR_{17} Discontinuance of sheltering requires determining a safe pathway out. This is done by making measurements of contamination and radiation levels and determining the areas that are outside of the plume and not impacted. Egress points need to be selected and staffed by people who understand how to use a radiation detector to survey people. If all areas have been equally impacted, wash down a pathway out before establishing egress stations.

PAR_{18} Discourage unnecessary entry into the area; for those who do enter or exit the area, direct them to the assistance center for radiological monitoring and assessment on their way out. Radiation levels do not prohibit necessary movement into the zone.

PAR_{19} After the initial event, there will be many reasons for people to reenter the event site, either for retrieving necessary items, or for longer periods such as work, keeping essential services operating, and security patrols. To reenter, the following steps should be taken:

1. Establish access/egress points with radiation monitors. Decontaminate the pathway if possible.
2. Give people training so they can be treated as occupational radiation workers. After training, the occupational dose limit of 5 rem can be applied to them. If they receive no training, the limit will be 2 rem.
3. Measure the dose rate and establish a stay-time for people reentering. Consider issuing dosimetry if practical or mount

dosimetry in the facility to be used for future dose assessments and to verify that stay-times are correct.

4. Recognize a decision could be made to increase dose limits if necessary.

Handling wash water used during cleanup is an issue for $PAR_{20,}$ $PAR_{21,}$ and PAR_{22}. One of the recommendations found in EPA 400 7.6.3 (see Reference 5) states that when cleaning surface contamination during emergency situations "Do not waste effort trying to contain contaminated wash water." This recommendation was made because, in most cases, the levels of contamination would not exceed standards for public health and safety. With this in mind, the following recommendations are made:

PAR_{20} Sewage Treatment Plant Operators may consider bypassing wash water into large bodies of water such as the Puget Sound to reduce exposure to workers and limit contamination of the plant and biosolids. From a radiological standpoint, it is considered safe to do this for wash water used during cleanup of the city after a radiological event.

PAR_{21} Opening transportation corridors: Major thoroughfares such as freeways into and out of a city could be used shortly after an event with the following stipulations:

- Assess dose rate and contamination levels on the freeway.
- Wash down the freeway if contamination is found.
- Block off exits so no traffic can enter the event zone or other areas where there may be contamination.

PAR_{22} Ferries can be washed with hoses and, from a radiation perspective, the water can go directly into the Puget Sound. It will be diluted below any health standards.

Recommendation to First Responders and Emergency Responders

PAR_{23} Use the following dose limits for emergency responders and workers performing emergency services. These limits apply to the sum of dose from external radiation exposure measured by detectors or dosimeters and dose received from inhaling radioactive material. A good rule of thumb is to limit exposure to approximately four fifths of the appropriate dose limit (as read on dosimeters) to leave a cushion for any potential internal exposure. For example, if the value being applied is 25 rem, then discontinue activities when dosimeter says you have received 20 rem.

Table 1 - Guidance for Emergency Responders*

Dose Limit (rem)	Activity being performed	Limitations or conditions
5	Any	None
10	Protecting valuable property	None
25	Life saving or protection of large populations	None
>25	Life saving or protection of large populations	Persons fully aware of the risks involved use this limit only on a voluntary basis.

*Taken from Table 2-2 of EPA 400-R-92-001 *Manual of Protective Action Guides and Protective Actions for Nuclear Incidents.*

Table 2 - Additional Guidance for Emergency Responders*

Turn-Back dose rate (lifesaving)	200 R/hr
Turn-Back dose	10 rem
Personnel Decontamination trigger level (beta, gamma β,γ)	2 times background
Personnel Decontamination trigger level (alpha α) **(Only applies to an alpha-only detector)**	Any constant, continuous clicks
Personnel Equipment reuse contamination level (beta, gamma β,γ)	1 mR/hr on contact (above this decontaminate the equipment prior to reuse.)

* Taken from references 1,5,6,7,8

References

1. NCRP-138 – *Management of Terrorist Events Involving Radioactive Material*, National Council on Radiation Protection Measurements (2001)

2. FRMAC – *Assessment Manual* DOE/ENV11718-061

3. Energy NW Manual 3.13.3

4. *Disaster Preparedness for Radiology Professionals – Response to Radiological Terrorism* American College of Radiology It can be found at www.astro.org/pdf/GR/disasterprimer.pdf

5. EPA 400-R-92-001 *Manual of Protective Action Guides and Protective Actions for Nuclear Incidents*, US Environmental Protection Agency (1991)

6. WAC 246-232-140 Schedule D *Acceptable Surface Contamination Levels*, Washington Administrative Code

7. NCRP Report No. 65 *Management of Persons Accidentally Contaminated with Radionuclides*, National Council on Radiation Protection and Measurements (1979)

8. NIOSH/OSHA/USCG/EPA *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*, US Department of Health and Human Services (1985)

9. NIST *Special Publication 981, Aid for Decontamination of Fire and Rescue Service Protective Clothing and Equipment After Chemical, Biological, and Radiological Exposures.*

10. *Individual Preparedness and Response to Chemical, Radiological, Nuclear, and Biological Terrorist Attacks*, Lynn Davis, T. LaToutette, D. Mosher, Lois Davis, and D. Howell, RAND Corp., 2003

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12. HOTSPOT (version 2.05, Lawrence Livermore National Laboratory)

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    http://www.nv.doe.gov/nationalsecurity/homelandsecurity/frmac/manuals.aspx

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Appendix A

Protective Action Recommendations for Small Communities

Because smaller communities often do not have equipment or resources to prepare for a possible RDD, guidance is needed specific to their needs. The information in this appendix is intended for use in situations where no radiological instruments or HazMat teams are readily available. These recommendations apply immediately and continue until additional help arrives and a more detailed assessment can be made.

While implementing these recommendations, make every effort to get instrumentation and additional help. Develop a list of contacts for places in your local area that have instruments. These include your state radiation control authority (In Washington State- 24-hour number 1-206-NUCLEAR), local hospitals, fire departments, law enforcement agencies, schools, universities and radioactive material licensees. Many of these groups can provide radiation safety expertise as well as equipment. There are also several inexpensive instruments available that can be used to indicate the presence of radioactive material at the scene. See Appendix B for information about one such kit

Many of the Protective Action Recommendations described earlier in this document will apply to small communities. They will be a bridge until more specific information is available. They are intended to be of relatively low cost, and to be protective for first responders and members of the public. See the introduction to this document for the philosophy and assumptions used. Three of the most pertinent for this appendix are shown below:

- Assume radioactive material is involved until you know otherwise.
- There will be no life threatening radiation levels outside of immediate blast area.
- Protective action recommendations should be applied to locations and individuals within 1 mile from the event until further information is gathered.

This appendix will only cover the beginning of the incident assuming that help will arrive soon after radioactive material is detected.

Once an explosion occurs:

Assume radioactive material is involved until measurements show it is not. Use the Phase I Recommendations as published in the beginning of this document (PARs 1-7). They are intended for use when no or little specific information is available.

Once radioactive material is detected, use Phase II Recommendations 8-11 for the public as practical. In addition, there are several simple things you can do to protect yourself and your family from contamination. These include:

- Hosing off car, roof of house, driveway, and sidewalks

- Washing homegrown vegetables to remove all dirt. Any contamination will be removed as well.
- Removing shoes when entering house.

For first responders, PARs 14-23 should be used to the extent practical, keeping these priorities in mind:

- Continue lifesaving activities.
- Minimize the entry into the blast area, a few hundred yards from the site. This will preserve evidence, and avoid the largest potential exposures to radioactive material.
- Use SCBA and turnout gear if available and if the immediate area must be entered for life-saving activities. Treat that gear as contaminated, until proven otherwise. Record the time any responder spends in that immediate area. Minimize that time, and try to limit it to 15 minutes.

Remember always that if an event such as this occurs, many federal, state, and regional resources will be readily available and come to the scene. State and local resources will be there within 2 hours and federal resources are available within 6 to 8 hours. It is important to recognize that the radiation exposure from an RDD will not be life threatening in the time it takes for help to arrive except, perhaps, very close to the explosion.

Annex For a
Nuclear Explosion Event or Improvised Nuclear Device Explosion

Purpose

The purpose of this annex is to provide Protective Action Recommendations (PAR) for nuclear explosion events, also know as Improvised Nuclear Devices (IND). Unlike radiological dispersion devices (RDDs), a nuclear explosion creates very large consequences that require immediate and specific actions in addition to those for RDDs. These considerations require that additional priorities be established beyond those identified for RDDs. Life-saving efforts are the first priority and these efforts should be directed in areas where fallout is seen. (See discussion for definition of fallout)

For these reasons, the PARs identified in this annex are focused on protecting the public from the immediate threats of radioactive fallout from a nuclear explosion, and should take precedence over other PARs during the first 24-48 hours following a nuclear explosion. PARs developed for RDDs should be applied only as secondary priorities during this immediate response phase and will become the primary recommendations only after 24-48 hours.

Nuclear Explosion Emergency Phase

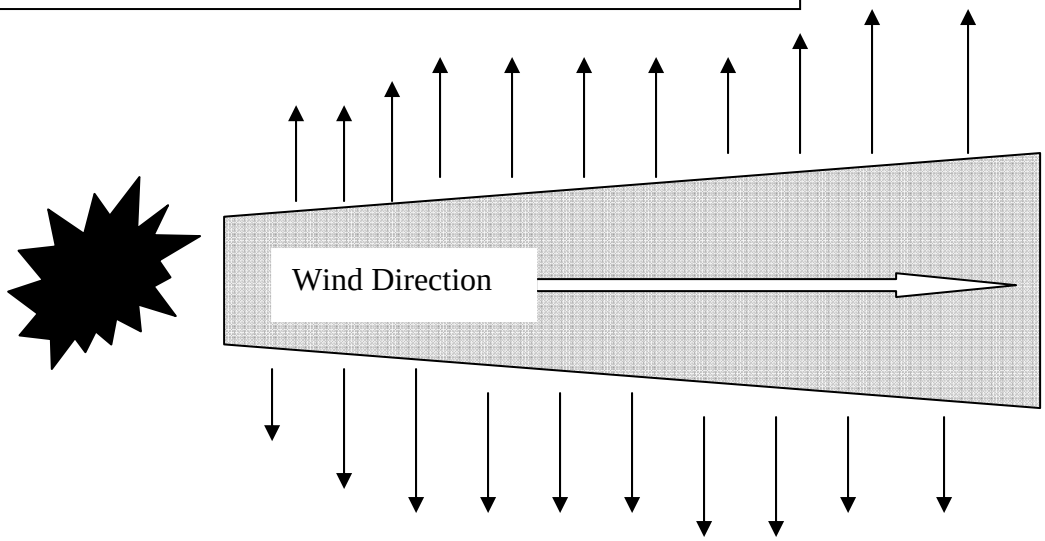
Immediate Response	Applies during the first 24-48 hours after explosion when actions to evacuate or shelter are necessary to save lives. It continues until the plume created dissipates.

Nuclear Explosion Protective Action Recommendations for the Public

1. Move away from the blast zone and out of the path of the radioactive fallout cloud as quickly as possible (Zones A & B as described below). The shortest distance to safety is at right angles to the prevailing wind direction and cloud movement. Walk if you have to. (See Figure 1)

2. If it is not possible to move out of the path of the radioactive fallout cloud, take shelter as far underground as possible, or if underground shelter is not available, seek shelter in the upper floors of a multistory (5 or more stories) building. If there are no multistory buildings, shelter in the very center of a building.

Figure 1 - FALLOUT EVACUATION: CROSSWIND DIRECTION



3. If it is not possible to move out of the path of the radioactive fallout cloud, take shelter as far underground as possible, or if underground shelter is not available, seek shelter in the upper floors of a multistory (5 or more stories) building. If there are no multistory buildings, shelter in the very center of a building.

4. Find ways to cover skin, nose, and mouth, but do not let such precautions impede your actions to evacuate or seek shelter.

5. Once protected from fallout, decontaminate by removing contaminated outer clothing and washing skin.

6. If outside the evacuation area, seek shelter to avoid any residual radiation.

Nuclear Explosion Protective Action Recommendations for Responders

1. Evacuations may be necessary immediately after the explosion in areas where radioactive fallout occurs. Responders attending to these and other actions to protect the public should be aware that radiation levels in areas where fallout has occurred might present imminent threats to the safety of responders. If you have the capability to monitor radiation levels and manage responder exposure, limit your exposure accordingly. In general, however, avoid areas where fallout has occurred. Expect radiation levels to decrease significantly over the first day due to natural decay.

2. If your instrument goes off scale on all scales, back out of the area.

3. See Tables 1 & 2 in RDD portion of this document for dose limits and turnaround values.

Nuclear Explosion Emergency Planning Zones

The size and extent of each zone will vary depending on the event (its size, the weather, wind direction, etc). The zones are a conceptual idea based on the range of effects possible at varying distances from ground zero. In the early part of the emergency, the actions will be based on the extent of damage and the dose rates measured. The demarcation between zones will not be absolutely defined for an extended period except that Zone A will be obvious.

Zone A **Evacuation is imperative.**
Massively impacted area. Depending on the nuclear yield, Zone A may extend 1/2 to 2 miles from ground zero. Lethal radiation doses are possible either from immediate radiation exposure during the explosion or from fallout (see definition of fallout). This zone can be readily determined as the area where fires and/or severe structural damage occur. In this zone, people must try to leave. Responders will probably not be able to enter this area due to high radiation levels. In a very short time, any survivors within the area will have received lethal exposures and they will not survive even if rescued.

Zone B **Fallout Evacuation Area.**
a beyond Zone A, extending out to 10 miles. It is the area where visible fallout has occurred. Very high life-threatening radiation levels are likely. In this area, sheltering is unlikely to be effective and evacuation is necessary to save lives (sheltering for a brief time until plume has passed may be a good idea to reduce inhalation of dust). The shape of this zone will depend on the pattern of fallout, which is dictated by meteorological conditions. For planning purposes, Zone B extends 10 miles from the explosion. Evacuation of this area will be the priority during the first 24 hours.

Zone C **24-Hour Shelter Fallout Area.**
This area is beyond Zone B and extends out to 100 miles in the direction that fallout has occurred. High life-threatening radiation levels are possible. In this area, sheltering is likely to be more effective than evacuation in limiting radiation exposure. The shape of this zone will depend on the pattern of fallout dictated by meteorological conditions. For planning purposes, Zone B extends 100 miles from the explosion. Determining if relocation from this area is necessary will be a priority after the first 24 hours.

Zone D **No short-term actions required.**
This is the area beyond Zone C where no short-term actions are necessary during the first 24-48 hours and relocation is unlikely to be needed. Some fallout is possible and additional PARs, such as those in the document created for RDDs, may apply.

Discussion

Improvised Nuclear Devices (INDs) are qualitatively and quantitatively different from Radiological Dispersal Devices (RDDs). INDs have the potential for nuclear explosions with extensive immediate blast, thermal, and radiation effects. Of unique importance are the radiation effects from fallout that would result soon after the explosion. In the case of an IND, very high life-threatening doses to the public are likely. Although the immediate blast, thermal and radiation effects may be extensive (e.g. up to a mile), many members of the public will survive these initial effects and will need prompt advice and help to avoid potentially lethal radiation doses from fallout.

Fallout consists of radioactively contaminated particles. When it falls to the ground it creates a large source of radiation that produces very high dose rates. These radiation fields are the primary source of radiation hazard following a nuclear explosion. Larger, heavier fallout particles will fall closer to the site of the explosion. Lighter fallout may be carried tens or hundreds of miles by winds. Fallout will be recognizable as visible dirt, dust, or ash falling from the sky. It will coat outside surfaces and be readily visible.

Radiological Protective Action Recommendations (PARs), such as those developed for RDDs, are designed primarily to reduce the long-term risk of delayed effects. Additional PARs are necessary for INDs to address the additional immediate threats to human life in the short term. Responsible authorities may need to make decisions that maximize the potential for survival of those potentially exposed to life-threatening radiation levels. These actions and decisions should be given priority over actions intended to reduce long-term risks. The situation is analogous to that of treatment of contaminated injured patients. Decontamination is important, but contamination is not an immediate threat to health or safety. Therefore treatment of medical needs must always be given priority over decontamination efforts. Similarly, the implementation of PARs intended to prevent life-threatening exposures should always be given priority over actions intended for long-term risk reduction.

The hazards following an IND are primarily due to the very high dose rates associated with fallout. As a basis for evaluating these consequences, this document has used a design assumption of a 10kT nuclear yield and a ground level explosion. The 10kT yield is at the upper end of the range discussed in NCRP 138 (Management of Terrorist Events Involving Radioactive Material, NCRP 2001), and assumption of a ground level explosion was used to maximize fallout effects. Smaller events (e.g. due to partial or incomplete detonation) are possible and the impacts will be proportionately less.

The nature of radiological decay associated with fallout means that the great majority of future doses will be incurred during approximately the first 24 hours. Hence it is imperative to focus response efforts on avoiding life-threatening exposures during the first 24 hours after the explosion. During this time, PARs related to long-term risk reduction should take secondary priority. After the first 24 hours or so, actions and decisions will transition to the more familiar criteria based on long-term risk reduction

(e.g. RDD PARs and EPA PAGs).

Evacuation is imperative for up to ten miles from the explosion. In other areas, sheltering can be an effective action even in the case of life-threatening radiation levels and can often reduce exposures by a factor of 10. Sheltering is recommended in these PARs when it is likely to maintain accumulated doses within the first 24 hours at less than approximately 100 rad. Below this dose, significant short-term (acute) radiation risks are unlikely. Sheltering in such cases is preferable to evacuation through unknown and potentially fatal fallout levels. Even where the fallout has not arrived, sheltering can be advised until it is clear where the fallout areas are likely to be. Evacuees could otherwise possibly flee unaffected areas and enter fallout zones.

Where shelter is unlikely to be effective in keeping 24-hour exposures below 100 rad, evacuation is the only option to protect the public. Evacuation must take place as soon as possible and must take into account the dimensions and distribution of the fallout pattern. Movement at right angles to the wind direction, and away from the plume centerline, can achieve the maximum dose reduction in the minimum distance. The fallout pattern will be readily visible on the ground and should be apparent within the first hour or so. Initial evacuation plans should be implemented soon after.

Attachment 1

Technical Basis

Estimates of the radiological consequences of an Improvised Nuclear Device (IND) were based on the computer code HOTSPOT (2.05, Lawrence Livermore National Laboratory) and on The Effects of Nuclear Weapons (Glasstone, 3rd edition). A surface detonation of 10 kT was assumed. Meteorological conditions of 2 m/s wind speed and F class stability were assumed consistent with HOTSPOT defaults. Increasing the wind speed was found to increase dose rates, but increased wind speed would correspond with less stable conditions (e.g. class D), which would increase dispersion and lower dose rates. The default HOTSPOT ground level wind speed of 2m/s was chosen as conservative for this application.

Under these conditions, the accumulated dose during the first 24 hours was calculated as 540 rad at 10 miles. Smaller yields will result in lower radiation levels, but the exact magnitude of the nuclear yield would be unlikely to be determined in the hours immediately following the explosion. A shielding factor for sheltering of 0.1 was assumed, consistent with factors for basements, concrete and masonry structures, and upper floors of multi-story buildings (Glasstone). Shielding provided by small aboveground frame structures (e.g. single family homes) is probably less (0.3 to 0.6). Those sheltering in frame structures may need additional recommendations (e.g. stay in the center of the structure on the ground floor) in order to minimize dose accumulated while in shelter.

First-year doses at 100 miles were extrapolated from HOTSPOT tabulated dose results for distances ranging from 5 to 80 miles (the HOTSPOT limit for such calculations under a 10 kT scenario). Based on these extrapolations, and on HOTSPOT dose contours, first-year doses decrease to 2 rem at approximately 100 miles from the explosion.

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