Student Guide:

Responding to a Nuclear Detonation

Los Angeles

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FEMA

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NNSA National Nuclear Security Administration

Student Guide: Response Strategies

Instructional Goal

By the end of this presentation, students should be aware of the actions that responders and regional emergency management authorities can take to save and sustain lives in the event of an improvised nuclear detonation (IND). By having these plans in place, emergency responders will be better prepared to save the lives of countless numbers of people. It would also help the general public in saving their own lives, by giving them the best possible life-saving plans. Being knowledgeable about the situation will prevent unnecessary loss of lives. This module will help students better understand differing evacuation strategies, as well as information on what type of evacuation should occur in the event of an IND.

Purpose

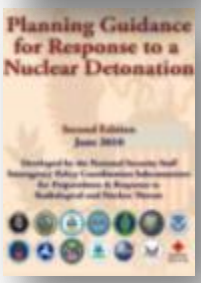
The purpose of this presentation is to inform attendees about how to conduct a successful response following detonation of an IND as well as evacuation strategies. By the end of this module, attendees should be able to understand the best possible response to an IND attack, and you should be able to incorporate this information into your emergency planning for future use.

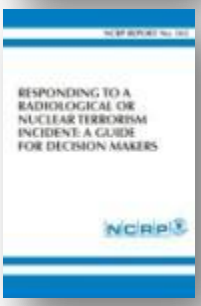
Module Objectives

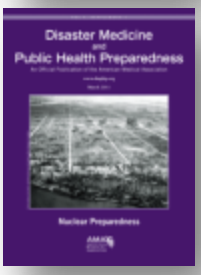
- Understand the Zoned Approach to Response
- Review the Dangerous Fallout Zone and Hot Zones
- Learn safety strategies for the public and responders
- Review evacuation strategies

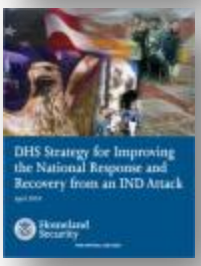
Notes

Student Guide: Response Strategies









DHS IND Modeling and Assessments Informing National Strategies

Recent research over the last few years has help greatly improve our understanding of appropriate actions for the public and responder community to take after a nuclear detonation. Much of this research was recently highlighted in a National Academies Bridge Journal on Nuclear Dangers. This research points out the potentially misleading shelter / evacuation conclusions that can be drawn from using oversimplified modeling assumptions (a.k.a circles of prompt effects and cigar shaped Gaussian fallout patters using surface wind conditions).

Planning Guidance for Response to a Nuclear Detonation. Developed by the Homeland Security Council, 2nd Ed, June 2010. This interagency consensus document provides excellent background information on the effects of a nuclear detonation and key response recommendations. Its definition of zones (damage and fallout) are becoming the standard for response planning and should be integrated in the planning process.

National Council on Radiation Protection and Measurement (NCRP) Report No. 165 - Responding to a Radiological or Nuclear Terrorism Incident: A Guide for Decision Makers was released Feb 2011 and is a National Standard that supplies the science and builds on many of the concepts of the Planning Guidance.

For public Health information, an entire edition of the journal for Disaster Medicine and Public Health Preparedness was dedicated to the public health issues associated with the aftermath of nuclear terrorism. All of the articles are available for free download from the highlighted link.

DHS Strategy for Improving the National Response and Recovery from an IND Attack, April 2010, is an Official Use Only document that breaks the initially overwhelming IND response planning activity down into 7 manageable capability categories with supporting objectives. This can be a valuable document to guide a state and regional planning process as a lot of work has already gone into time phased capability requirements for Doctrine/Plans, Organization, Training, Materiel, Leadership, Personnel, Facilities, and Regulations/Authorities/ Grants/Standards. Please contact Dave Sheehan, David.Sheehan@FEMA.gov or 202-212-1608 for more information or a copy of the document

Key Response Planning Factors for the Aftermath of Nuclear Terrorism developed by Lawrence Livermore National Laboratory in support of the DHS preparedness activity was released in August 2009 reviews the science behind many of the recommendations noted in the video and above doctrine.

Zoned Approach to Response

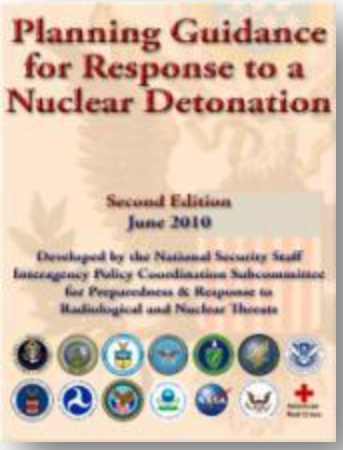
Defining Zones

- A well-thought out response plan can help maximize life-saving potential, and minimize the risks to emergency responders. When setting up a response plan, it is important to remember three steps that are essential to an organized, life-saving response plan:

1. **Identify Priority Zones**
   Priority zones should be identified by deciding which zones have the best chance for saving lives without putting responders into conditions that are too dangerous for them. Look for areas that victims might have found shelter in, and help victims nearest the outside of structures first. While the initial response may be to rush in and help those closest to the detonation, emergency responders must learn to not follow that ideal because they can not risk themselves because they will be integral to the survival of thousands that they can save.

2. **Prioritize Actions within Each Zone**
   Determine the actions (in order) which will maximize the response. Determine which structures to enter first, estimate out how much time can be spent in each area before radiation doses get too high, and determine evacuation routes.

3. **Identify Responder Protection in Each Zone**
   Ensure that responders are safe in each zone they enter. If responders decide they can enter a zone safely, ensure that adequate safety measures are taken based on the level of radiation and other possible hazards (debris, smoke, etc.) in the area. Use personal protective equipment (PPE) like dosimeters and respirators to ensure safety.



"The goal of a zoned approach to nuclear detonation response is to save lives, while managing risks to emergency response worker life and health."

-From the Planning Guidance for Response to a Nuclear Detonation

Zone Review

Severe Damage Zone

-The Severe Damage Zone extends to about half a mile from the blast site for a 10kT. This zone will see severe structure damage from the initial blast wave, and most likely fatal injuries from the blast, thermal pulse, and prompt radiation.

Moderate Damage Zone

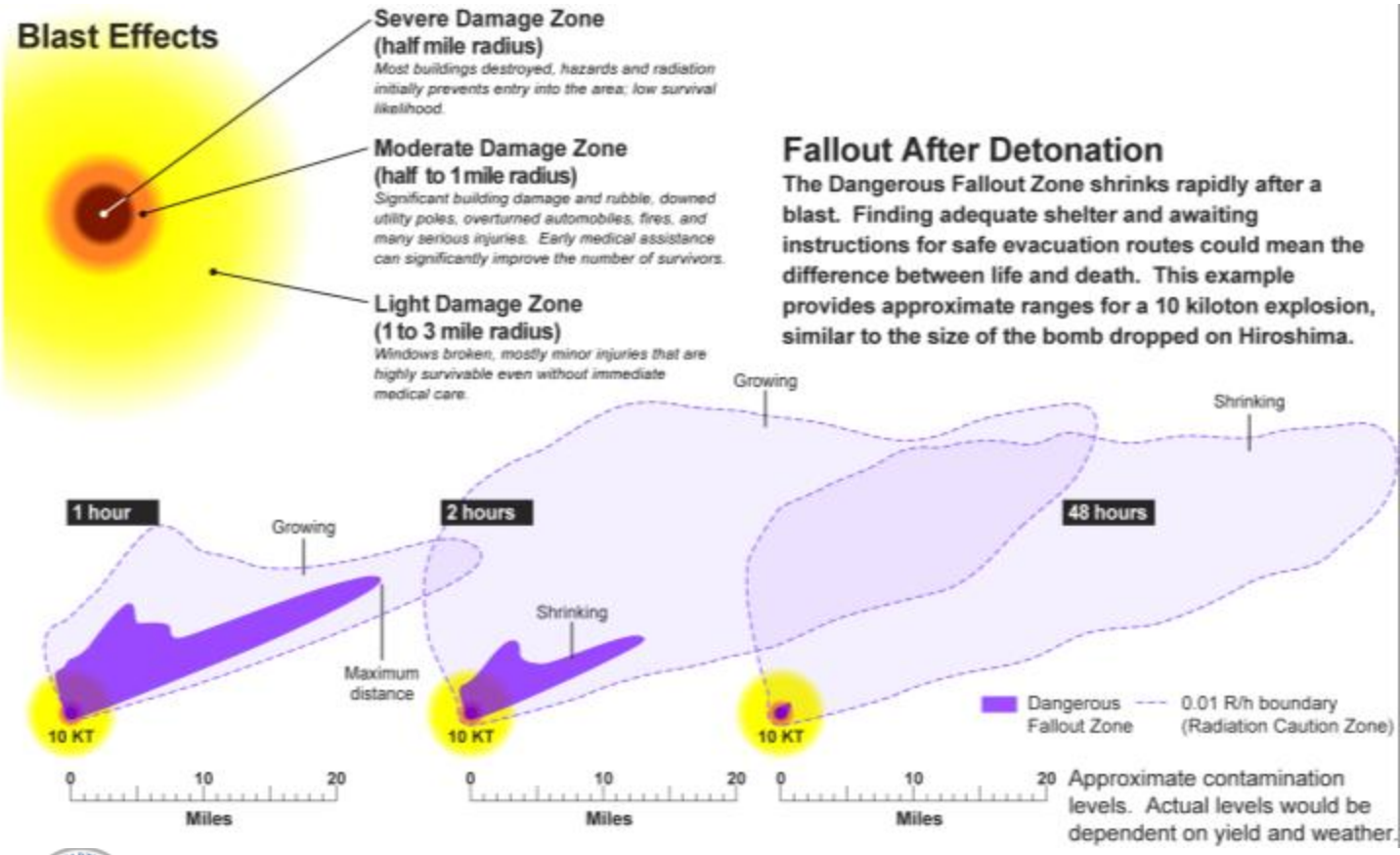
-From ½ a mile to 1 mile from the blast site of a 10KT is the moderate damage zone, This is the area with a large number of significant injuries and represents the area with the most life-saving potential.

-This area has significant structural damage and fires. Victims in this area have the greatest chance of avoiding deadly radiation doses by seeking shelter immediately.

Light Damage Zone

-The last blast zone is the light damage zone. This extends from about one to three miles from a 10KT explosion, and represents the largest of the 3 blast zones.

-The majority of injuries within this zone consist of cuts from broken glass. There will also be minor structural damage, mainly consisting of the destruction of large, weak and flat surfaces.



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Zone Recognition

Severe Damage Zone (SDZ):

- Few, if any, buildings are expected to be structurally sound or even standing
- Very few people would survive; however, some people protected within stable structures (e.g., subterranean parking garages or subway tunnels) at the time of the explosion may survive the initial blast.
- Very high radiation levels and other hazards are expected in the SDZ, significantly increasing risks to survivors and responders. Responders should enter this zone with great caution, only to rescue known survivors and with appropriate radiation monitoring equipment.
- Rubble in streets is estimated to be impassable in the SDZ making timely response impracticable.
- The SDZ may have a radius on the order of a 0.5 mile (0.8 km) for a 10 KT detonation. Blast overpressure that characterizes the SDZ is 5–8 psi and greater.

Moderate Damage Zone (MDZ):

- Responders may expect they are transitioning into the MDZ when building damage becomes substantial. This damage may correspond to a distance of about one mile (1.6 km) from ground zero for a 10 KT nuclear explosion. The determination is made by ground-level and/or overhead imagery.
- Observations in the MDZ include significant structural damage, blown out building interiors, blown down utility lines, overturned automobiles, caved roofs, some collapsed buildings, and fires. Some telephone poles and street light poles will be blown over. In the MDZ, sturdier buildings (e.g., reinforced concrete) will remain standing, lighter commercial and multi-unit residential buildings may be fallen or structurally unstable, and many wood frame houses will be destroyed.
- Substantial rubble and crashed and overturned vehicles in streets are expected, making evacuation and passage of rescue vehicles difficult or impossible without street clearing. Moving towards ground zero in the MDZ, rubble will completely block streets and require heavy equipment to clear.
- Within the MDZ, broken water, gas, electrical, and communication lines are expected and fires will be encountered.
- The MDZ is expected to have the highest proportion of '***survivable victims'*** who require medical treatment.
- The MDZ presents significant hazards to response workers, including elevated radiation levels, unstable buildings and other structures, downed power lines, ruptured gas lines, hazardous chemicals, asbestos and other particulates released from damaged buildings, and sharp metal objects and broken glass, for which consideration and planning is needed.

Excerpts from the Planning Guidance for Response to a Nuclear detonation (June 2010).

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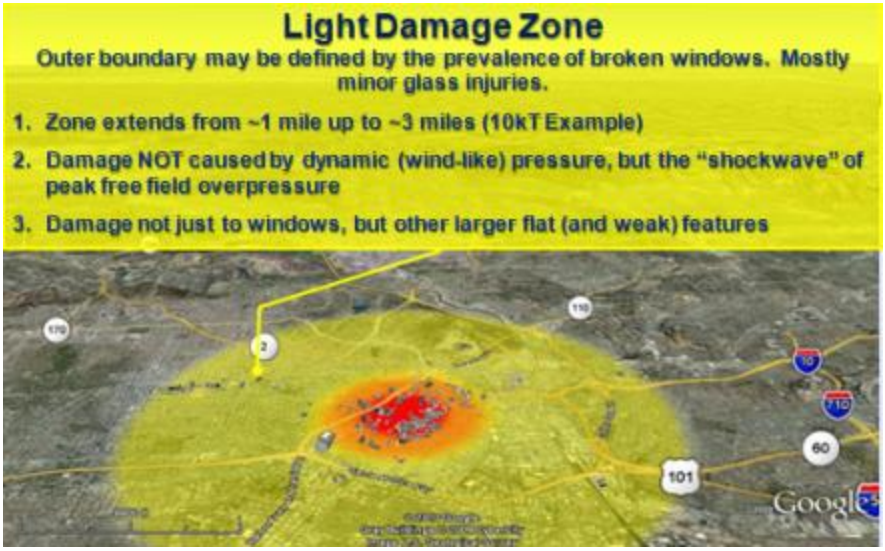
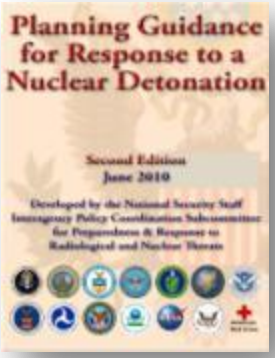
Zone Recognition



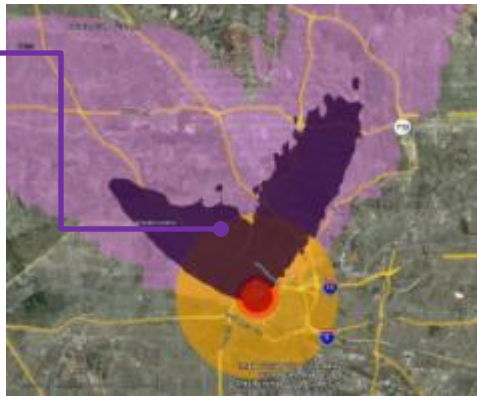


Excerpts from the Planning Guidance for Response to a Nuclear detonation (June 2010).

Light Damage Zone (LDZ):

- Damage is caused by shocks, similar to those produced by a thunderclap or a sonic boom, but with much more force. Although some windows may be broken over 10 miles (16 km) away, the injury associated with flying glass will generally occur at overpressures above 0.5 psi. This damage may correspond to a distance of about 3 miles (4.8 km) from ground zero for a 10 KT nuclear explosion. The damage in this area will be highly variable as shock waves rebound multiple times off of buildings, the terrain, and even the atmosphere.
- As a responder moves inward, windows and doors will be blown in and gutters, window shutters, roofs, and lightly constructed buildings will have increasing damage. Litter and rubble will increase moving towards ground zero and there will be increasing numbers of stalled and crashed automobiles that will make emergency vehicle passage difficult.
- Blast overpressures that characterize the LDZ are calculated to be about 0.5 psi at the outer boundary and 2–3 psi at the inner boundary. More significant structural damage to buildings will indicate entry into the moderate damage zone.
- Much of the LDZ may be essentially non-radioactive. However, responders should be prepared to encounter elevated radiation. The most hazardous radiation levels would be associated predominantly with the major path where fallout deposition overlays the LDZ.
- The severity of injuries responders will encounter in the LDZ should be relatively light and, consist of mostly superficial wounds with occasional flash burns. Glass and other projectile penetrations are expected to be superficial (i.e., about ¼ inch depth) in the torso, limbs, and face. Eyes are particularly vulnerable. As responders proceed inward they will begin to observe an increasing frequency and severity of injuries from flying glass and debris, and crush, translation, and tumbling injuries.

Dangerous Fallout Zone (DFZ)



- Bounded by radiation levels of 10 R/hr
- Reaches 10-20 miles downwind
- Reaches maximum extent at 1 hour
- Also Called:
  - High-Hazard Zone *(Key Response Factors)*
  - Dangerous Radiation Zone *(NCRP Report #165)*

"Identifying the dangerous-radiation zone [exposure rate ≥10 R/h] will have critical implications on response activities in or near fallout areas. The dangerous-radiation zone is an area where large doses could be delivered to emergency responders in a short period of time."
~National Council of Radiation Protection and Measurement, Report #165

In physical locations where the dangerous fallout (DF) zone overlaps the LD or MD zones, response activities should be guided by the potentially lethal radiation hazard of the DF zone.

The most important mission in the DF zone is communicating protective action orders to the public. Effective preparedness requires public education, effective communication plans, messages, and means of delivery in the DF zone.
~OSTP, Planning Guidance for the Response to a Nuclear Detonation (2010)

Dangerous Fallout Zone (DFZ)

- DFZ will overlap damage zones
- When zones overlap, radiation precautions take precedent
  - even if responders know there are victims within the moderate and light damage zones, they should not enter until dangerous radiation levels are no longer present
- Initial efforts should focus on the portions of the damage zones that are outside the dangerous radiation areas
  - responders should initially wait to enter areas within the light and moderate damage zones, and focus on responding to areas outside of the dangerous fallout zone

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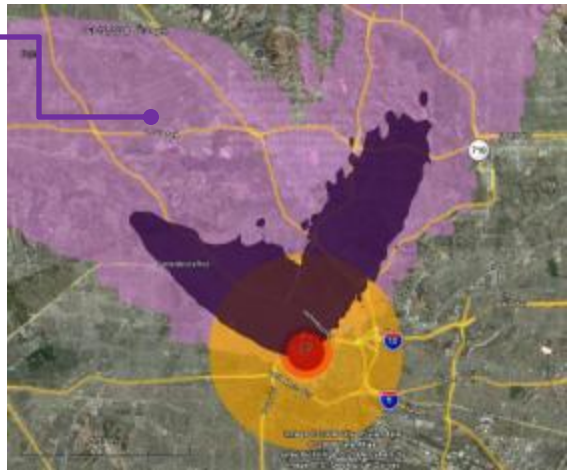
0.01 R/h Boundary

Hot Zone (0.01 R/h boundary)



- Bounded by radiation levels of 10 mR/hr (0.01 R/h) (1/1000th of the DRZ)
- Can Extend 150 miles or more
- Reaches maximum extent at ~ 1 day
- Extended Response Actions will NOT result in life threatening exposures (>100 rem)
- Also Called:
  - 0.01 R/h Boundary *(Planning Guidance for Response to a Nuclear Detonation)*

In routine radiation emergency response entering the zone bounded by 0.01 R/h entails donning appropriate personal protective equipment (PPE) and being properly monitored for radiation. For a nuclear detonation, the 0.01 R/h line can reach a maximum extent of several hundred miles within hours of the incident.

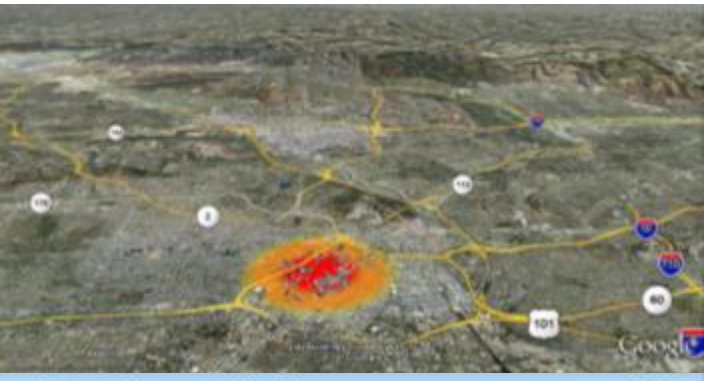
~OSTP, Planning Guidance for the Response to a Nuclear Detonation (2010)

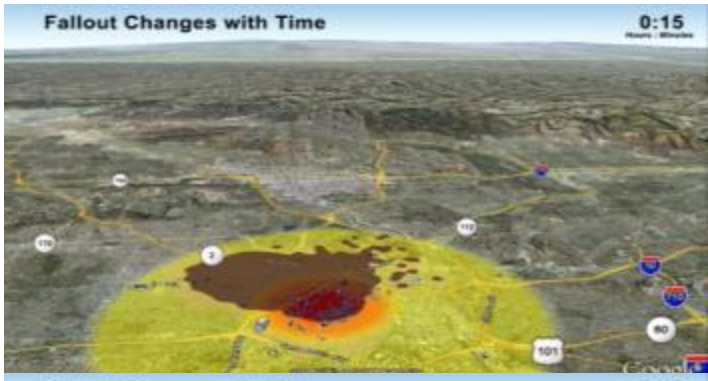
Although it is not life threatening, responders need to be aware that there are significant areas outside of the DFZ that have radiation levels that with be easily detectable, and may even saturate many of the instruments.

Response operations can and should continue in this area, though additional precautions are warranted to ensure that responders do not spend unnecessary time in the area and have the tools to alert them when they cross over to the DFZ.

Movie demonstrating the dynamic nature of the DFZ and 0.01R/r Boundary

The 'Silver Lining' of radiation is the short half-life; it decays extremely rapidly. This animation shows how the Dangerous Fallout Zone area reaches its peak after about an hour, than begins to recede, but the 0.01 R/h boundary will continue to grow as material is deposited. It will reach its max extent after ~ 1 day.

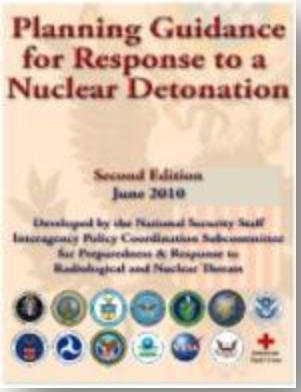




Zone Priorities from the Planning Guidance for Response to a Nuclear Detonation

- Most of the injuries incurred within the LDZ are not expected to be life threatening and would be associated with flying glass and debris from the blast wave and traffic accidents.
- The benefits of rescue of ambulatory survivors in the LDZ are low. If injured survivors are able to move on their own, emergency responder actions should focus on directing citizens to medical care or assembly shelters and proceeding towards the MDZ where victim rescue will be needed most.
- The MDZ should be the focus of early life-saving operations. Early response activities should focus on medical triage with constant consideration of radiation dose minimization.
- Response within the SDZ should not be attempted until radiation dose rates have dropped substantially in the days following a nuclear detonation, and the MDZ response is significantly advanced. All response missions must be justified to minimize responder risks based on risk/benefit considerations built into worker safety plans.

For more detailed information, please read Chapter 2 - A Zoned Approach to Nuclear Detonation



Priorities for Immediate Life Safety

The two most important aspects of a successful response effort are: ***saving as many lives as possible and keeping responders safe*.**

- **Public Protection Strategy**

  -In the case of an IND, saving lives involves a set Public Protection Strategy. To maximize life-saving potential, having everyone in the Dangerous Fallout Zone (DZF) seek immediate, adequate shelter followed by an informed, phased evacuation is the best course of action.

- **Response Strategy**

  -In order to accomplish this, response personnel need to take a number of critical steps.

  1. Protect response personnel
  2. Support regional situational assessment
  3. Support public safety

  -These topics will be covered in more depth later on, but the key point of this slide is the priority order. There may be an intuitive response to try and help nearby victims, but support to regional situation assessment can save far more lives in the long run.

  -Only emergency personnel can perform a "size up" of a scene A regional "size up" is required to define the zones that are critical for immediate action. Just as important is defining low radiation hazard zones and communicating those to a central location so outside response elements know where it is safe to initially provide assistance.

-With that information, the regionally coordinated response has the best potential to save and sustain lives and public safety.

Protecting Response Personnel

Again, keeping responders safe allows response efforts to continue, and as many lives as possible to be saved.

Steps to protecting responders include:

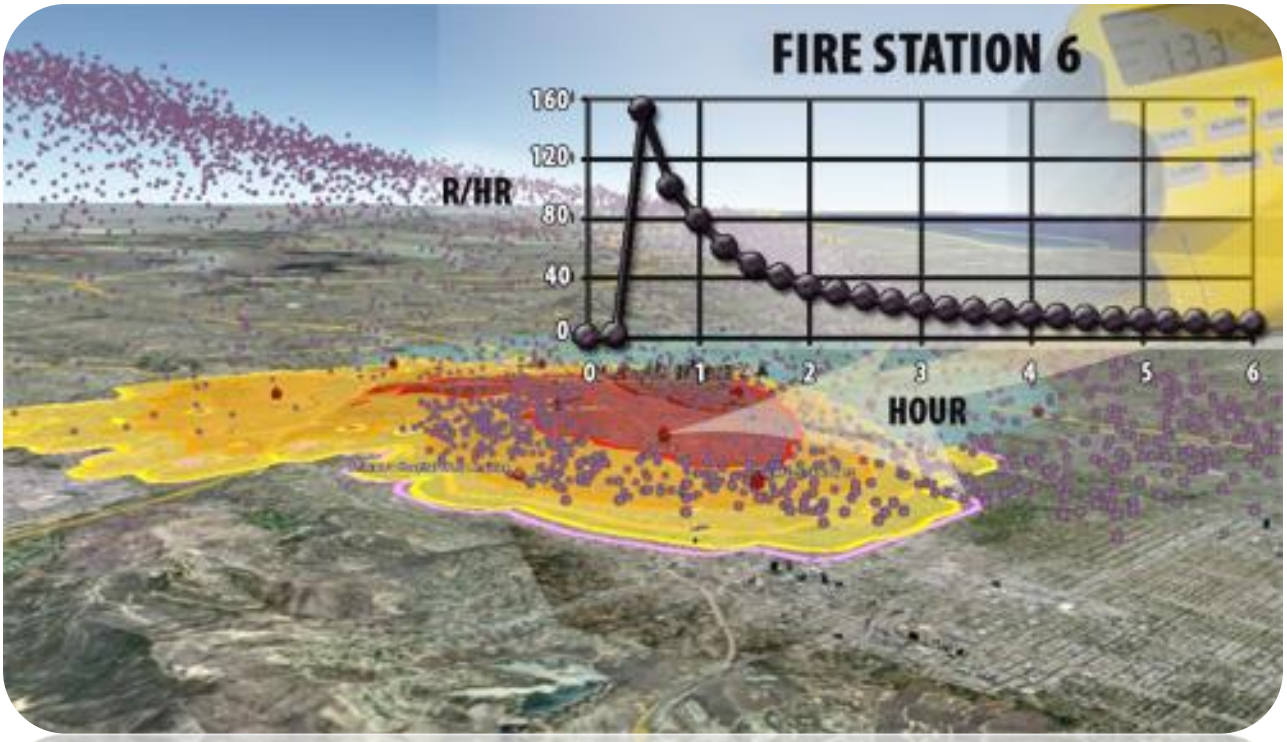
- **Responders without radiation detection instruments, follow the general public protection strategy**

  ✓ seek shelter and wait for informed evacuation instructions

- **Responders with radiation instruments, shelter using radiation detection equipment to monitor shelter conditions:**

  ✓ **Do not exit….**
  - wait until radiation levels are below 10R/hr, unless there is an immediate risk to safety like a fire or building collapse

  ✓ **Provided outdoor….**
  – When outside radiation levels are below 10R/hr, responders can begin to perform scene assessment for hazards around their shelter.



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Responder PPE

- **SCBAs, Respirators, Firefighter "turnouts", Level A, B, or C HAZMAT suits do not protect against the primary hazard - the penetrating gamma radiation given off by fallout.**

  - **Radiation / dose monitoring primary protection**
  - **Inhalation & ingestion is a secondary concern compared to the external exposure.**
  - **Turnouts and anti-contamination clothing can help ease decontamination after entries, but not delay time-critical, life saving activities.**

Early, gross, dry decontamination such as though those used on soldiers who entered fallout contaminated areas at the Nevada Test Site, is far more effective than delayed, full, wet decontamination used for hazardous chemical spills.

"Reducing the time spent in high dose-rate areas is the greatest protective measure. Bulky isolation suits and elaborate respiratory protection methods may actually increase exposure as they reduce the speed, the ability to communicate, and worker efficiency."

~Key Response Planning Factors for the Aftermath of Nuclear Terrorism

Support Regional Situational Assessment

Coordination can speed up response efforts and prevent unnecessary harm. Coordination is aided through regional situation assessment. This can be done by:

- **Designating a regional situational assessment center**

  ✓– this should be outside of the DFZ and away from other hazardous conditions

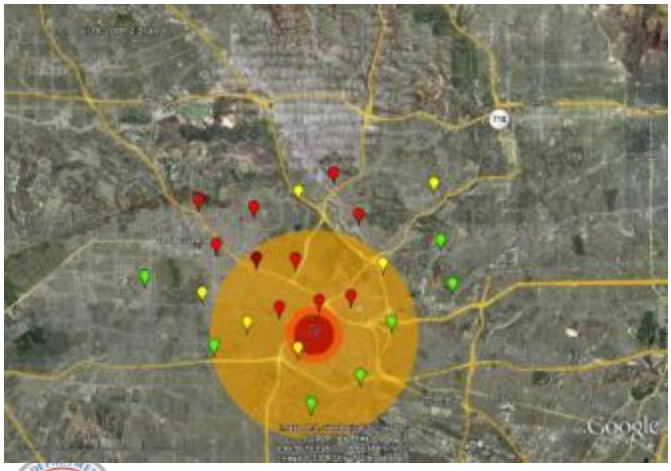
- **Establishing communication with responders in the affected area**

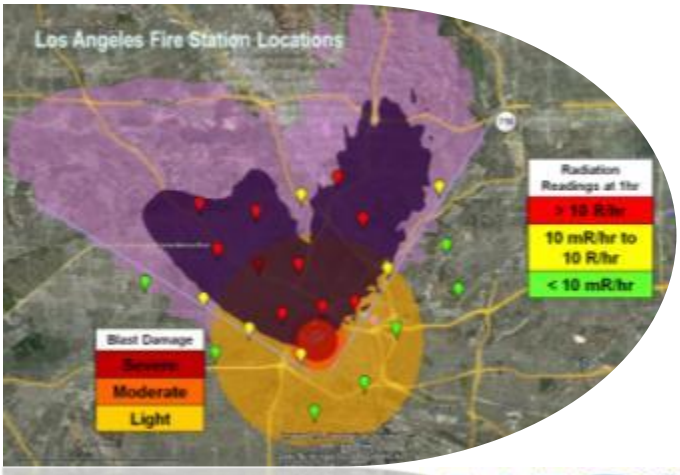
  ✓ be aware of conditions for responders in all affected areas, as well as their radiation dose reports

- **Report radiation levels in the area**

  ✓Responders in affected zones should continue to monitor outside dose rates until conditions are safe. Those in safe areas (areas where radiation levels are below 10mR/hr) should also report dose rates to help determine safe evacuation routes and response staging areas.

  LA Example
  ✓These dots represent the fire stations in Los Angeles.
  ✓By taking radiation readings, a pattern can be determined. Even though some are closer to blast zones than others, there are all levels of dose rates. Those with dose rates of 10R/hr and higher are within the DFZ and color red, those within the hot zone (0.01 R/h – 10 R/h) are colored yellow.
  ✓Even without the modeling (seen on the right image), the fire station measurements alone can successfully identify the DZZ and Hot Zone
  ✓Rapid collection and coordination of this information can provide situational assessment





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Support to Public Safety

- Although "shelter in place" broadcast messages can begin immediately, most offensive response actions will require knowledge of the hazard zones, particularly the DFZ.

- Once the DFZ is established, response actions such as:

1. Establishing receptions centers and triage sites for safe staging areas, injured extractions, and firefighting techniques can begin that make the best use of response actions.
2. Direct response resources to the moderate Damage Zone to support injured extraction
3. Fight fires and control hazards

- Some actions can be performed in the DFZ, but they require such a significant amount of support that it is not an effective use of limited response resources.

Emergency Alerts

- Communicating after a nuclear detonation will be difficult. The blast and electromagnetic pulse will damage communication infrastructure and devices for the population in the blast damage zones and potentially cause cascading effects in the surrounding areas, including the most critical region for communications – the dangerous fallout zone

- Planners in adjacent communities should collaborate in advance to determine the assets necessary to reestablish communications after a nuclear detonation. They should also identify and remedy gaps in their capabilities

- After a nuclear detonation, use all information outlets when conveying messages including, but not limited to, television, radio, e-mail alerts, text messaging, and social media outlets

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Emergency Alerts

- Planners must consider options for communicating in areas where the infrastructure for electronic communications has been disabled or destroyed. Any remaining operational communications systems will be severely overloaded. Communications into and out of the impacted area via these systems will be extremely difficult. Radio broadcasts may be the most effective means to reach the people closest to and directly downwind from the nuclear explosion site.

- Pre-incident preparedness is essential to saving lives. After a nuclear detonation, public safety depends on the ability to quickly make appropriate safety decisions. Empowering people with knowledge can save thousands of lives.

- Messages prepared and practiced in advance are fundamental to conveying clear, consistent information and instructions during an emergency incident.

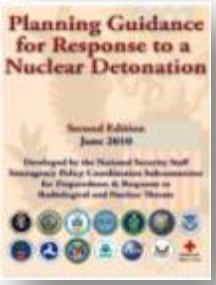
- Planners should select individuals with the highest public trust and confidence to deliver messages and should be prepared to deliver key information to the public in the affected areas about protection almost immediately in order to maximize lives saved.

Sample Key Message from Federal Government IND Messaging Effort

Impacted Community: Immediate Action Message
Suggested for local or state spokesperson: Fire Chief, Mayor, Governor

- We believe a nuclear explosion has occurred at [Location] here in [City].
- If you live anywhere in the metropolitan area, get inside a stable building immediately.
- You can greatly increase your chance of survival if you take the following steps.
  - **Go deep inside:**
    - Find the nearest and strongest building you can and go inside to avoid radioactive dust outside.
    - If better shelter, such as a multi-story building or basement can be reached within a few minutes, go there immediately.
    - If you are in a car, find a building for shelter immediately. Cars do not provide adequate protection from radioactive material.
    - Go to the basement or the center of the middle floor of a multi-story building (for example the center floors (e.g., 3 – 8) of a 10-story building).
    - These instructions may feel like they go against your natural instinct to evacuate from a dangerous area; however, health risks from radiation exposure can be greatly reduced by:
      - Putting building walls, brick, concrete or soil between you and the radioactive material outside, and
      - Increasing the distance between you and the exterior walls, roofs, and ground, where radioactive material is settling.
  - **Stay inside:**
    - Do not come out until you are instructed to do so by authorities or emergency responders.
    - All schools and daycare facilities are now in lockdown. Adults and children in those facilities are taking the same protective actions you are taking and they will not be released to go outside for any reason until they are instructed to do so by emergency responders.
  - **Stay tuned to television and radio broadcasts for important updates**
    - If your facility has a National Oceanic and Atmospheric Administration (NOAA) Weather Radio, this is a good source of information.
    - If you have been instructed to stay inside, stay tuned because these instructions will change.
      - Radiation levels are extremely dangerous after a nuclear detonation, but the levels reduce rapidly in just hours to a few days.
      - During the time when radiation levels are the highest, it is safest to stay inside, sheltered away from the material outside.
    - When evacuating is in your best interest, you will be instructed to do so.
    - People in the path of the radioactive plume – downwind from the detonation - may also be asked to take protective measures.

For more information and sample messages, please read Chapter 6 - Public Preparedness - Emergency Public Information



Initial Priority: MDZ

The MD zone should be the focus of nuclear explosion emergency response efforts, with the goal of managing the impacted scene through aggressive rubble removal and site access, fire suppression, and structural and utility stabilization, in order to facilitate expeditious search and rescue and medical triage. On a city-specific basis, response planners should develop plans for MD zone response that includes:

- Establishing nuclear emergency response procedures that maximize rescue operations focused on survivable victims
- Minimizing the total risk to responders
- Organizing neighboring response units (and sharing such plans with the State emergency management officials so they will be aware which jurisdictions would be stepping in)
- Pre-deploying appropriate supplies to locations likely to contain large populations, including fallout shelters or subways
- Deploying radiation assessment teams, engineering response teams (e.g., road clearing, debris hauling, and stabilization capabilities), Hazmat, search and rescue teams, medical response teams, and law enforcement (to secure the scene) The MD zone should be the focus of early life-saving operations. Early response activities should focus on medical triage with constant consideration of radiation dose minimization.

Secondary Priority

- Response within the SD zone should not be attempted until radiation dose rates have dropped substantially in the days following a nuclear detonation, and the MD zone response is significantly advanced.
- All response missions must be justified to minimize responder risks based on risk/benefit considerations built into worker safety plans.

Fires

- The thermal pulse following detonation of the IND is hot enough to start fires around the city.
- Fires that begin from falling structures are also likely.
- If these fires are not managed quickly, they will spread and endanger sheltered populations.

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Evacuation Considerations

Even during the initial (most dangerous) phases of the event, we need to make sure that we do not have "tunnel vision" regarding the radiation hazard and look at all the life safety issues. In particular, it does no good to shelter from the radiation if your shelter collapses on you or is on fire. Be sure that the public knows that other life threatening hazards can take priority.

AFTER THE DFZ IS ESTABLISHED

Evacuation planning can begin

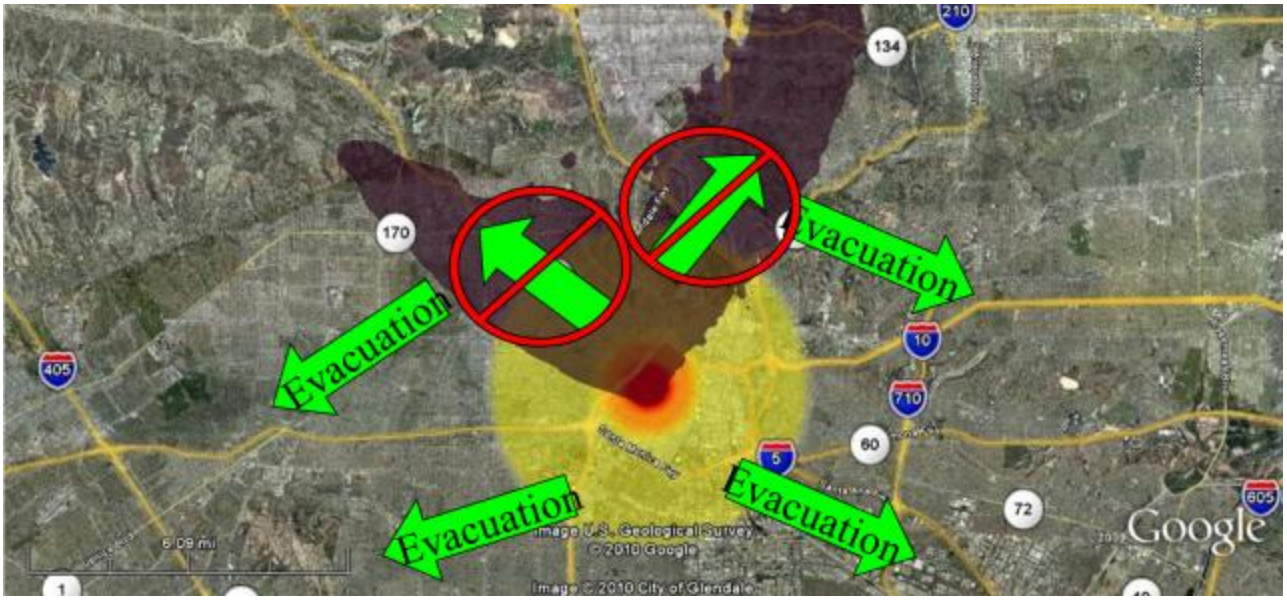
- Evacuation routes should be cleared if possible
- Routes that take advantage of sheltered passage (subways, underground connectors, through building lobbies) should be used if possible
- Execution should be phased to reduce the time spent transiting through fallout areas

Evacuation Planning

As stated in the planning guidance:

- When evacuations are executed, travel should be at right angles to the fallout path (to the extent possible) and away from the plume centerline, sometimes referred to as "lateral evacuation."

- For more complex fallout patterns like the one pictured here, ensure that evacuations **do not** move people down the length of the fallout pattern or into another fallout contamination area.



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Response Strategy Conclusions

- **Protect Response Force**
  - Identify protection strategy
  - Identify early response priorities
- **Local Emergency Management:**
  - Establish early public communication
  - Rapid identification of hazard zones
  - Established coordinated safe evacuation routes
  - Identify priority candidates for early shelter departure (i.e., those in inadequate shelters or threatened by other hazards)

- **The first hour is the most critical**
  –The worst radiation doses will be received within the first hour following detonation of the IND. If everyone can seek immediate, adequate shelter, 100,000s of lives can be saved.

- **100,000s of people can be saved through proper action (both individual and leadership)**
  –Again, if residents are aware of that they must seek an adequate shelter immediately, many lives will be saved. After the detonation, leadership roles must be quickly established (preferably based on decisions made from prior response planning documents), and decisions about damage zones, the DFZ and evacuation results must be made quickly.

- **Situational awareness and communication will be difficult, but essential**
  –Communication systems may be down following detonation. It is critical that these systems be quickly reestablished, and responders know that the priority is to report radiation readings and emergency broadcast messages are broadcasted to the public. Anyone in a response capacity must be aware of their surroundings, and realize that they may have to wait to start response until they are not in danger from radiation.

- **Knowing what to do before the event is critical**
  –Prior response planning and training for responders and the public is the key to saving many lives after detonation of an IND.

- **Rapid, independent responder actions are also key**
  -Many responders may not be able to assist initially due to their locations within the DFZ. Other responders must be able to carry out actions in a situation where they are temporarily without leadership.

Check Your Understanding

1. Name two resources for Planning the Response to a Nuclear Detonation?

2. Will dangerous radiation zones from fallout overlap damage zones?

3. What is the most important piece of personal protective equipment?

4. Is Level A or B Protection required for fallout?

5. What is the most effective decontamination technique for reducing exposure?

6. Which damage zone is the initial priority of Rescue activities?