Response to an Improvised Nuclear Device
Keeping Responders Safe

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Centers for Disease Control and Prevention

NIOSH Radiation Emphasis Areas:
- Certification of CBRN PPE
- Occupational Energy Research Program
- Energy Employee Illness Compensation Program
- Technical Assistance
- Training
- Response
Identifying Key Challenges for Responder Health and Safety

Two approaches

Identifying Gaps in

- Strategy
- Leadership
- Priorities
- Accountability

Recognizing and Responding to Lessons Learned from past incidents
Key Challenges for Incident Command

- Need for consensus on hazard exposure limits for emergency response
  - EPA, DHS, NCRP, IAEA, CRCPD, ICRP

- Will emergency response exposure limits be realistic and practical?
  - OSHA limits not focused on emergency response

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**EPA “Protective Action Guides”**

<table>
<thead>
<tr>
<th>Total Effective Dose Equivalent (TEDE) Guideline</th>
<th>Worker Activity</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 rem (0.05 Sv)</td>
<td>All occupational exposures</td>
<td>- All reasonably achievable actions have been taken to minimize dose.</td>
</tr>
</tbody>
</table>
| 10 rem (0.1 Sv)                               | Protecting valuable property necessary for public welfare (e.g., a power plant) | - All appropriate actions and controls have been implemented; however exceeding 5 rem is unavoidable.  
  - Responders have been fully informed of the risks of exposures they may experience.  
  - Dose > 5 rem is on a voluntary basis.  
  - Appropriate respiratory protection and other PPE is provided and used.  
  - Monitoring is available to project or measure dose. |
| 25 rem (0.25 Sv)                               | Lifesaving or protection of large populations  
  - RDD incident: this dose level unlikely to be reached for response workers  
  - JND incident: this dose level is conceivable for response workers | - All appropriate actions and controls have been implemented; however exceeding 5 rem is unavoidable.  
  - Responders have been fully informed of the risks of exposures they may experience.  
  - Dose > 5 rem is on a voluntary basis.  
  - Appropriate respiratory protection and other PPE is provided and used.  
  - Monitoring is available to project or measure dose. |
Key Challenges for Responder Organizations

- Training and Education
  - Few responders receive adequate training in radiation safety, and have little experience with radiation response
  - “Informed consent” from individual responders will be required for those entering the hot zones
  - Research indicates potential reluctance of responders to respond to event involving significant radiation hazards
Key Challenges for Monitoring Responders

- Monitoring and Surveillance
  - Area and Personal Monitoring
    - Availability of dosimetry and radiation detection equipment
    - Proper maintenance of existing equipment
    - Blast-damaged equipment
  - Long term surveillance and dose reconstruction
    - Emergency Responders vs “Radiation Workers”
      - Particularly in the Recovery phase
Key Challenges for State & Local Public Health Capability & Capacity

- Response capability & capacity varies across state and local jurisdictions
  - 31 States with nuclear power plants
  - States with high risk metropolitan areas

- Inconsistent integration of radiation control programs with public health agencies
  - State radiation control programs reside in state public health agencies in 35 states
  - Radiation control/expertise is found elsewhere with state government in remaining 15 states
Challenges to Planning & Response for State, Local, Tribal, and Territorial Jurisdictions

- Lack of awareness public health responsibilities in radiological/nuclear emergencies
- Lack of funding
- Lack of subject matter expertise
- Lack of human resources for planning, exercises, and response
Fukushima – Lessoned Learned

• Equipment & personnel resources to monitor potentially-exposed people for radioactive contamination are limited

• Insufficient number of radiation health experts

• Public health risk communication messages need improvement

• Public health authority to detain people contaminated with radioactive materials is unclear

• Medical countermeasure treatment capacities are limited, and the best policy for stockpiling and delivery is unclear

• National and international exposure standards for radiation measurements and protective action guides lack uniformity

• Public Health access to federal radiation monitoring data is limited

• Nuclear contamination impacts interstate commerce
Leadership brings it all together

- **Anticipate:** Do as much in advance of an incident as possible.

- **Prioritize:** Focus efforts on the most important, most fruitful work.

- **Synchronize:** Get Departments, agencies, and partners working towards common goals.
Primary Occupational Hazards of IND

- **Prompt and Delayed Ionizing Radiation**
  - Initial prompt radiation from blast
  - Nuclear Fallout
    - Groundshine: gamma radiation exposure
    - Nuclear contamination on skin and clothing: beta burns
    - Inhalation of respirable fallout: radionuclide absorption

- **Numerous Physical/Chemical Hazards**
  - Collapsed structures/rubble
  - Heat/Fire
  - Broken glass/sharp objects
  - Downed power lines/Ruptured gas lines

- Impaired Communications (Secondary to EMP)
Roles for Responders

**Pre-event**
- Identify pre-existing radiation sources/baseline
- Conduct training and exercises
- Coordinate with response partners

**Early-phase**
- Monitor indicators of a release
- Identify likely areas of contamination
- Provide public guidance
- Identify agent and characterize contaminated area
- Assess victim decontamination and medical needs
- Ensure critical Infrastructure safety
- Monitor responder exposures and health

**Intermediate-phase**
- Conduct epidemiologic investigation
- Provide emergency laboratory support
- Establish victim registry
- Monitor shelter and mass care conditions
- Ensure food and water safety
- Ensure animal safety (Veterinarians)

**Late-phase**
- Manage contaminated fatalities
- Define re-occupancy criteria
- Decontaminate facilities and resources
Operational S&H Responsibilities

**Employer:**

**Prior:**
1. Establish & prioritize Admin controls, policies & procedures to control exposures
2. Provide health monitoring & surveillance program
3. Provide protective devices, PPE, monitoring equipment, & training/retraining

**During:**
1. Supervise hot zone to ensure implementation of P&P
2. Provide Just-In-Time training
3. Arrange for dosimetry services
4. Facilitate worker compliance

**After:**
1. Arrange for post-event health surveillance
2. Maintain & provide access to exposure records

**Responder:**
1. Accept S&H information & training
2. Follow regulations & procedures
3. Properly use monitoring equipment & devices
4. Cooperate with health surveillance and dose assessment programs
5. Report health/pregnancy status
6. Report circumstances that could affect the decision dose or safety compliance

**Incident Command:**
1. Determine pre-established exposure levels
2. Establish protective actions that produce more good than harm
3. Ensure that responder exposure is optimized to achieve the lowest exposure under the circumstances
4. **NCRP does not recommend a dose limit for responders** – exposure decisions should be made based on operational awareness and mission priorities
Portal Monitors & Survey Meters

A radiation survey meter is needed to:

- Detect radioactive material
- Measure radiation levels
- Survey personnel
Personal Dosimetry

Newer technologies measure the radiation dose rate, total dose, and remaining “stay time” for the responder, and may provide flashing display, audible and vibration alarms and data logging capabilities.

Pagers

Ruggedized design for field use

Badge dosimeter
### EPA Guidelines for Emergency Procedures*

*(expected only once in a lifetime)*

*Minors and pregnant females have much lower limits*

<table>
<thead>
<tr>
<th>Dose limit</th>
<th>Emergency Activity Performed</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>5,000 mrem</td>
<td>All activities</td>
<td>All activities during emergency</td>
</tr>
<tr>
<td>10,000 mrem</td>
<td>Protecting major property</td>
<td>Where lower dose not practicable</td>
</tr>
<tr>
<td>25,000 mrem</td>
<td>Lifesaving or protection of critical infrastructure</td>
<td>Where lower dose not practicable</td>
</tr>
<tr>
<td>More than 25,000 mrem</td>
<td>Lifesaving or protection of large populations</td>
<td>Only on a volunteer basis to persons fully aware of the risks involved.</td>
</tr>
</tbody>
</table>

**Dose Limit:**

Pre-determined maximum radiation dose that a responder is allowed to receive

**Purpose of Dose Limit:**

Allow responders to perform emergency actions, yet keep risk as low as possible
Decision Dose

50 rad (500mSv) to Emergency Responders

- Triggers decision on whether to withdraw an emergency responder from within or near (but outside) the inner perimeter during the early phase of response.
- Triggers decision on whether to withdraw an emergency responder from within the outer perimeter after prolonged activities.

NCRP Commentary No. 19
(consistent with CRCPD HS-5 Task Force)
Web-Based Resources for Responders

**REMM** — HHS/ASPR Radiation Emergency Medical Management Website, managed by the NLM (http://www.remm.nlm.gov/index.html)

Provides guidance for health care providers, primarily physicians, about clinical diagnosis and treatment of radiation injury during radiological and nuclear emergencies

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**NIOSH Radiation Website**  
http://www.cdc.gov/niosh/topics/radiation/

**OSHA Radiation Website**  

**US EPA Radiation Website**  
http://www.epa.gov/radiation/index.html

**US FDA Medical Countermeasures**  
Workforce Protection
Existing Guidance

Planning Guidance for Response to a Nuclear Detonation
Second Edition
June 2010

NCRP Report No. 138, Management of Terrorist Events Involving Radioactive Material

NCRP Report No. 138 on Management of Terrorist Events Involving Radioactive Material is 232 pages with 13 sections, eight appendices, a glossary, list of acronyms, conversions of conventional and International System of dosimetric quantities, and references. The Report's main emphasis is on guidance to "first responders" and "emergency medicine personnel" that would be involved in the management of terrorist events involving radioactive material. The sections of the report are: 1. Introduction (4 pages), 2. Considerations Impacting Response (7 pages), 3. Characteristics and Consequences of Terrorist Incidents that Involve Radioactive
NRT Best Practices Guides for Responders

Volume I
Guidance for Managing Worker Fatigue During Disaster Operations
Technical Assistance Document

April 30, 2009

USE OF VOLUNTEERS
GUIDELINES FOR OIL SPILLS

September 27, 2012
New & Coming Very Soon Guidance that will inform Responders & ICS

Health and Safety Handbook
For First Responders Following
A Nuclear Detonation

Health and Safety Planning Guide
For Protecting First Responders
Following A Nuclear Detonation

Communicating During and After a Nuclear Power Plant Incident

DHS IND Handbook & Guide should be released in early 2013
Emergency Responder Health Monitoring and Surveillance

National Response Team Technical Assistance Document (TAD)

January 20, 2012

Audience: Anyone implementing ERHMS: Safety Officers, Occupational Safety and Health staff, Epidemiologists, Industrial Hygienists

Available at: http://nrt.sraprod.com/erhms/

Audience: Emergency managers, Incident Commanders, Agency leadership
Goals of ERHMS

- **Pre-Event**: Ensure only qualified, trained, and properly equipped personnel are selected for deployment.

- **During Event**: Ensure all receive sufficient on site training, monitoring, and risk assessment.

- **Post-Event**: Ensure responders receive long-term tracking of health where appropriate and recommended.
Pre-Deployment Objectives

- Rostering and credentialing
- Providing health screening
- Ensuring adequate health and safety training
- Data management
During Deployment Objectives

- On-site rostering
- On-site safety training
- Develop a Health and Safety Plan (HASP)
- Document worker activities and use of personal protective equipment
- Exposure assessment at the site
- Link exposure information to responder activities
- Responder injury and illness monitoring and surveillance (physical and mental health)
- Communications
Post-Deployment Objectives

- Out-processing assessments
- Analyze exposure data in conjunction with self-reported and healthcare provider-generated information
- Determine the need for long-term monitoring
- After action assessments
Longer Term Tracking Decision Process

- Deployment Roster
- Exposure and Health Analysis
  - Analysis components:
    - Medical monitoring data
    - Medical surveillance data
    - Exposure assessment data
    - Environmental sampling data
    - Exit Survey Data
    - Responder Activity data
    - Pre-deployment baseline data
    - Medical Examination results
- Workers Identified for Health Tracking
- Long-Term Tracking options:
  - Medical Surveillance program
  - Medical monitoring program
  - Academic Research Study
  - Periodic Health Survey program
  - No follow-up deemed necessary
- Health Tracking Program Type

Key: blue diamond = decision point; black box = information about responders
Future plans for ERHMS project

- Implementation phase of development
  - Electronic database
  - Field tools
  - Training materials: classroom and online
  - Field-testing of ERHMS concepts
- Communication products
  - Factsheets for each ERHMS topic
  - Blog, tweets, etc.
  - http://www.cdc.gov/niosh/topics/erhms
Contact & Additional Information

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National Institute for Occupational Safety and Health
Emergency Preparedness and Response Office

NIOSH Emergency Response Resources:
http://www.cdc.gov/niosh/topics/emres/

Emergency Responder Health Monitoring & Surveillance System:
http://nrt.sraprod.com/erhms/
http://www.cdc.gov/niosh/topics/erhms
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4. Renee Funk, DVM, NIOSH
5. DHS - Office for Domestic Preparedness

Questions?
EXTRA SLIDES
<table>
<thead>
<tr>
<th>Exposure Amount</th>
<th>Short-Term Whole Body Dose (rad)</th>
<th>Acute Symptoms (Within 4 Hours) (%)</th>
<th>Excess Lifetime Risk of Fatal Cancer (%)</th>
<th>Emergency Activity Performed</th>
<th>First Responder Condition (Minors &amp; pregnant females have much lower limits)</th>
<th>Health Impact</th>
<th>Health Impact</th>
<th>Audible Warning, Alarms &amp; Consent</th>
</tr>
</thead>
<tbody>
<tr>
<td>10,000,000</td>
<td>1000</td>
<td>100</td>
<td>&gt;80d</td>
<td>No go</td>
<td>No go</td>
<td>Exceed Lethal Range</td>
<td></td>
<td></td>
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<tr>
<td>7,500,000</td>
<td>750</td>
<td>60</td>
<td>No go</td>
<td>No go</td>
<td>Exceed LD₅₀ Range</td>
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<td></td>
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<tr>
<td>6,000,000</td>
<td>600</td>
<td>100</td>
<td>&gt;40d</td>
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<td>No go</td>
<td>Exceed LD₅₀ Range</td>
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<tr>
<td>3,000,000</td>
<td>300</td>
<td>75</td>
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<td>Sub LD₅₀ Range</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>2,500,000</td>
<td>250</td>
<td>20</td>
<td>No go</td>
<td>No go</td>
<td>Exceed Clinical Range</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2,000,000</td>
<td>200</td>
<td>60</td>
<td>No go</td>
<td>No go</td>
<td>Clinical Range</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>1,500,000</td>
<td>150</td>
<td>40</td>
<td>No go</td>
<td>No go</td>
<td>Acute Radiation Syndrome</td>
<td></td>
<td></td>
<td>Consent must be obtained in advance</td>
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<tr>
<td>1,000,000</td>
<td>100</td>
<td>5-30</td>
<td>No go</td>
<td>No go</td>
<td>Onset of Vomiting</td>
<td></td>
<td></td>
<td>Intentional excursion must be justified</td>
</tr>
<tr>
<td>500,000</td>
<td>50</td>
<td>0</td>
<td>Lifesaving or protection of large populations</td>
<td>Only on a volunteer basis to persons fully aware of risks involved</td>
<td>Sub Clinical Range</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>250,000</td>
<td>25</td>
<td>0</td>
<td>Lifesaving or protection of large populations</td>
<td>Where lower dose not practicable</td>
<td>Chronic range threshold</td>
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<td>100,000</td>
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<td>0</td>
<td>Protecting Major Property</td>
<td>Where lower dose not practicable</td>
<td>no adverse health effects threshold</td>
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<td>50,000</td>
<td>5</td>
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<td>All activities during emergency</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10,000</td>
<td>1</td>
<td>0</td>
<td>All activities</td>
<td>All activities during emergency</td>
<td></td>
<td></td>
<td></td>
<td>Env. Contamination Alarms level</td>
</tr>
<tr>
<td>3,600</td>
<td>0.36</td>
<td>0</td>
<td>All activities</td>
<td>All activities during emergency</td>
<td></td>
<td></td>
<td></td>
<td>Ave. American annual dose from natural and background radiation</td>
</tr>
</tbody>
</table>
Respiratory Protection

The Department of Energy recommends full-face respiratory protection for entrance into a contaminated area. DOE/RW-0362 SR Office of Civilian Radiological Waste Management

The respiratory threat can be eliminated by employing High Efficiency Particulate Air (HEPA) or P100 filters. Domestic Preparedness Technician-HAZMAT Course

The U.S. Army specifies a M40 full-face gas mask with a two-element canister containing (HEPA) filtration and ASZM-T Cooperite carbon filtration media.
Particulate Radiological\Nuclear Agents
(USAMRIID and/or DOE Lists)

- Hydrogen 3
- Carbon 14
- Phosphorous 32
- Cobalt 60
- Nickel 63
- Strontium 90
- Technetium 99m
- Iodine 131

- Cesium 137
- Promethium 147
- Thallium 204
- Radium 226
- Thorium 232
- Uranium 235 & 238
- Plutonium 239
- Americium 241
Personal Protective Equipment

- Standard protective clothing
  - Bunker/Turnout gear
  - Level B
- Respiratory protection
  - APR
  - PAPR
  - SCBA

**Civilian PPE**
Two classification systems used in the US

- Occupational Safety and Health Administration (OSHA) /Environmental Protection Agency (EPA) PPE ensemble classification system
  - **Level A** (most protective)
  - **Level B**
  - **Level C**
  - **Level D** (least protective)
- National Fire Protection Association (NFPA) PPE ensemble classification system
  - **Class 1** (most protective)
  - **Class 2**
  - **Class 3**
  - **Class 4** (least protective)

**US Military PPE**
Mission Oriented Protective (MOPP) gear: six different readiness levels achieved by adding or removing individual MOPP gear ensemble components

- **MOPP Ready** [lowest level of readiness (i.e., no ensemble elements are worn)]
  - **MOPP 0**
  - **MOPP 1**
  - **MOPP 2**
  - **MOPP 3**
  - **MOPP 4** [highest level of readiness (i.e., all ensemble elements are worn)]