**NRT Quick Reference Guide:**
**Improvised Nuclear Device (IND) [1]**

*[1]For references, please see Key References Cited/Used in National Response Team (NRT) Quick Reference Guide (QRG) for Radiological WMD.*
*QRGs are intended for Federal On Scene Coordinator (FOSC) Responders.*

## Characteristics

**Agent: Radiological** **Type: Improvised Nuclear Device (GROUND DETONATION)**

**Description:** Ground detonation of a 10 kiloton (KT) improvised nuclear device (IND) (Note: A larger or smaller bomb will have proportional effects.) in a medium to large American city will result in a: 1) SEVERE DAMAGE ZONE (SDZ) - near total destruction & loss of life for up to a half mile from the detonation; 2) MODERATE DAMAGE ZONE (MDZ) - heavy to moderate destruction up to 1 mile away with many deaths and serious injuries due to building collapses and fire; 3) LIGHT DAMAGE ZONE (LDZ) - injuries, mostly due to flying glass up to 3 miles away with eye damage from nuclear flash.

Radiation levels will fluctuate dramatically within the first 48 hours post detonation: first increasing due to fallout then waning due to radioactive decay of fission products. **Fallout particles will be a variety of sizes and may or may not be visible on surfaces.** Lethal radiation exposures will occur in the immediate blast area and SDZ. Regardless of damage and bodily injury, people up to 20 to 30 miles downwind must immediately take shelter or risk lethal exposures. People in this area who aren't sheltered from fallout will likely experience radiation sickness and death if no medical intervention is received. Most people in the LDZ (who find shelter from fallout) will survive their blast injuries without immediate medical intervention.

## Expected Situation

This QRG addresses the information needed to conduct response activities as safely as possible in the first days following an IND. The extent of damage, overwhelming numbers of dead and injured, severe disruptions to utilities, transportation and communication systems, high radiation levels, and masses of spontaneous self-evacuations, will result in extremely chaotic conditions for several days post detonation. The initial local response will likely be fractionated and disorganized BUT will focus on life-saving, decontamination and relocation of the public, and providing medical services. In accordance with the Nuclear/Radiological Annex to the National Response Framework (NRF), the Federal civilian response will focus on radiological environmental monitoring activities as part of the Federal Radiological Monitoring and Assessment Center (FRMAC). Communications at all levels will be difficult. There will likely be requests for assistance from many sectors and expectations that Federal responders will support initial life-saving efforts. In order for Federal On-Scene Coordinators (FOSCs) to safely and effectively respond in the first days following an IND, they must be fully self-supporting, self-monitoring, and self-regulating for radiation exposure and other health risks. This is so FOSCs will not burden local responders or become victims themselves. FOSC support in the first days following an IND should only be provided if they have appropriate respiratory protection, PPE, personal and environmental radiation monitoring/measuring equipment (described in the "Radiation Detection Equipment Section" below), and take all necessary safety precautions to avoid excessive radiation exposures and other potentially significant health risks. FOSC response actions will be critical in the weeks and months following an IND, therefore, by avoiding excessive radiation exposures early on, FOSC responders will be available for long-term recovery operations.

To assist responders, example results of "7/10 Rule" calculations are provided in the table below. The "7/10 Rule" for an IND (not relevant for Radiological Disbursal Device) states that ***for every 7 fold increase in time post detonation, there will be a 10 fold decrease in radiation exposure levels.*** The exposures depicted in the "7/10 Rule" table below are provided to show how critically important it is to shelter immediately post detonation and that responder doses can be managed and reduced by properly timing non-critical response activities post detonation.

| Time Post Detonation | Example Exposure Rates |
|---|---|
| 1 hr | 1000 R/hr |
| 7 hr | 100 R/hr |
| 49 hr (2 days) | 10 R/hr |
| 14 days (2 wk) | 1 R/hr |

## Lethal Dose Levels

| Total Absorbed Dose | Health system affected | Comments | Outcome |
|---|---|---|---|
| 0 - 100 rad | No noticeable affects | Blood cell count changes ≥ 25 rad | 100% survival |
| 100-1000 rad | Bone marrow | Bone marrow impacted | Extent of impact is dose dependent |
| 1000-2000 rad | Gastrointestinal | 100% fatal | Death within 5-12 days |
| 2000-5000 rad | Cardiovascular | 100% fatal | Death within 2-5 days |
| > 5000 rad | Central nervous | 100% fatal | Death within hours |

## Emergency Worker Dose Levels

| Dose[a] | Emergency Dose Guidelines |
|---|---|
| 5 rem (0.05 Sv) | Regulated occupational exposure limit |
| 10 rem (0.1 Sv) | • Dose is unavoidable<br>• Purpose is to protect valuable property<br>• Responder has volunteered and has been thoroughly informed of the risks associated with the dose<br>• Respiratory protection, PPE, and dosimetry is provided<br>• Dose monitoring equipment is available to measure and project dose |
| 25 rem (0.25 Sv) [b] | • Dose is unavoidable<br>• Purpose is for lifesaving or protection of large populations<br>• Responder has volunteered and has been thoroughly informed of the risks associated with the dose<br>• Respiratory protection, PPE and dosimetry is provided<br>• Dose monitoring equipment is available to measure and project dose |

[a] The doses in this table are the Total Effective Dose Equivalent (TEDE) doses. The TEDE dose is the projected sum of the Effective Dose Equivalent from external radiation exposure **PLUS** Committed Dose Equivalent from any internal radioactivity uptake.
[b] EPA's 1992 Protective Action Guide (PAG) Manual.

**PPE Recommendations**

**CAUTION:** In the first few days post detonation, dust and fallout particles will be highly radioactive and dangerous. Prevent inhalation of respirable sized fallout particles and deposition of fallout particles directly on the skin. Responders should always wear respiratory protection and PPE when performing decontamination of persons and handling decontamination wastes. Radioactive wastes and materials should be removed from areas occupied by workers and the public ASAP. Waste packaging can then be delayed to allow radioactive decay to reduce waste handling doses.

Respiratory Protection

**CAUTION: After an IND detonation, there will most likely be gaseous radioactive material in the air. These gasses will NOT be filtered out with either a Chemical-Biological-Radiological Nuclear (CBRN) or P100 cartridge!**

Air monitoring should be performed ASAP to determine the appropriate level of respiratory protection. While Self Contained Breathing Apparatus (SCBAs) and supplied air devices provide protection from gaseous and particulate radioactive material, the increased time to accomplish any task when wearing an SCBA may increase the worker's radiation exposures. In addition, the extra physical stress from wearing an SCBA may increase the worker's risk of physical injury. As soon as air conditions allow, use Full-Face Air Purifying Respirators (APRs) with CBRN or P100 cartridges.
NOTE: In Immediately Dangerous to Life or Health (IDLH) environments, an SCBA must be used!

When using an APR with CBRN or P100 cartridges, radioactive material will gather on the face pieces, filter cartridges and protective clothing, increasing the dose received by workers. Using Powered Air Purifying Respirators (PAPRs) moves the contaminated filter cartridges away from the worker's face.

| Respiratory protection | Removes Gaseous Contaminants | Removes Particulate Contaminants |
|---|---|---|
| SCBA | x | x |
| CBRN | | x |
| P100 | | x |

PPE

PPE should be appropriate to all hazards associated with the site and response. In the first few days following an IND detonation, the radiation doses to responders will primarily be from:

1) Gamma radiation
2) Radiations from the decay of activated materials in the environment
3) Ingestion and inhalation of airborne radioactive particulates and gases.

As time progresses, the majority of concern will shift to contamination control. Good general hygiene practices (i.e., hand washing, covering wounds, no eating, drinking or smoking in contaminated areas) must be followed to prevent personnel contamination. Care should be taken to avoid the spread of contamination onto survey/monitoring equipment. A variety of other hazards (i.e., physical, chemical, and biological) may be of greater concern to the responder based on the location and extent of the damage caused by the IND. The PPE clothing (paper and cloth) only prevent skin contamination and exposures from alpha and beta radiations – PPE do NOT provide protection against gamma or neutron exposures.

**Radiation Detection Equipment**

**Self-Reading Dosimeters:** The Self-Reading Dosimeter will be the FOSC responder's ONLY indicator they are nearing their agency's dose limit. This instrument will provide live-time readout until Thermoluminescent Dosimeter (TLD) or Optically Stimulated Luminescent (OSL) Dosimeter reports can be provided. It is imperative the FOSC responder keep track of their doses and provide their dose estimates to Health and Safety Officer ASAP.

**Recommended Minimum Radiation Detection Equipment:**

- High range gamma instruments that read in the Roentgen/Hr (R/Hr) or Rem/Hr range
- Low range gamma instrument that reads in the microRoentgen/Hr (µR/Hr) to milliRoentgen/Hr (mR/Hr) range
- Geiger Mueller pancake probe for personnel surveying

NOTE: A large number of instruments will be required to supply all the responders. Local instrumentation resources are expected to be quickly exhausted. Additional instrumentation will have to be acquired from other agencies/sources.

**Public Messaging**

FOSC responders should defer to local officials for advising the public. But, if advice is requested, the following statement is recommended:

1) If downwind, seek immediate shelter in the deepest, farthest, thickest walled room within the nearest structure until an "All Clear" message is received.
2) Avoid burning or unstable structures.
3) If caught in fallout, breathe through a cloth or respirator.
4) Exercise caution until in a known clean area. Areas outside fallout zones that may be thought to be clean may have higher radioactive contamination levels than expected. Radioactive contamination is carried out of the fallout zones on the vehicles of the previously evacuated people and on the people themselves.
5) Once arrived in a clean area, brush dust from clothes, hair, and skin and remove contaminated clothes. Shower if possible.
6) Listen for official updates. Evacuate or relocate only when directed.

**Short-Term Waste Management**

**Handling of Wastes and Contaminated Materials From Operations in First Days post IND:** In the first few days, operational wastes will primarily be generated from decontamination of the public, Critical Infrastructure Key Resources (CIKR) facility workers and emergency responders. Wastes will either be dry (e.g., PPE, clothes, personal effects, etc.) or decontamination wash water. Responders and members of the public should be directed to bag clothes and PPE that have been removed and seal the bags. Wastes should be handled as little as possible and placed in weather-proof containers - if available. Wastes and contaminated materials should be staged away from areas occupied by workers and the public ASAP. Waste packaging should be delayed to allow for adequate radioactive decay to reduce waste handling doses. If weather-proof containers are not available and precipitation is expected, place the wastes under a roof, if possible. This area will become contaminated, if it isn't already. If wash water can't be containerized or if sufficient containers can't be obtained, direct the wash water discharge away from areas occupied by workers and the public and away from any down-slope/downstream populations.