Student Guide: Overview of Recent Federal Nuclear Detonation Response Planning

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NNSA National Nuclear Security Administration

Student Guide: DHS IND Modeling and Response Planning

INSTRUCTIONAL GOAL

The goal of this module is to describe how to orient emergency response personnel on current improvised nuclear detonation (IND) response planning activities within the federal government. This presentation will review the current response planning that's in place for state and local government for a nuclear attack, as well as the future for preparedness planning will be shown during this presentation. By the end of this presentation, students should be able to identify the key points of the Federal IND specific Response guidance that has been developed, and the location of additional information on nuclear preparedness.

PURPOSE

Upon completion of this module, one should have a better understanding about the responses that are set in place for nuclear preparedness for the Federal level, as well as state and local governments. Also identifiable will be further tools and information that are available to the general public.

MODULE OBJECTIVES

- Identify congress identified IND response planning as a priority and part of an all-hazards response planning
- IND analysis indicates a significantly reduced prompt radiation and thermal effects from cold war planning
- Identify federal IND specific response guide
- Understand that State and local planning is critical to reducing initial loss of life.

Please provide feedback for these draft documents to brooke2@llnl.gov

Notes

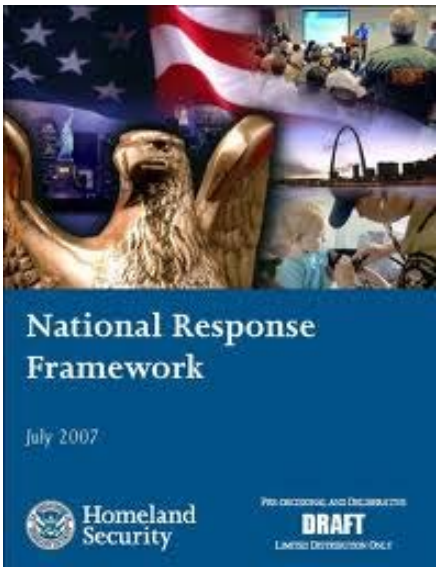
IND Response Fundamental Part of Federal Response Planning

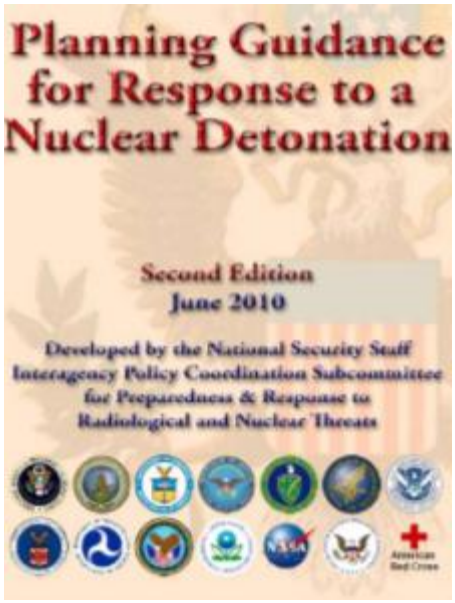
- Improvised Nuclear detonation response planning is a **fundamental** part of Federal response planning. The nuclear detonation scenario is one of the 15 national planning scenarios, and these 15 scenarios are considered to be the foundation for key response task and capability identification.

- The National Response Framework (formally the National Response Plan) has incorporated aspects of nuclear terrorism response planning in the Nuclear/Radiological Incident Annex*. The need for preparation is obvious with publications like the Federal register publication of "Preparedness Directorate; Protective Action Guides for Radiological Dispersal Device (RDD) and Improvised Nuclear Device (IND) incidents" on January 3, 2006 (updated August 1, 2008) which was expanded on with the January 2009 "Planning Guidance for Response to a Nuclear Detonation" and further with the June 2010 revision of this document.

15 National Planning Scenarios

1. Improvised Nuclear Device
2. Aerosol Anthrax
3. Pandemic influenza
4. Plague
5. Blister agent
6. Toxic industrial chemical
7. Nerve agent
8. Chlorine tank explosion
9. Major earthquake
10. Major hurricane
11. Radiological dispersal device
12. Improvised explosive device
13. Food contamination
14. Foreign animal disease
15. Major cyber attack





Student Guide: DHS IND Modeling and Response Planning

Congressional Guidance

The Federal Budget Supplemental in FY07 provided funding to the DHS Office of Health Affairs to support IND response planning. Congress has continued to provide funding to FEMA to support this effort because preparation for a nuclear attack is integral to the survival of countless American lives. By spending the money wisely and efficiently it will continue to help the planning and preparedness process to better protect the American people.

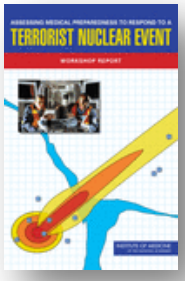
- The act was just one of the ways in which Congress has recognized the need to prepare American cities for a nuclear attack. With their support, it is easier to spread the word that nuclear preparedness needs to occur.
- Congress has continued to provide funding to FEMA to continue this effort in later budget cycles.

Nuclear Response Communication Strategy Tasking

"The **Office of Health Affairs…shall ..set a strategy … to ensure consistent and sufficient delivery of information to the public, medical community, and first responders on appropriate protective actions to prepare for and respond to a nuclear attack."**

- One of the key tasks in this effort is to develop a communication strategy. As daunting as that task is, it can not begin until appropriate actions can be defined and communicated.
- One of the major road blocks to creating a communication strategy was the consensus on what the right actions are.
- Knowing what should be done, and what to expect from a nuclear event is the first step needed to create the communication strategy for the public, medical community, and first responders.
- Chicago responder Joseph Newton may have said it best when he stated,

"We don't know what perfect looks like."



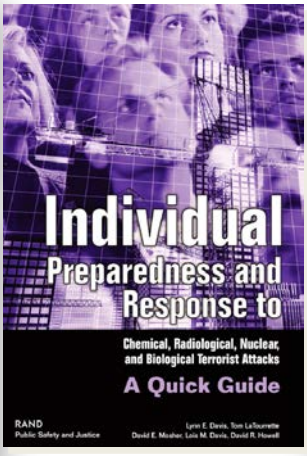
-Quote from Joseph Newton said on August 8th during the 2008 National Academy of Science, Institute of Medicine Workshop entitled "Assessing Medical Preparedness for a Nuclear Event."

Initial Lack of Scientific Consensus on Appropriate Actions

- The lack of appropriate actions was due to the general lack of scientific consensus and conflicting recommended actions.
- Many of the Cold War assumptions about nuclear detonation response actions are not appropriate for an IND.
- Conflicting guidance can be found in common preparedness guides, even for the basic question of initial shelter or evacuation recommendations.

Ready.gov (DHS) says, "**Take cover** immediately, as far below ground as possible.."

RAND says, "Avoid radioactive fallout: **evacuate** the fallout zone quickly.."



We cannot afford to have this kind of conflicting guidance in the critical time period right after the detonation.

[i] National Academy of Sciences, 2005, Nuclear Attack, factsheet created for News and Terrorism: Communicating in a Crisis.
[ii] Federation of Americal Scientist, 2006, Analysis of Ready.gov. Available online: http://www.fas.org/reallyready/analysis.html.
[iii] Davis, L., LaTourrette, T., Mosher, D.E., Dais, L.M., & Howell, D.R., 2003, Individual Preparedness and Response to Chemical, Radiological, Nuclear, and Biological Terrorist Attacks [Electronic version]. Arlington, Virginia: RAND Corporation.
[iv] Orient, J., May 2005, Unready.gov. Civil Defense Perspectives, 21(4). Retrieved June 23, 2006, from http://www.oism.org/cdp/may2005.html.

Perceptions shaped by the Cold War

- It is important to understand the context in which many response planners have been approaching nuclear terrorism response. The map that is shown below represents the aftermath of thermonuclear war.
- The shaded areas represent the fallout radiation* levels that would enough to severely injure or kill the people that remain outdoors.
- Planning for the aftermath of such an event seems futile

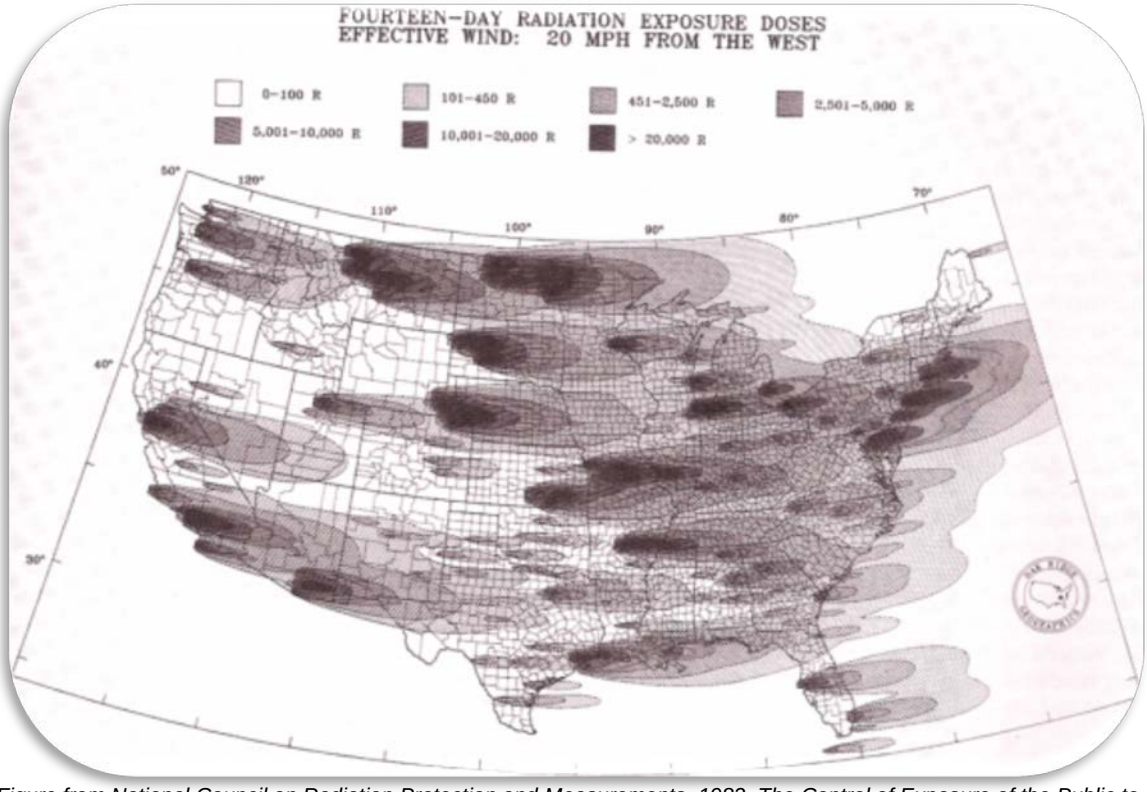


Figure from National Council on Radiation Protection and Measurements, 1982, The Control of Exposure of the Public to Ionizing Radiation in the Event of Accident or Attack. NCRP Symposium proceedings (Session C, Topic 2; Radiological Instrument Requirements for a National Emergency Such as Nuclear Attack, FEMA)

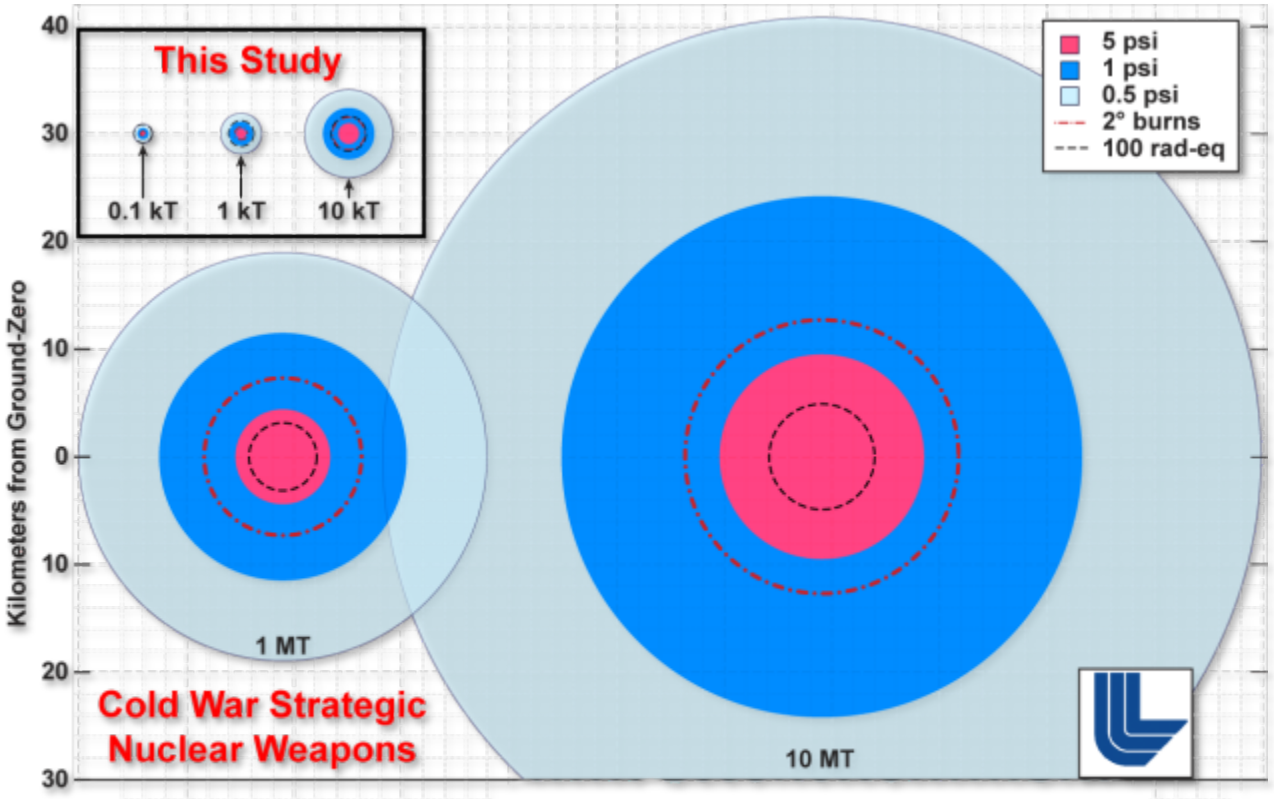
Many considered the cold war event to be so catastrophic that local response planning may be useless. Which has led to a misguided impression that the low yield detonation of an nuclear terrorist attack would lead to the same consequences and there would be no local response capability left to save and sustain lives. Without planning, this might be a self fulfilling prophecy with hundreds of thousands of additional potential casualties as a result.

Difference Between Terrorism and the Cold War

"Today, the Cold War has disappeared but thousands of those weapons have not. In a strange turn of history, the threat of global nuclear war has gone down, but ***the risk of a nuclear attack has gone up. Testing has continued****. Black market trade in nuclear secrets and nuclear materials abound. The technology to build a bomb has spread.* ***Terrorists are determined to buy, build or steal one."***

President Barack Obama
Prague, April 5, 2009

- The differences between terrorism and the Cold War are notable and should be considered when determining the appropriate actions to take after an attack.
- The graphic below shows the relative size difference of the prompt effects* from both Cold War strategic thermonuclear weapons (1 & 10 MT) and improvised nuclear weapons (0.1, 1, and 10 kT) . As indicated in the graphics, the prompt effect ranges for improvised devices are significantly less.



*Prompt effects are those effects that radiate outward from the detonation location (ground zero), and are usually within the first minute after detonation.

Observations on Starting Conditions

- Based upon workshops that were conducted in 2008 across the United States, some observations allowed researchers to see the starting conditions of local and state communities.

- **For state and local communities:**

  ✓ No communities had a coordinated regional response plan for the aftermath of a nuclear detonation and, there is a general lack of understanding about what the response needs where, and the roles that the Federal, State, and Local authorities play.

  ✓ Many response planners assumed that there would be no survivors or that the response would be led by the federal government. Unfortunately such assumptions led to an apathy in planning that could get 100,000s of people killed or injured unnecessary. The critical decisions that are made at the local level in the first few hours represent the greatest opportunity for saving lives.

  ✓ Currently these decisions are not likely to be technically informed, and the correct actions tend to be counter intuitive.

Scientific Working Group Established

- To help address the lack of scientific consensus, the Department of Homeland Security established a scientific working group called the IND Modeling and Analysis Coordination working group or "MACWG" for short.

- Comprised of the technical organizations that support federal government agencies, this group is working to collaborate and come to consensus on as many issues as possible to support IND response planning.

- The MACWG has 3 key objectives:

  1. Establish a scientific consensus (where possible) on the IND effects and issues

  2. Bound uncertainty and identify unknowns

  3. Deconflict recommended IND response actions.

This working group is a coordination point for the Department of Homeland Security funded modeling and analysis work on IND response planning. Other organizations with interest and similar efforts or expertise invited to attend to encourage process transparency and collaboration.

Advanced Detailed Analysis

- Detailed urban information combined with advanced modeling capabilities has resulted in unprecedented improvements in the understanding of nuclear detonation effects in a modern urban environment. For example, detailed day and night time population density and 3-dimensional urban terrain modeling have allowed for an unprecedented, "block by block," analyses of nuclear detonation effected in the urban environment. Each 100m x 100m block in a city can be evaluated for the prompt blast, thermal, and radiation effects. Fallout arrival and decay can also be evaluated in each block of a city, allowing for unprecedented community specific response strategy optimization analysis.

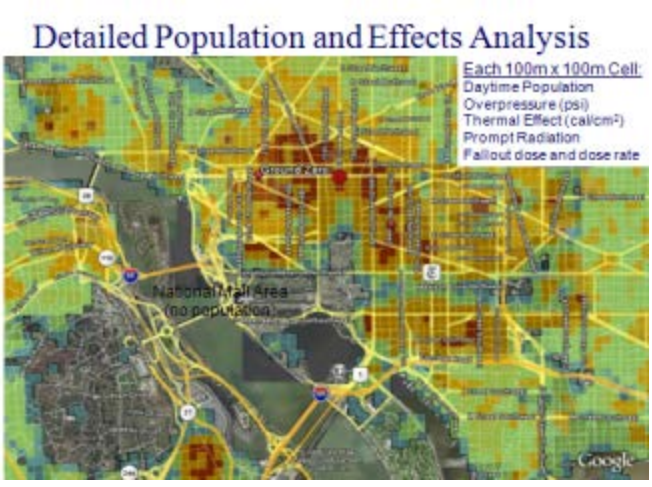
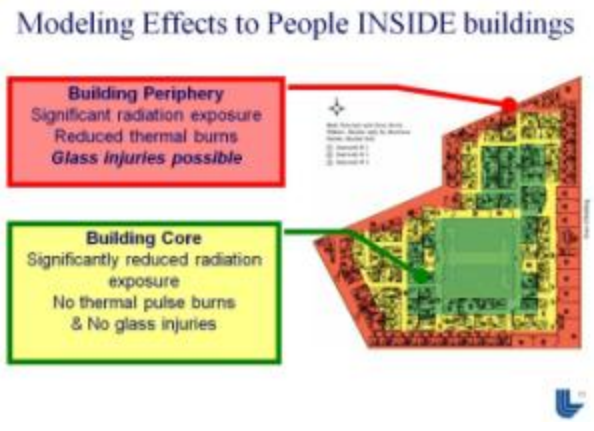


Figure 1

- Building specific information can provide detailed injury assessment to provide for advanced public health response planning.



Modeling the Effects to People inside Buildings

- Buildings can both protect and injure their occupants from the effects of a nuclear weapon. In addition to modeling how modern urban buildings interact with blast effects, the distribution of personnel within building is being evaluated for an overall injury assessment.

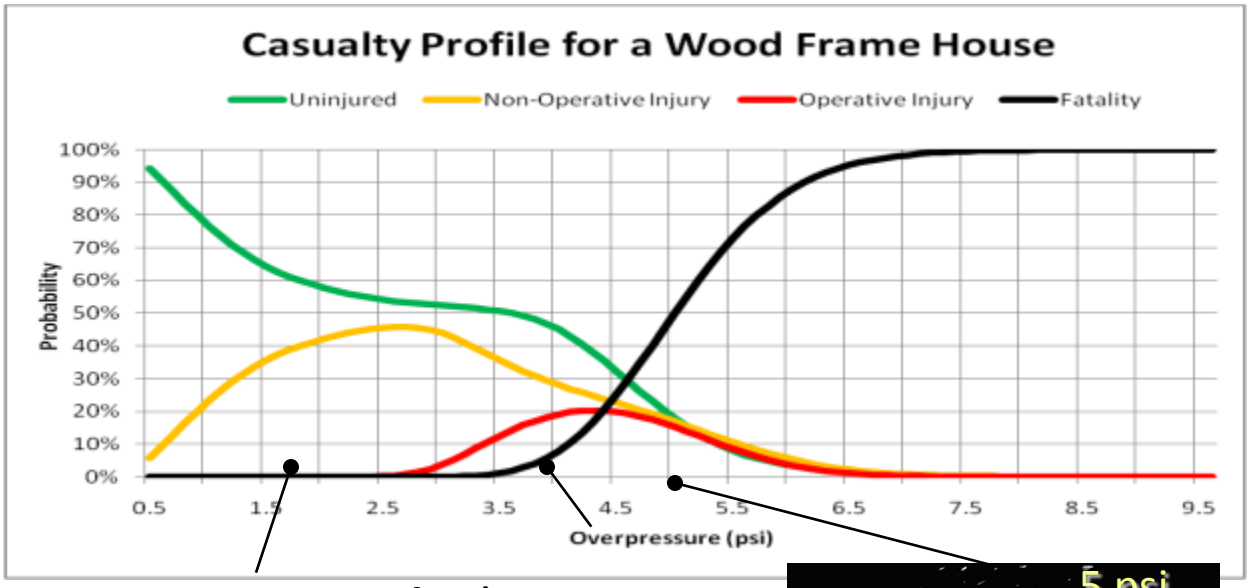
Commonly used modern models do not consider the import and effect building have on protecting the population from prompt effects, often making the assumption that the city population is outdoors to calculate prompt and fallout effects. Updated work from DHS Science and Technology and Health and Human Services has dramatically changed injury assessments by including the potential effects of Urban building on the population

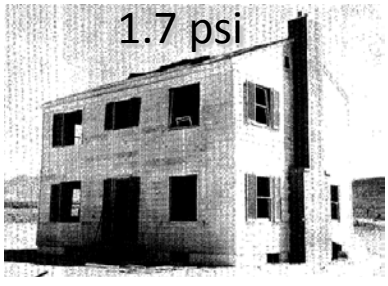
Blast and Glass Injury

"… missile injuries will predominate. About half of the patients seen will have wounds of their extremities. The thorax, abdomen, and head will be involved about equally."

- NATO medical response planning documents for nuclear detonations

- Previous models for human effects from blast stop at 5 psi (the threshold for eardrum rupture), yet you can see from the image a house at 5 psi can be easily destroyed. ***An occupant in a house undergoing the destruction pictured might get more than an eardrum rupture***. Advanced modeling now accounts for the collapse, severe damage, or glass breakage to the structure and the subsequent effects on the occupants.

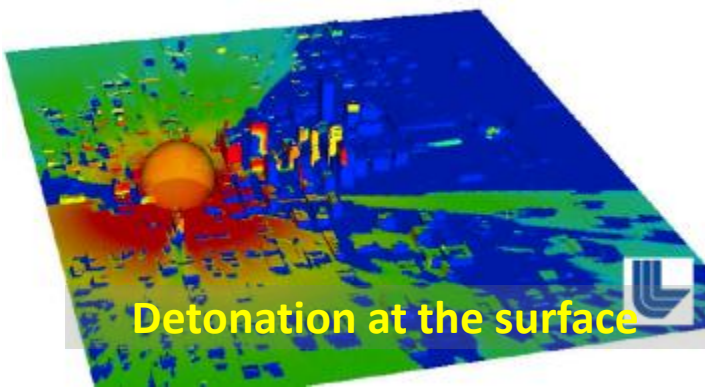




- Recent analysis work helped better understand the relationship between people and the urban environment. Most of the injuries outside of the Murrah building in the 1995 Oklahoma City bombing were caused by glass injury, not direct blast effects. A significant number of victims from Hiroshima and Nagasaki arriving at field hospitals exhibited glass breakage injuries, but this effect has not been previously modeled.

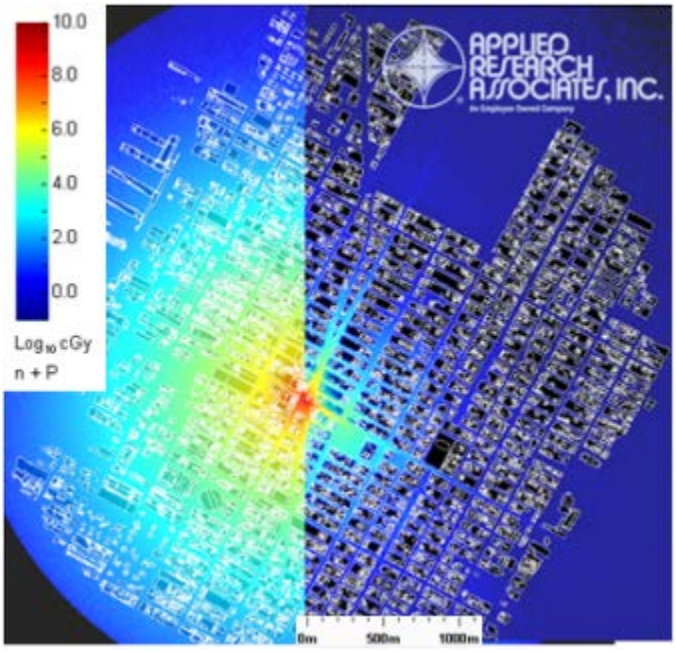
Evaluating Line-Of-Sight Exposures

- Evaluating the line of sight exposures in the urban environment demonstrates a reduction in the number of previously calculated burns that have been cited in many previous studies. A ground level detonation would reduce the range of both lethal radiation, as well as thermal burns.
- The image demonstrates how much of the thermal energy from that fireball is blocked by the urban environment. The areas of green and blue on the map represent areas of little thermal injury.



R. E. Marrs, W. C. Moss, B. Whitlock, Thermal Radiation from Nuclear Detonations in Urban Environments, Lawrence Livermore National Laboratory, June 7, 2007. UCRL-TR-231593

Advanced Radiation Analysis



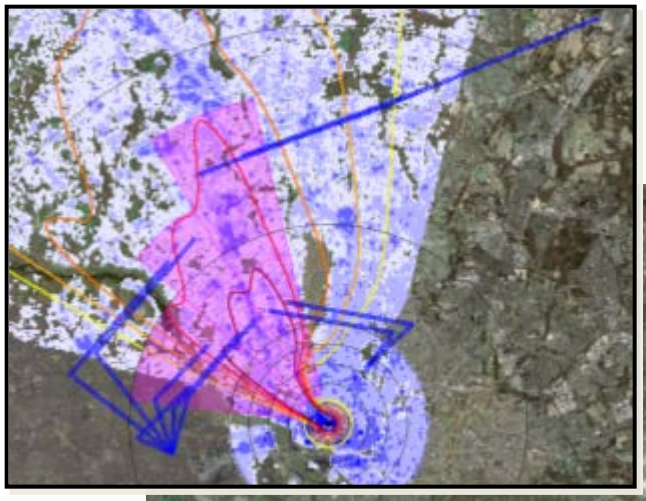
•Analysis of the reduction of prompt radiation in the urban environment

J. Bergman, K. Kramer, B. Sanchez, J. Madrigal, K. Millage, and P. Blake, The Effects of the Urban Environment on the Propagation of Prompt Radiation Emitted from an Improvised Nuclear Device, 56th Annual Meeting of the Health Physics Society, June 29, 2011.

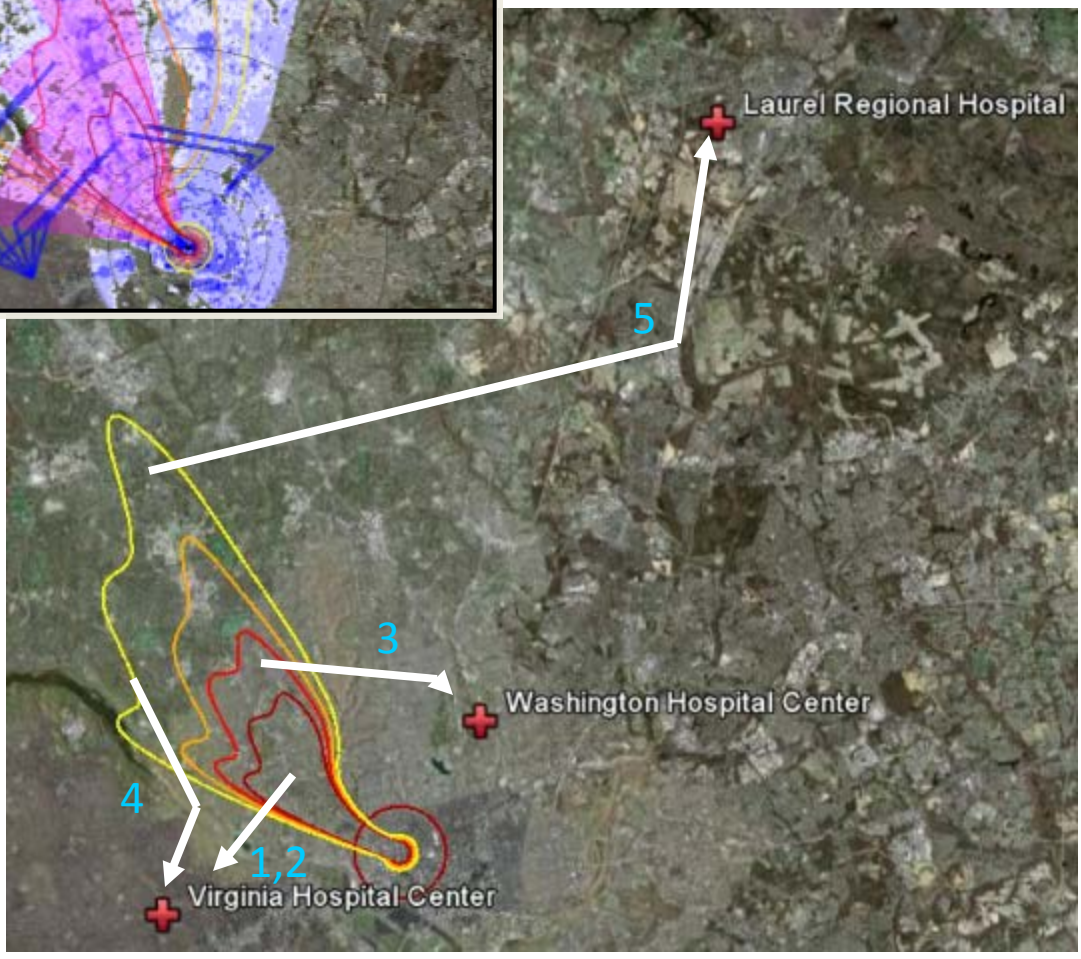
- Models developed at Applied Research Associates (ARA) and Los Alamos National Laboratory have shown similar reductions in injuries from the initial radiation produced in the first minute of a nuclear explosion. The figure demonstrates the nonsymmetrical reduction in radiation exposure by the urban environment. The left side of the image represents an unobstructed exposure from a 10kT surface detonation as compared to the reduction of outdoor radiation levels indicated in the right side of the image. Like the thermal analysis, these studies indicate that the ambient radiation levels from a low-yield, ground-level nuclear detonation in an urban environment could be significantly reduced. For example, the unobstructed range for a potentially lethal radiation exposure of 400 rads (cGy) is about 1,200 yards. Initial results by ARA indicate that the range might be reduced by as much as half, down to 500 to 700 yards from the detonation point in highly built-up areas.

Shelter/Evacuation Evaluation

- New analysis and tools developed at Sandia National Laboratories have taken the detailed 100mx100m prompt (mentioned earlier, slide 10) and fallout analysis files generated at Lawrence Livermore National Laboratory and provided community specific shelter and evacuation optimization analysis.



Sandia National Laboratories



1. Brandt, L.D. 2009. Mitigation of Nuclear Fallout Risks Through Sheltering and Evacuation. Report SAND2009-7367C. November 18, 2009. Sandia National Laboratories, Albuquerque, N.M. For more information email *lbrandt@sandia.gov*.

2. Brandt, L.D., and A.S. Yoshimura. 2009a. Analysis of Sheltering and Evacuation Strategies for an Urban Nuclear Detonation Scenario. Report SAND2009-3299, June 2009. Sandia National Laboratories, Albuquerque, N.M. For more information email *lbrandt@sandia.gov*.

3. Brandt, L.D., and A.S. Yoshimura. 2009b. NUclear EVacuation Analysis Code (NUEVAC): A Tool for Evaluation of Sheltering and Evacuation Responses Following Urban Nuclear Detonations. Report SAND2009-7507, November 2009. Sandia National Laboratories, Albuquerque, N.M. For more information email *lbrandt@sandia.gov*.

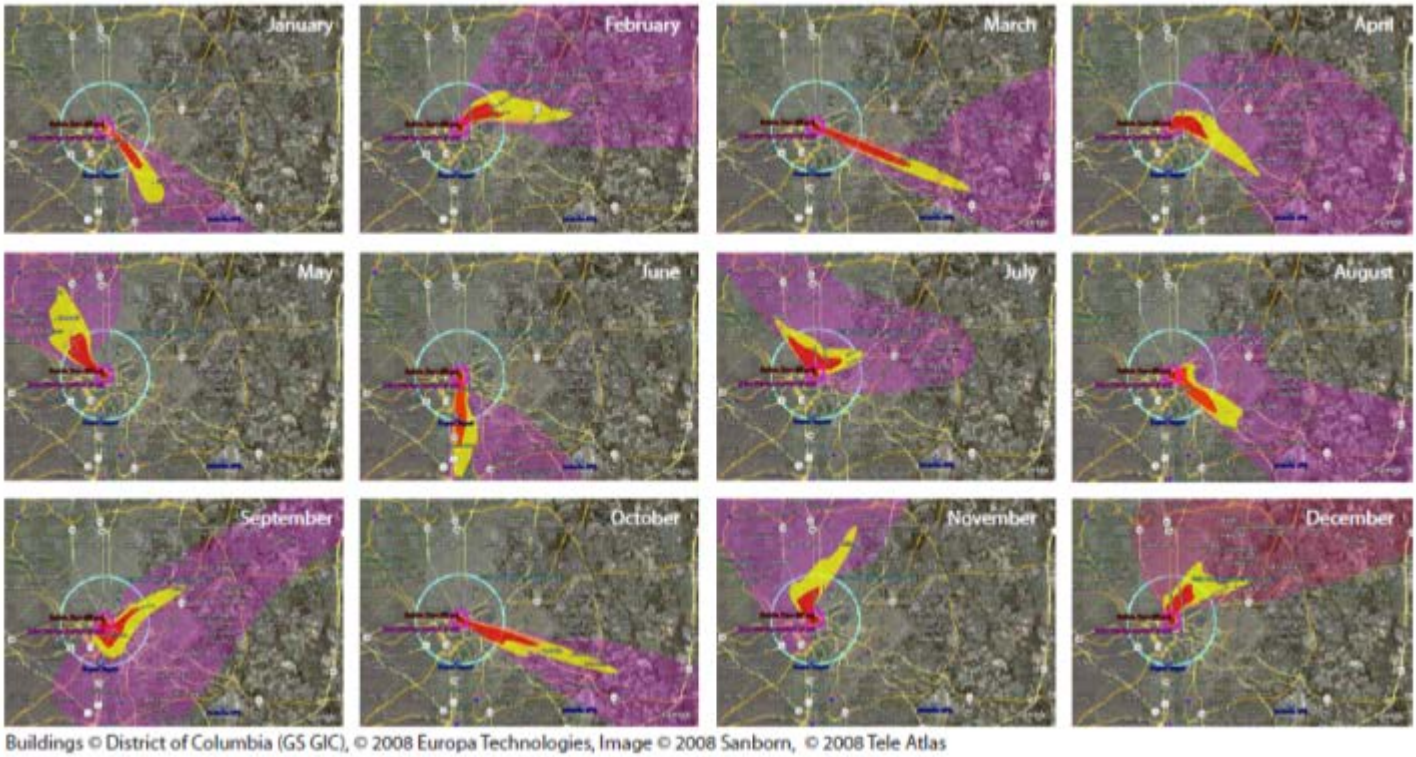
Illustrative Weather Variations

- One major consideration for planning is the fact that **weather matters!** The ability to do 3-dimensional atmospheric dispersion modeling has been a key technological advancement in the recent decades. Previous models assumed uniform wind directions and speed at all atmospheric levels. This resulted in "Gaussian fallout patterns (classic cigar shape) that gave the false impression that fallout patterns would always be conveniently shaped in a long narrow pattern like the one pictured below.

- Real atmospheric patterns have different wind directions and speeds at different altitudes. Each day is different than the previous one so it is hard to calculate precisely the range and size of the fallout cloud.

- Understanding the variability in the patterns, shapes, and directions support realistic planning assumptions.

- To demonstrate the weather variability, here are examples using real weather from noon on the 15th day of each month in the year 2006. They are presented on the following pages.



- Note that the typical "Gaussian" only occurs 3 or 4 times in the yeas and much more complex fallout patterns are a regular occurrence.

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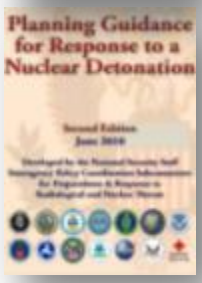
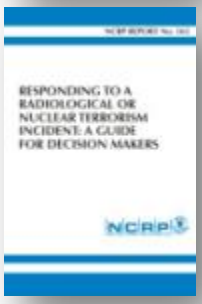
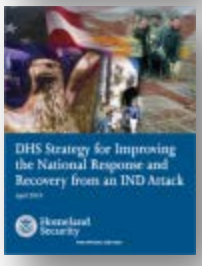






DHS IND Modeling and Assessments Informing National Strategies

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).

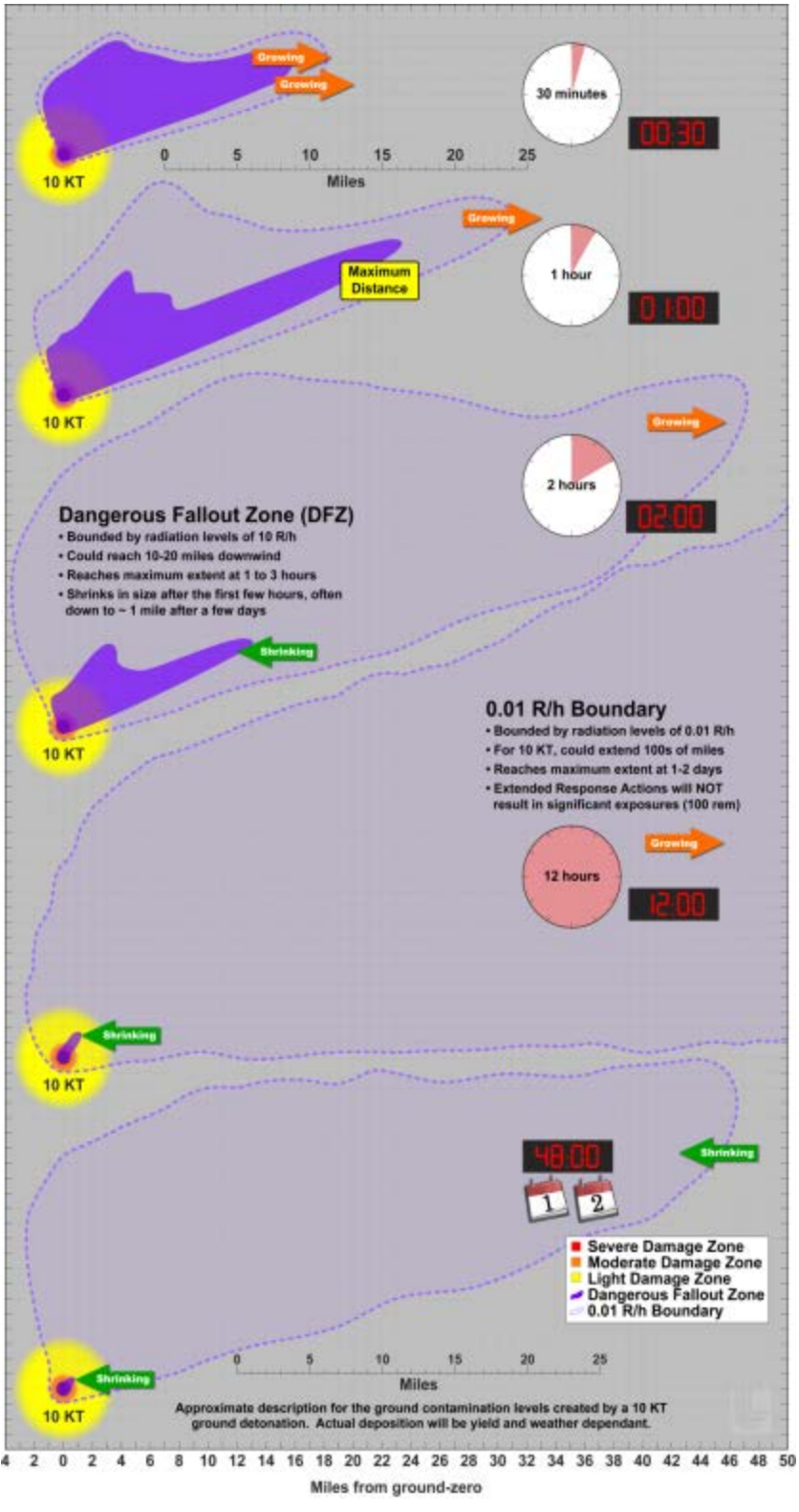
Planning Guidance for Response to a Nuclear Detonation. Developed by the Homeland Security Council, 2nd Ed, June 2010. This interagency consensus document provides excellent background information on the effects of a nuclear detonation and key response recommendations. Its definition of zones (damage 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.



State and Local Preparedness

- Using National Laboratories to understand the context for an IND event is a critical element for state and local response planning. Providing sound supporting science to specific communities through details on effects specific to those communities including potential casualties, infrastructure effects, and response issues is fundamental to a response planning effort.

- Visualization aids was one of the key requests by responders trying to understand the event. They are tired of "plume maps" providing an abstract view of an image that they wont see for days during a real event. Instead, they prefer, "How will the even appear to me?" This question is one of the most important ones, because just knowing the statistics within a community will not help much when the chaos of an actual detonation occurs. Using 1st person point of view and ground level views which are dynamic with time and location will allow for a more visual representation of how the explosion will look to people on the streets in the midst of chaos.

- By combining all of the data, the hope is that emergency responders will begin to see an image of what could potentially happen if an explosion occurs.

Summary

- While it may not be known what the perfect response looks like yet, by using the advanced technology that is now available, researchers can get a good idea of what might happen if an improvised nuclear device detonated in one of the Urban communities. By combining all aspects of sound science and operational realities, researchers can begin to understand the appropriate actions that need to be taken to save the lives of as many people as possible.

- The main goal of today's presentation was to orient emergency response personnel on current improvised nuclear detonation response planning activities within the federal government, and to identify the capabilities and doctrine that exist to support their response planning efforts.

Are there any questions?

Notes

The 30 minute video, Reducing the Consequences of a nuclear detonation is available on YouTube (LLNL Channel) and shows a presentation given last year at an LA County Public Health Conference. It provides a lot of information on DHS IND response planning research and demonstrates the very dynamic nature of an IND event. It was developed to provide "ground level" points of view and demonstrate the timing of the event and the consequences of different actions.

Check Your Understanding!

1. ***Name the two main myths about a low yield nuclear detonation that inhibit regional planning.***
2. ***What's the name of the scientific working group that was established by the Department of Homeland Security?***
3. ***Name 2 prompt effects and how updated modeling is changing assumptions about response planning needs.***
4. ***How does the common Urban environment offer more protection from fallout radiation?***
5. ***How can planning assumptions about cigar shaped ,Gaussian fallout patterns cause poor response plans?***
6. ***Name some of the guidance documents that have come out to help state and local emergency response organizations.***