Review of NCRP Commentary 19

Key Elements Of Preparing Emergency Responders For Nuclear And Radiological Terrorism

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Objectives of Presentation

- Overview of Commentary
- Identify Key Points
  - Radiation Protection
  - Equipment
  - Medical Issues

Commentary Background

- Prepared for Department of Homeland Security (DHS)
  - Prepare emergency responders for nuclear and radiological terrorism
- Resource for state and local planning
- Builds on previous NCRP Reports
  - NCRP 65, *Management of Persons Accidentally Contaminated with Radionculides*
  - NCRP 138, *Management of Terrorist Events Involving Radioactive Materials*
- Categories of Advice to DHS
  - Radiation Protection Guidance
  - Equipment needs
  - Medical supplies
  - Training needs

Introduction

- Recommendations apply only to an emergency
  - only until declared emergency over
- Post Emergency
  - reinstate established radiation protection practices
    - occupational
    - public exposure
  - Special arrangements for long-term control

Local Implementation

- Consistent with the existing format and content of Standard Operation Procedures
- Identify local potential hazards and vulnerabilities
- Compatible with the equipment used by the end user
- Consider local customs and language
- Identify local radiological emergency response resources
- Prepare for an elevated radiation environment

Emergency Responder

- Those individuals who, in the early stages of an incident, are responsible for protection and preservation of:
  - Life
  - Property
  - Evidence
  - Environment

Radiation Protection Guidelines

Radiation Protection Goals

- Prevent acute injuries and deaths due to short-term high-level radiation exposure
- Minimize long-term effects
  - ALARA principle
    - Use time, distance, and shielding

Total Dose Guidelines

- Control absorbed dose to an individual emergency responder
  - Cumulative absorbed dose for external photons only
  - Neutrons are not expected or minimal contributor
  - Alpha and beta particles can not penetrate bunker gear
  - Control inhalation by respiratory protection
- Establish Decision Dose
  - Decide when to remove a responder from the inner perimeter
- Record the cumulative absorbed dose to responders working in or near the inner perimeter
- Applies for life saving or other critical actions

Outer Perimeter

- Establish an outer perimeter if:
  - 10 mR h^{-1} exposure rate
  - Surface contamination is above:
    - 60,000 dpm cm^{-2} for beta and gamma
    - 6,000 dpm cm^{-2} for alpha

Outer Perimeter Activities

- Evacuate members of the public
- Isolate area
- Minimize time spent in the area
- Follow *appropriate* personal protection guidelines
- Activities to keep *outside* area
  - Command Post and support
  - Staging areas
  - Decontamination areas

Inner Perimeter

- Establish an inner perimeter at:
  - 10 R h^{-1}
  - Potential to produce acute radiation injury
- Restrict access to time-sensitive, mission critical activities, eg life-saving
- Wear an alarming personal radiation detector inside the inner perimeter

Decision Dose

- Short-term cumulative absorbed dose that triggers a decision to remove a responder
  - Incident Commander makes decision necessary to protect responder and public from harm
- Based on the absorbed dose where acute effects occur
  - Threshold for acute effects is ~100 rad on average
  - Applies a factor-of-two safety margin to minimize the risk
  - Allows for possible uncertainties in:
    - individual susceptibility
    - radiation dose measurement
    - contingencies

High Dose Considerations

- Recognize symptoms of high absorbed doses
  - nausea
  - vomiting
- If symptoms occur within the inner perimeter, remove the individual
- Physical injuries such as burns and wounds significantly increases risks of acute radiation effects
- Death can result from combined injuries, if injury or radiation exposure alone not lethal

High Absorbed Dose Risks

- Estimated excess cancer risks at doses < 100 rad are less than the normal risk of cancer without radiation exposure
- For doses above several hundred rad, the excess cancer risk approaches or exceeds the normal lifetime cancer risk

Basis for Decision Dose

Short-term Whole-Body Dose [rad]	Acute Death[b] from Radiation without Medical Treatment (%)	Acute Death from Radiation with Medical Treatment (%)	Acute Symptoms (nausea and vomiting within 4 h) (%)	Lifetime Risk of Fatal Cancer without Radiation Exposure (%)	Excess Lifetime Risk of Fatal Cancer due to Short-term Radiation Exposure (%)
1	0	0	0	24	0.08
10	0	0	0	24	0.8
50	0	0	0	24	4
100	<5	0	5 – 30	24	8
150	<5	<5	40	24	12
200	5	<5	60	24	16
300	30 – 50	15 – 30	75	24	24[d]
600	95 – 100	50	100	24	>40[d]
1,000	100	>90	100	24	>50[d]

a Short-term is exposure during response. The acute effects likely reduced by ½ if exposed occurs over weeks
b Acute deaths are likely occur 30 to 180 d after exposure, few if any after. Estimates are for healthy adults. Persons with other injuries, and children, will be at greater risk.
c Most cancers occur several decades after exposure; leukemia has a shorter latency period (< 5 y)
d Applies to those individuals that survive the acute radiation syndrome.

Equipment Recommendations

First Responder Equipment

- Post Event equipment requirements are very different than illicit radiation source detection (pre-event)
  - Pre-event equipment range is too limited to support most emergency operations
- Inexpensive radiation-monitoring equipment can help responders quickly determine if radiation is involved in an incident
- Equipment should alert responders to the radiation without any special action
- Some training is necessary to operate and interpret results
  - especially contamination monitors
- A positive indication for radiation
  - characterization efforts
  - Implement dose controls (establish inner and outer perimeters)
- Standard protective clothing (**bunker gear**) and respiratory protection devices **are sufficient to protect emergency responders**

First Responder's Emergency Vehicle

- Alert personnel to the presence of radiation
  - Alert at 10 mR h^{-1}
    - corresponds to the outer perimeter
- Essentially "go" or "no go"
- Protective of responders
  - Do *not* need other alarms
    - 10 R h^{-1} (the inner perimeter) or
    - Decision Dose (50 rad)

First On-Scene

For a suspected radiological event:

- An individual monitor is preferred over a single detection instrument for an entire response team
- Unambiguous alarms at:
  - 10 R h^{-1} - The inner perimeter
  - Decision Dose of 50 rad

Detection Instrument

Initial responders should have simple tools to:

- Identify contamination at outer perimeter
- Detection is more important than selectivity, sensitivity and accuracy
- Find surface contamination
  - 60,000 dpm cm^{-2} for beta and gamma
  - 6,000 dpm cm^{-2} for alpha

Post-Incident Monitor

- Easy to interpret in bunker gear
- Alert at higher than normal radiation levels w/o interaction
  - Recognize levels above 10 mR h^{-1}
  - Alarm at decision dose for dose (50 rad)
  - Alarm at high exposure rate (10 R h^{-1})
- **Visual** or audible indicators
  - green/yellow/red light or large numeric display
- Displays exposure rate and records cumulative dose

- Works continuously without user intervention
- Simple and intuitive, requires little training to operate
- Small size, and easily and securely worn (not carried)
- Inexpensive to purchase and maintain
- Rugged enough for field use

Alarming Personal Radiation Detectors

- Identify radiation exposure rates
  - 1 mR h^{-1} to 500 R h^{-1}
- Integrate exposure up to 500 R
- Visual status indicator (not necessarily a numerical readout)
- Assigned to each emergency responder
  - If not possible,
    - first individual to enter the area should have a radiation-detection instrument
    - Warn others of radiation presence
    - Implement administrative exposure controls

Instrument Alerts

- Alert and alarm levels set by the local authority
  - ensure compliance with local guidelines
  - reduces need for the wearer to read and interpret
- Steady Red light (and audible or vibration)
  - cumulative absorbed dose of 50 rad
- Blinking Red light
  - exposure rate above 10 R h^{-1}
- Yellow light
  - exposure rate between 10 mR h^{-1} and 10 R h^{-1}
- Green Light
  - exposure rate is below 10 mR h^{-1}

Decontamination and Medical

Decontamination Goals

- Minimize the time to treat victims
- Promptly remove victims from the incident scene while providing responder safety

Screening People

- Additional equipment and supplies needed to screen large numbers of people for contamination
  - At the scene
  - At emergency facilities for initial decontamination
  - Designated reception centers
  - Hospitals

Instruments to Decontaminate People

- Detect the presence of an external radiation and surface contamination
  - readily available
- A thin-window GM (either "pancake," or end-window)
- Supplement equipment and expertise by using:
  - academic and medical centers
  - biomedical research facilities
  - nuclear medicine departments

Capabilities

- Detect surface contamination
  - 6,000 dpm cm^{-2} for beta or gamma
  - 600 dpm cm^{-2} for alpha
- Make Equipment easy to use:
  - For a standard 15 cm^2 GM probe
    - 20 percent efficiency (1 cpm = 5 dpm)
    - Divide the number of cpm by three to get dpm cm^{-2}
      - # dpm cm^{-2}= (cpm/15 cm^2) x (5 dpm/cpm) = cpm/3

Radionuclide Identifiers

- Initial response can be managed without knowing the specific radioactive material
- Identifiers should be available to but not needed at scene
- Identification allows better management of contaminated people and protective measures
- Commercial identifiers have been available for many years
  - Identify gamma-ray emitting radioactive materials
  - Requires considerable knowledge and skill to operate
  - Improved units available for a technician level person to interpret
- High initial and ongoing operating costs of an identifier may not warrant purchase
  - Expect state radiation control organizations to bring
  - Nuclear medicine laboratories
  - University radiation safety programs
  - Research laboratories
  - Radioactive materials licensees
  - Hazardous materials teams
- Nuclear medicine gamma cameras can identify radionuclide

Initial Monitoring and Decontamination

- Prevent acute radiation effects to victim
- Cross contamination is a secondary concern
  - especially when the contaminated area and number of evacuees is large
- Spot contamination > 2.2 X 10^6 dpm (1 μCi) should be a priority for decontamination
  - presume spot size is 0.2 cm^2
- Screening can be done quickly
  - ~15 s per person using a thin window "pancake" GM
  - ~2.5 min per person using an end-window instrument (CDV-718 civil defense meter)
  - ~4 min per person with a "hotdog" style GM probe (CDV-700 civil defense meter)

Decon Fluid Release

- Not a priority to contain all the fluids generated in decontamination
- The Incident Commander decides based on
  - Incident severity
  - Immediacy of the decontamination
  - Resources available
- EPA (CERCLA, 1980) states:
  - Will not pursue enforcement actions for the environmental consequences of necessary and appropriate emergency response actions
  - Emergency responders should take any necessary emergency actions to save lives and protect the public and themselves

Victim/Patient Decontamination

- Staging and Decontamination Area should have:
  - Adequate triage
  - Supplies
  - Copious water supply
    - Containment (if possible)
  - Consideration of clothing exchange and individual privacy
  - Protection from hypothermia
    - May be more hazardous than the contamination

Consider Self-Decontamination

- Cover mouth to reduce inhalation of resuspended particles
- Remove and bag outer clothing before entering the residence
- Shower with warm (not hot) water
  - Use soap and shampoo (not hair conditioner)
  - Do not abrade skin
- Remove contaminated clothing
  - Normally removes 80 to 90 percent of contamination
  - Wrap patient in a sheet prior to transport

Self-Decontamination (cont)

- Spot decontaminate with soap and warm (not hot) water
  - Stop decontamination if:
    - skin abrasion occurs
    - Two successive attempts do not reduce the contamination
- Reduce surface body contamination
  - To less than 9,000 dpm cm^{-2}
  - any one spot to $< 2.2 \times 10^5$ dpm (0.1 μCi)
- Extensive Decon facilities not necessary unless:
  - large number of contaminated victims
  - immediate medical care is not the primary consideration

Medical Evaluation

- Radioactive material contamination is rarely an immediate danger to the health of the victim or the responder
  - Reduce the immediate need for decontamination
  - Allow greater flexibility in selecting decontamination options
- Nausea and vomiting are the earliest clinical signs of acute radiation syndrome
  - WD Dose > 100 rad
  - Remove from inner perimeter activities if signs exhibited
  - Consider potential for more than one agent
    - symptoms may be caused by other agents

Emergency Dept Plan

- Radiation danger to emergency hospital personnel is minimal
  - outside of the radiation control zones
- Focus on standard medical care
- Establish plans for patient care
  - Determine patient routing (destination of casualties)
  - Facility requirements for the treatment of emergent and trauma patients
- Address psycho-social concerns
- Provide psychological assistance at healthcare facilities for:
  - concerns about radiation contamination
    - victims
    - individuals
    - friends and relatives

ED Staff Protection

- Universal precautions are sufficient for treatment of victims of radiological incidents
  - Dress in surgical clothing (scrub suit, gown, mask, cap, eye protection, and gloves)
  - Wear waterproof shoe covers
  - Tape all open seams and cuffs
  - Wear two pairs of surgical gloves
    - first pair taped at the arm cuff
    - second pair should be easily removable and replaced
  - Assign a self-reading radiation dosimeter
    - Place on the outside of the surgical gown
      - at the neck
      - easily removed and read

ED Entrance Monitoring

- Report above normal radiation levels
- Monitor for contaminated individuals
- Set alarm high enough to minimize response to nuc med patients ($10\ mR\ h^{-1}$)
- Possible radiation portal monitor or pedestrian portal monitor

Triage

- Multi-parameter triage (time to vomiting, lymphocyte kinetics and other biodosimetry indicators) is the best early assessment of victim dose
- Treat promptly
  - The first hour is best change to save lives of severely injured
  - Radioactive material must not interfere with rapid triage, removal and treatment
- Rad concerns must not preclude life-saving efforts
  - Patients in shock or near shock can die if not treated w/in 1st hr
- Nasal swabs indicates likelihood of inhalation
  - not always a confirmation of no intake
  - inhaled material is cleared from nasal passages w/ 17 hr half-time

ED Dose Control

- Establish plans to operate critical medical facilities and critical care equipment with low levels of radioactive contamination
  - Label fixed contamination
  - Use barriers and lead sheeting to reduce exposure rates to < 2 mR h^{-1} during decontamination efforts
  - Keep the cumulative dose to staff and uncontaminated patients to < 100 mrem in the year following the event
    - could increase to 500 mrem, if necessary for medical care
  - Keep critical facilities operational
- 50 rem dose guideline applies when undertaking life-saving medical care
    - surgical removal of highly radioactive embedded shrapnel

Medical Care PPE

- Standard Personal Protection Equipment normal clothing (a uniform) will provide some protection from contamination
- Avoid prolonged wearing of contaminated clothing
  - Will not protect a person from external radiation exposure
- Cover the mouth and nose with a handkerchief or bandana to reduce the possibility of inhaling airborne radioactive materials
- Exposure rates from contaminated wounds rarely exceed a few mR h^{-1}
- Emergency responders should be reassured that exposures very likely insignificant

Medical Vehicles

- Monitor transport vehicles before reuse
- Reuse low-level contaminated vehicles
  - Consider outer perimeter values
  - Document in local emergency plan
  - Consult local and state radiation control programs

Training

Training Objectives

- Enhance ability to take appropriate measures to protect themselves and the public
- Increase confidence to effectively manage a radiation emergency involving
- Integrate with existing training

Base Messages

- Radio-contamination is rarely life-threatening
- Radiation exposure does not make a person radioactive

Baseline Training

- All emergency responders should receive initial training related to duties
- Integrate into the overall training requirements
- Reinforced through professional accreditation or continuing education credits
- Radiological emergencies can be safely managed using the emergency responder's equipment and protocols
- Rescue and medical emergencies take precedence over radiological
- Train those potentially involved in life-saving activities at the operations level
- Annual refresher training to maintain proficiency not as extensive as initial training