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THESIS

SACRAMENTO REGIONAL RESPONSE GUIDE TO RADIATION EMERGENCIES

by

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September 2006

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13. ABSTRACT (maximum 200 words)

Accidental or intentional release of radiation may result in catastrophic consequences to urban and suburban populations. Any emergency response is compromised by insufficiently detailed protocols, and qualitative or quantitative wants in equipment and training. These challenges are no less acute for Sacramento County which is an archetype of at-risk suburban and urban settings. Recognized standards in critical patient care illustrate the need for specific considerations for radiological contaminated patients in a response protocol. Current practices in Sacramento require patient decontamination prior to treatment or transport. This may adversely affect survival profiles, despite national and international standards which specifically provide for consideration of alternative procedures.

Radiation responses require a systems approach, whereby all work collaboratively towards a common goal. Incident commanders must appreciate their role in a radiation response, and how to incorporate the response into a unified multi-jurisdictional, unified command. Additionally, an essential component of any radiation response protocol is to decrease the associated "fear" of radiation in the general public as well as emergency responders.

Best practices research, and recommendations at local, state, national and international levels are compiled into a usable radiation response protocol which can be utilized in formulating protocols in radiation emergency response.

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SACRAMENTO REGIONAL RESPONSE GUIDE TO RADIATION EMERGENCIES

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I. INTRODUCTION

A. PROBLEM STATEMENT

Potential radiological emergencies will task the Sacramento Region of California to re-evaluate the current procedures to respond effectively to a large scale radiation incident, either caused by an act of radiological terrorism, or by accident. The lack of specific policies addressing triage, treatment and transport of critical patients in the aftermath of a radiation event will hamper an effective response. Additionally, insufficient distribution of radiation detection equipment will delay early evaluation of radiation exposure to emergency responders.

Pre-identification of authority and prior coordination of local, state and federal stakeholders to mitigate the incident will be addressed in the regional radiation protocol. The coordination from the initial response to recovery efforts in the late stage of a radiation incident will ensure the effective use of resources, and enhance the efficiency of emergency operations.

The current understanding of responding and treating victims of a radiation incident falls within the response to generalized hazardous materials. The hazardous material policy in the Sacramento region requires all contaminated victims of a hazardous materials incident to be decontaminated prior to medical treatment or transport. The existing policies are in place to protect the first responders and medical community from exposure hazards associated with hazardous materials. The Sacramento County Emergency Medical Service policy number 8029.05 states medical transportation units will only accept decontaminated patients from a HAZMAT team, and there are no provisions in place to accommodate transportation of critically injured, radiation contaminated patients.[1] Unlike decontamination procedures required for generalized hazardous materials, the critically injured patients at a radiological event must be triaged and treated for life threatening injuries prior to initiating time-consuming

[1] "Policy 8029.5, Hazardous Materials," in *Sacramento County Emergency Medical System Response Protocol* (February 27, 2004), http://www.sacdhhs.com/download/pdfs/ems/ems_Policy%208029.05%20Hazardous%20Materials.pdf. [Accessed June 30, 2005].

decontamination processes to remediate radiation contamination.[2] The existing procedures for treating critically injured patients at a radiological event, as called for in the current policy, will make it extremely difficult to save the lives of the critically injured contaminated patient due to the policies requiring decontamination of all contaminated patients prior to transportation to treatment facilities.

In addition to policy adjustments, the Sacramento Region needs to deploy additional initial radiation detection capability and radiation dosimeters to appropriately protect first responders.

B. RESEARCH QUESTIONS

The research will investigate the appropriate use of emergency response assets, (i.e. equipment and personnel) as well as the appropriate decontamination and recovery of those assets, incorporating this information as part of a regional radiation protocol. Appropriate preplanning and identification of required procedures necessary to decontaminate victims, personnel and equipment will be investigated to reduce confusion and anxiety over the presumed loss of assets due to radiation contamination by existing policies. Additionally, the effective utilization of protective clothing ensembles, and hasty patient packaging techniques to reduce the likelihood of radiation contamination to the first responders, will be important considerations of a revised radiation response protocol.

As part of the radiation response protocol, local, state and federal resources will be pre-identified. In collaboration with the associated responder training, the protocol will work to minimize radiation responder concerns associated with radiation exposure, treatment of radiation contamination from a first responder perspective, and concerns of lost resources due to contaminated assets and fixed facilities.

A large component in responding to radiation incidents is to minimize the fear associated with radiation both in the response community and the public at large.

[2] U.S. Department of Justice, Office of Justice Programs, Office for Domestic Preparedness. *Weapons of Mass Destruction (WMD) Radiation/Nuclear Course for Hazardous Materials Technicians, Student Manual, version 5.1* (Washington, D.C.: Office for Domestic Preparedness, Department of Homeland Security, n.d.), 9-5.

Research as to the science of the radiological threat and strategies to educate responders as well as the public as to the associated hazards are an integral part of the response protocol.

C. SIGNIFICANCE OF PROJECT

The immediate and long-term ramifications of an interoperable regional emergency response protocol, to be used in planning, response and in the aftermath of a radiological accident or intentional radiation attack will equate to more lives saved, reduced anxiety for responders and facilitate effective operations in a radiation emergency.

As part of the radiation response protocol, local, state and federal recovery resources will be identified, and in concert with training, will alleviate concern of cost recovery associated with contaminated transportation assets and fixed facilities. The clarification of recovery stage cost reimbursement, and decontamination procedures will reduce the confusion and potential on-scene debate over which resources will be used. The development of the radiation response protocol in Sacramento will potentially be applicable to other regions of the country, furthering the radiation response capability throughout the nation.

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II. RADIATION RESPONSE SCENARIOS

A. POTENTIAL RESPONSE SCENARIOS

The emergency response to a radiation event can be anticipated in several scenarios:

- Industrial accidents during normal day-to-day handling, or transportation of radioactive materials.
- Intentional sabotage of storage or transportation vessels containing radioactive materials for malicious purpose. This may include nuclear facilities such as, power plants, or industrial facilities.[3]
- Detonation of a tactical nuclear weapon such as nuclear artillery shells, land mines, "suit case" bombs, etc. Tactical nuclear weapons from the former Warsaw Pact countries arsenal could theoretically be used conventionally by terrorist groups if they fall into the wrong hands. "Russia continues to deploy a number of its most portable nuclear weapons on its front lines, where security controls are the weakest."[4]
- The distribution of radioactive materials via a "dirty bomb" (Radiation Dispersal Device). The term "dirty bomb" is a slang term, originated by the news media, and used to describe a radioactive material packaged with explosives for the intended purpose of spreading radiation.[5]
- Radiation Exposure Device that consists of a radiation source positioned to expose unsuspecting victims to harmful levels of radiation.
- Improvised Nuclear Device (IND)-the formation of a nuclear-yield reaction that can be an improvised weapon with acquired nuclear materials, or modification to a U.S. or foreign nuclear weapon.[6]

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[3] Charles D. Ferguson et al., *The Four Faces of Nuclear Terrorism* (Monterey, Calif.: Center for Nonproliferation Studies, 2004), 3.

[4] Ibid., 1.

[5] Health Physics Society, "Guidance for Protective Actions Following a Radiological Terrorist Event," http://hps.org/hsc/documents/wmd_factsheet.pdf [Accessed July 2, 2005].

[6] Ibid.

- Improvised methods of distributing radiation by utilizing liquid sprayers or other mechanical means to spread radiation contamination.

B. TYPES OF RADIATION AND THEIR CHARACTERISTICS

Alpha Radiation: Particulate cat ion, consisting of two protons and two neutrons which will not pass through a piece of paper or the dead layer of intact skin. Alpha radiation travels approximately 1-2 inches in air and is primarily an internal inhalation or absorption hazard.

Beta Radiation: Smaller than alpha particles, beta radiation can, depending on their energy, travel up to 10 feet in air, and can penetrate the intact skin, making beta radiation both an external and internal hazard. Shielding can be accomplished with plastic, glass, and foil.

Gamma and X-rays: Electromagnetic radiation, that travels at the speed of light. Shielding can be accomplished by dense material such as lead, steel, and concrete. Gamma radiation can easily penetrate protective clothing; therefore gamma radiation is considered an external and internal exposure hazard.

Neutron Radiation: High-speed particulate matter traveling at close to the speed of light. There are only limited numbers of radionuclides that are natural emitters of neutron radiation. Neutron radiation is associated with a nuclear fission event such as a detonation of a nuclear weapon. Deposits energy in hydrogenous materials such as fat and water, and thus, it is an external and internal radiation hazard.

C. TERMINOLOGY FOR FIRST RESPONDERS REGARDING RADIATION

Electromagnetic radiation: Is defined by the modular emergency response radiological transportation training program (MERRTT) as visible light, heat, radio waves, and microwaves which are low level radiation energy which is referred to as non-ionizing radiation. High energy radiation is referred to as ionizing radiation. Ionizing radiation is of sufficient energy to eject an electron from an atom, thereby changing the electron configuration of the atom and thus its chemical properties. This is the initiating event that can ultimately lead to biological damage and the potential adverse health consequences of ionizing radiation.

Radiation physical half-life (T_p1/2): the time required for a quantity of a radionuclide to decay (i.e., transform) by one-half. Some radionuclides have a T_p1/2 of a few hours (e.g. Tc-99m used widely in Nuclear Medicine- T_p1/2=6 hrs), or many years (e.g. Cs-137 used in instrument calibration facilities T_p1/2-30 yrs and U-238 found in nature T_p1/2= 4.5 billion years.[7]

Radioactive material: Any material that spontaneously emits ionizing radiation.[8]

Radioactive contamination: Radioactive material where it is not intended.[9]

ALARA: Acronym for "as low as (is) reasonably achievable." Means making every reasonable effort to maintain exposures to ionizing radiation as far below the dose limits as practical, taking into account the state of technology, the cost of incremental reductions in dose, and other societal and socioeconomic considerations, regarding the utilization of radioactive material in the public interest

Total Effective Dose Equivalent (TEDE): The sum of the internal and external doses of radiation exposure.

Inverse Square Law: The relationship that states that electromagnetic radiation intensity is inversely proportional to the square of the distance from a point source. Thus reducing the distance from a radiation source by 1/2 increases the exposure rate four times. The same law works in reverse, whereby increasing the distance from a radiation source by a factor of 2 reduces the exposure rate four fold.

Fissile Material: Any material in which neutrons can cause a fission reaction. The three primary fissile materials are uranium-233, uranium-235, and plutonium-239.

Low Specific Activity (LSA): Radioactive material with limited amounts of radioactivity relative to the amount of the material. An example would be uranium or thorium ores, mill tailings or contaminated earth.[10]

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[7]Health Physics Society, "Guidance for Protective Actions," 2-7.

[8] Ibid.

[9] Ibid., 2-8.

[10] U.S. Department of Energy, "Modular Emergency Response Radiological Transportation Training (MERRTT) Student Guide" (May 2006), 8-7.

Special form radioactive material: Can be either a single, solid piece of material, or a sealed capsule that can be opened only by destroying the capsule. Special form material is considered to be non-dispersible during accident conditions. [11] Special form material should not be confused with "Special Nuclear Material" which is plutonium, uranium-233, or uranium enriched in isotopes uranium-233 or urnium-235.[12]

Surface contaminated objects: Solid object that is not radioactive in of itself, but has radioactive contamination on its surface.

D. MEASUREMENT TERMINOLOGY

First responders must understand that radiation is measured for different applications and purposes. Additionally, like unit measurements for distance, weight and temperature, there are different units of measurements for radiation utilized throughout industry both domestically and internationally. Emergency responders must understand the difference in order to reference and respond to radiation incidents appropriately. There is terminology that is based on the English system which is used primarily in the United States, and the international system (SI) which is used commonly in the rest of the world.

The English system of measurement utilizes the roentgen equivalent man (rem) as the measurement of radiation energy deposited in man and roentgen (R) to measure radiation exposure in air. Radiation absorbed dose (rad) is the unit for measuring absorbed dose in any material. The international unit of measurement for radiation energy deposited in man is the Sievert (Sv), and the international unit for absorbed dose in a material is the Gray (Gy).[13]

- For emergency response purposes, these term may be considered to be approximately equal to one another (i.e., 1 R = 1 rem = 1 rad).
- 1 Sv = 100 rem

[11] Department of Energy, *Modular Emergency Response,* 8-7.

[12] U.S. Nuclear Regulatory Commission, "Special Nuclear Material," http://www.nrc.gov/material/sp-nucmaterials.html, [Accessed September 3, 2006].

[13] U.S. Department of Justice, Office of Justice Programs, Office for Domestic Preparedness, *Weapons of Mass Destruction (WMD) Radiation/Nuclear Course for Hazardous Materials Technicians, Student Manual, Version 5.1* (Washington, D.C.: Department of Homeland Security, n.d.), 2-23.

- 1 Gy = 100 rad.
- The terms Curie (Ci) and Becquerels (Bq) are used to measure the amount of radioactivity which is the number of decay events or disintegrations a quantity of radioactive material undergoes in a certain period of time. The Ci is utilized by the English system and is a large quantity of radioactive material equal to 3.7 x 10^{10} disintegrations per second. The Bq is a much smaller quantity of radioactive material equal to 1 disintegration per second. UN placarding and labeling utilizes the Bq to indicate the quantity of radioactive material, but sometimes has the Ci equivalent in parenthesis next to the Bq value.

It is important to note that the U.S. Department of Defense (DOD) utilizes the SI units, so clarification of terminology utilizing units of measurement between local responders and DOD assets will need to be confirmed to minimize confusion or misinterpretation of reported measurements of radiation.

E. AVAILABLE RADIOACTIVE MATERIALS FOR POTENTIAL TERRORIST ATTACKS

There are an estimated 10,000 radioactive sources throughout the world that exceed 1,000 curies, and an estimated one thousand sources that exceed 100,000 curies.[14] To put these numbers into perspective, an unshielded 25-gram source of Cs-137 would have a dose rate of 1,000 rem/hr at one meter, thus resulting in a lethal exposure in one hour .[15] If this same material was spread over a ten square block area in a metropolitan area, the dose rate would be less than 1 rem/yr.[16] It should be noted that there are some large sources exceeding 220,000 curies used in large food irradiation units that if spread in the above mentioned example, would still result in dangerous doses rates even if distributed over the 100 square blocks mentioned in the previous example.[17]

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[14] James L. Conca and Michael H. Reynolds, "Dirty Bombs, Practical Plans," in *Homeland Protection Professional Magazine* (May 2006): 22.

[15] Ibid.

[16] Ibid.

[17] Ibid.

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III. ROLE OF THE FIRST RESPONDER

> The events of 9/11 have necessitated that the emergency response community take a critical look at existing response programs, and develop a systems approach for the future. Terrorist groups will continue to attempt to obtain WMD material with the goal of attacking targets in the U.S. Consequently, response assets must be prepared to respond. We no longer have the luxury of reach back with six or seven hour response times. As so often is the case, local first responders are the key. Emergency responders will be the first on the scene where decisions made in the initial stages of the incident will contribute greatly the overall success of the response effort. They must be given the capability to detect radiological materials and be provided with timely technical information and evacuation advice.[18]

The term "systems" approach is understood by the author to mean a collaborative, multi-discipline approach to complex emergency response scenarios. Response protocols must incorporate all stakeholder agencies. Individual response protocols that do not incorporate, and identify all responding agencies roles and responsibilities will be ineffective.

A. TERRORISM VERSUS ACCIDENTAL RADIATION RESPONSE

Response to a radiation accident differs from response to a radiological terrorist attack. Accidents generally happen in radiation facilities where there is resident expertise and pre-planned response guidelines for specific releases of known radionuclides. Often there is a great deal of time in anticipation of the accident to activate pre-developed response plans.[19] Radioactive materials involved in accidents are generally well identified and the hazard is immediately known once an accident occurs. Both the transportation routes and location of fixed facilities for large radioactive sources are located in areas where accidents, generally, will impact the least amount of people.[20]

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[18] John M. McBroom, "How the DOE/NNSA nuclear and biological search and response capability and the first responders across the nation can work together," testimony in House Armed Services Committee (Washington, D.C., March 5, 2002), http://www.house.gov/hasc/openingstatementsandpressrelease/107thcongress/02-03-05mcb [Accessed July 2, 2005].

[19] "Preparedness Directorate; Protective Action Guides for Radiological Dispersal Device (RDD) and Improvised Nuclear Device (IND) Incidents," *Federal Register* 71, no. 1 (January 3, 2006): 175.

[20] Ibid.

Conversely, terrorist attacks will be intentionally committed in areas where the most impact will occur. The radionuclide or quantity will not be immediately known, and will remain unknown until responders arrive on scene with appropriate equipment to evaluate the hazard and protective actions will be needed immediately without notice.

A terrorist attack, utilizing a nuclear weapon or improvised nuclear device, would most likely be initiated at the surface, which will cause a tremendous amount of radiation fallout.[21] Without a specific radiation response plan, emergency workers may find themselves over committed in the contaminated area, becoming contaminated and exposed to harmful radiation levels. "Response techniques, therefore, must be modified so that emergency responders are able to protect themselves while saving as many lives as possible."[22]

B. DETECTION/DOSE MONITORING

The early notification and accurate assessment of a radiological event will be paramount in the management of a radiation emergency. In the Sacramento Region, The Sacramento City Fire Department, Sacramento Metropolitan Fire District, Folsom Fire District, Elk Grove Fire District, West Sacramento Fire Department, and the Roseville Fire Department have been issued "pager style" radiation dosimeters to detect gamma radiation during the initial response to an emergency. The distribution of radiation pagers has not been consistent throughout the aforementioned fire department agencies within the operational area. Some fire agencies have inexplicably elected to retain their dosimeters to be deployed in the event of a declared radiological emergency. This clearly is going to be too late for their initial responders, who may be unaware of the presence of radiation environment during initial assessment of an incident. The Sacramento Metropolitan Fire District has placed the dosimeters on all first response vehicles including front-line engines, trucks, medics, battalion chief and assistant chief vehicles. Additionally, procurement and distribution of radiological dosimeters to the area law enforcement agencies is necessary. The California Highway Patrol has deployed radiation detection equipment to their commercial enforcement units, but none of the other CHP

[21] Ferguson et al., *Four Faces,* 91.

[22] Ibid.

assets (i.e., patrol vehicles); nor the City of Sacramento Police Department; Sacramento County Sheriff's Department; Citrus Heights Police Department; Rancho Cordova Police Department; Folsom Police Department; or the Elk Grove Community Services District Police Department, are equipped with radiation detection equipment. Additionally, the private ambulance providers have not procured early radiation detection capability at the current time. These assets will potentially be the first arriving emergency resources on scene, and need to have the early radiation detection capability to ensure the proper protective actions and notifications are made during the initial stages of a radiation incident. These dosimeters will be deployed in the same manner as those deployed by the area fire agencies. Initially, the implementation of a pilot initiative to distribute the dosimeters and related training to area law enforcement officers will be implemented per the attached Strategic Plan Appendix. It is the intent of a regional strategic protocol to facilitate radiation detection/dosimeters to all first responder apparatus in the region. This includes all law enforcement, fire, and emergency medical services (EMS) vehicles.

C. PROTECTIVE CLOTHING

Structural firefighting clothing, in combination with a full face respirator or self contained breathing apparatus, offers protection from alpha and beta radiation.[23] Additionally, area fire departments have been issued chemically resistive PPE ensembles for use in WMD environments, and for decontamination operations in a chemical hazardous material incident involving chemical hazards. Area law enforcement has procured level "C" protective clothing ensembles increasing their initial safety and response capability. The private ambulance providers, per the Sacramento County Emergency Medical Service policy, do not operate in hazardous environments; therefore, these resources do not require personal protective clothing beyond universal precautions for radiation incidents. As mentioned previously, it is necessary for private ambulance providers to be equipped with radiation detection equipment to provide initial detection of radiation on an emergency scene. Therefore, the author recommends utilizing regional fire-based EMS transportation assets for triage, treatment and transportation of radiological patients in hazardous areas due to the availability of PPE that is carried by

[23] Department of Energy, *Modular Emergency Response,* mod 9-9.

firefighters staffing the units. Private ambulance providers will function in the support zone once a radiation emergency is declared. Additionally, the Sacramento County Emergency Medical Service policy, needs to be amended to incorporate changes recommended in the regional radiation response protocol.

D. OPERATING GUIDELINES FOR RADIATION RESPONSE[24]

- Defining the hot zone is the most important first response, and a simple alarming dosimeter is the most useful piece of equipment for initial radiation response.
- By following emergency response protocols for radiation, that are aligned with nationally recognized standards for allowable dose rates to radiation for emergency response, first responders can operate safely in the initial phase of a radiation incident.
- The greater the dispersion of material, the greater the affected area, but the lower the radiation dose rate.
- Individuals with no significant physical injuries should not be significantly contaminated.
- Firefighting PPE will be sufficient protection for alpha and beta radiation, nothing will be practical to wear to protect from gamma radiation. Utilizing time, distance and source shielding is the most practical approach to protection from gamma radiation.

Early detection is critical, but the radiation dose monitoring of first responders is also important to ensure their doses are kept within safe ranges during the incident.

[24] Conca and Reynolds, "Dirty bombs," 18.

Figure 1. Response Worker Guidelines[25]

Total effective date equivalent (TEDE) guideline	Activity	Condition
5 rem……………………	All occupational exposures	All reasonably achievable actions have been taken to minimize dose.
10 rem*…………………	Protecting valuable property necessary for public welfare	Exceeding 5 rems unavoidable and all appropriate actions taken to reduce dose. Monitoring available to project or measure dose.
25 rem**…………………	Lifesaving or protection of large populations	Exceeding 5 rems unavoidable and all appropriate actions taken to reduce dose. Monitoring available to project or measure dose.

*For potential doses>10 rems, special medical monitoring programs should be employed, and exposure should be tracked in terms of the unit of absorbed dose (rad) rather than TEDE (rem).

**In the case of a very large incident such as an IND, incident commanders may need to consider raising the property and lifesaving response worker guidelines in order to prevent further loss of life and massive spread of destruction.

Advancements in personal dosimeters makes available instant, self-reading instruments that do not require external power supplies and are capable of measuring wide dose ranges (0.001-1,000 rem). Currently, the area fire departments are equipped with SAIC PD-3 pager style dosimeters, and Canberra dosimeters that alarm at 1 mR/hr or 100 mR of dose. Rapidly advancing technologies are emerging to include alarming dosimeters which have visual aids to aid responders in determining radiation rates and doses. The experience of the author in educating first responders in radiation response has found their familiarity with radiation related subjects to be short-lived. The "short-lived" memory of responders highlights the need for easy method for easy to use devices that enable the responders to rapidly assess radiation hazards and thereby predict sustained operation time lines in contaminated environments. Dosimeters that not only give accurate rates and doses, but reinforce safety margins by computing safe work durations, will be valuable potentially enhancing user confidence thereby reducing the fear and anxiety of working in a radioactively contaminated environment.

25 "Preparedness Directorate; Protective Action Guides."

A self-reading/alarming dosimeter must be worn by a supervising member of each unit working in a radiation contaminated environment for the purposes of dose tracking of unit personnel and to alert when dangerous levels are encountered during initial operations requiring personnel to enter radioactive fields to perform emergency duties such as rescue, or firefighting operations. The deployment of the dosimeter will be the responsibility of the supervisor or senior crew member if a supervisor is not assigned. To the extent possible, the dosimeter should be in the closest proximity to the highest activity source to ensure the dose reflected is the maximum dose. These measurements will be valuable in dose reconstruction efforts after the initial emergency is contained to account for each member working in the exclusion zone during initial emergency operations.

Additionally, the utilization of thermo luminescence dosimeters (TLD) may be beneficial to track long term exposure for individuals working in the contaminated areas during the intermediate and later phases of the incident. Regional hazardous material response team (HMRT) policies require all hazmat personnel to carry individual dosimeters for dose tracking purposes. HMRT personnel will be working in the most contaminated areas, but support personnel such as law enforcement officers, EMS and fire personnel will need to have dose tracking capability as well. It is not financially practical to purchase hundreds of alarming dosimeters, but the utilization of TLD’s may be an affordable alternative. In the short term, most municipalities maintain old civil defense equipment including pencil dosimeters. If the units are deemed to be serviceable, these dosimeters might be incorporated into a long-term dose tracking strategy. Available pencil dosimeters, in addition to TLD’s should be retained in mobile stockpiles, such as the homeland security supply trailers which are deployed strategically throughout the region for response to large-scale incidents, to include large scale radiation emergencies. These resources will be brought to the incident during the initial phases by urban area security initiative (UASI) personnel and/or special operations personnel having regional homeland security responsibility, such as members of the terrorism early warning group and or the regional hazardous materials coordinators.

E. DOSE RATES DURING THE COURSE OF THE INCIDENT

It should be noted that once a dose has been received, there is no further protective actions to administer for that dose. An interesting way to evaluate an action response with a radiation exposure is to ask the question: “How much radiation dose will be avoided by taking the action as compared to taking no action at all.”[26]

The protective action guideline (PAG) establishes four criteria that should be met during the first two phases of the radiation emergency, the early and intermediate phases respectively.

- Acute health affects due to radiation exposure should be avoided;
- Chronic health effects should not exceed a level that is judged to be acceptable during an emergency;
- Any reduction of risk to public health, achievable at acceptable cost, should be done;
- The risk to health from protective actions should not exceed the risk to the health from the dose avoided.[27]

1. Recovery (Late) Phase

During the recovery phase of a radiological incident, dose rates will become a potential source of controversy and debate based on the lack of definitive standards or recommendations for acceptable post-event radiation dose rates. The concept of ALARA (As low as reasonably achievable) will be the basis by which the dose rates will be determined in the late phase. These recommended dose levels will take into consideration both economic and social factors.[28]

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26 Health Physics Society, "Background Information on ‘Guidance for Protective Actions Following a Radiological Terrorist Event’ Position Statement of the Health Physics Society*," http://hps.org/documents/RDDPAGs.Background.pdf. [Accessed May 3, 2006).

27 Ibid.

28 Ibid.

F. POPULATION MONITORING

"The term 'population monitoring' is made up of immediate monitoring after an incident and long term monitoring for health effects from the attack."[29] The U.S. Department of Health and Human Services (DHHS), as outlined in the National Response Plan, has tasked the U.S. Center for Disease Prevention (CDC) with being the lead agency responsible for population monitoring.[30] CDC is also responsible for supporting local, state and tribal governments regarding decontamination of internal contamination, and providing guidance as to pharmaceuticals to remove internal contamination from the bodies of victims.[31]

G. DOSE RECONSTRUCTION

Dose reconstruction is utilized to provide estimated radiation dose exposures to individuals or populations in the aftermath of a radiation incident where dose monitoring was unavailable, incomplete or inconsistent.[32] Dose reconstructions may be utilized, for example, in the aftermath of a dirty bomb attack to estimate the accumulated dose to civilians in the immediate vicinity of the blast or directly affected by the radioactive plume. First responders, without sufficient early detection capability such as alarming dosimeters, would rely on dose reconstruction performed by radiation experts to assist in determining potential exposure prior to the arrival of detection or monitoring equipment.

According to the National Institute for Occupational Safety and Health (NIOSH) Fact Sheet, dose reconstruction may include analysis of data such as:[33]

- Internal dosimeter data developed from urinalysis, or *in vivo* measurement
- External dosimeter data collected from film badges, dosimeter readings etc.
- Monitoring of the effected area with air samples or site surveys
- Solubility studies and particle size measurements

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29 Department of Health and Human Services, Centers for Disease Control and Prevention, "Population Monitoring After a Release of Radioactive Material" (June 2005): 1.

30 Ibid.

31 Ibid.

32 Department of Health and Human Services (NIOSH), "NIOSH Fact Sheet: What a Claimant Should Know About Radiation Dose Reconstruciton,"1. www.cdc.gov/niosh/ocas/pdfs/misc/2002-138.pdf. [Accessed May 29, 2006].

33 Ibid.

- Process descriptions for work areas or control zones.

"If individuals' radiation exposures were monitored using present-day technology and consisted of only external radiation exposure, dose reconstruction would be very simple. It might only require summing the radiation doses recorded from radiation badges and adding estimated potential 'missed' doses resulting from the limits of detection monitoring badges (devices) used."[34] For trained first responders who utilize universal precautions, avoiding ingesting, inhalation or absorption of radioactive contamination, dose reconstruction will be effective in predicting the exposure to these personnel. Once radiation detection and monitoring equipment arrives, the documentation as to time and place of personnel on scene prior to arrival of equipment, plus the doses measured by dosimeters, once in operation will, provide an accurate estimate of individual exposure. Additional information will be necessary to ensure these estimates are correct such as:

- Determining specific characteristics of the monitoring procedures
- Identify activities of personnel where monitoring did not take place
- Specific nature of the radionuclide involved

H. SHELTERING IN PLACE VERSUS EVACUATION

The Health Physics Society recommends, in the initial phase (early phase) of a radiation incident due to terrorism, sheltering in place will be the most likely recommendation. Pre-warning will be very limited. Persons evacuating into a plume will be exposed to potentially more radiation than if they shelter inside buildings. In an industrial accident, more advanced warning may be available; therefore, evacuation in advance of a plume is the recommended course of action.[35]

I. HEATING, VENTILATION AND AIR CONDITIONING (HVAC) SYSTEMS

Large HVAC systems are complex and generally are controlled by building engineers. The feasibility of being able to shut down a large system in the aftermath of a radiological terrorist attack is minimal unless the system was incorporated into an early

[34] Department of Health and Human Services (NIOSH), "NIOSH Fact Sheet."

[35] Health Physics Society, "Background Information," 11.

detection system as scene in some "metro detection" systems.[36] High efficiency particulate air (HEPA) filters in the ducting systems will be effective filters for most radiation particles.[37] Small systems that can be shut down with minimal time delay, such as individual office buildings or residential systems should be shut down.

J. INITIAL RECOMMENDATIONS FOR RESPIRATORY PROTECTION OF EXPOSED POPULATIONS

Emergency response personnel shall wear self contained breathing apparatus until atmospheric monitoring indicates downgrading to an air purifying respirator mask, or a dust mask (N95 at the minimum) based on oxygen concentration and air sampling data.

Victims or responders caught in a radiological plume should make attempts to minimize the inhalation of radiological contamination. Ideally, this information should be available in the pre-incident education strategies, or techniques will not be known until after inhalation of contamination has occurred. The following recommendations are proposed:

- Cover the mouth and nose with a dry cloth or handkerchief.[38] "In some cases, wet material could actually enhance the amount of inhaled particles." [39]
- There are recommendations to remove the improvised protection after thirty minutes following detonation.[40] The conditions on scene will ultimately dictate when improvised protection can be removed. The churning of dust due to erratic wind patterns in urban areas or vehicular/pedestrian traffic may cause re-agitation of settled dust causing conditions requiring the maintained use of improvised respiratory protection.

[36] Conca and Reynolds, "Dirty Bombs," 22.

[37] James L. Conca, Michael H. Reynolds, "Dirty bombs, practical plans," *Homeland Protection Professional Magazine* (May 2006): 22.

[38] Stephen V. Musolino and Frederick T. Harper, *Emergency Response Guidance for the First 48 Hours after the Outdoor Detonation of an Explosive Radiological Dispersal Device* (December 30, 2005), 383.

[39] Ibid.

[40] Ibid.

IV. MEDICAL TRIAGE, TREATMENT AND TRANSPORT OF RADIOACTIVELY CONTAMINATED PATIENTS

The international, national and state standards of responding to a radiological incident provide for the immediate treatment of critical patients, this medical response has priority over decontamination. The International Atomic Energy Agency (IAEA) states,

> In virtually all cases there will be little or no health risk to response personnel provided that, for response actions near any hazardous material, they follow the General part of the Personal Protection Guidelines. There would not be a health hazard to medical staff treating or transporting of contaminated persons provided that they protect themselves against the inadvertent ingestion of radioactive material by the use of normal barrier methods (use of surgical gloves and mask) and take actions to prevent the spread of contamination (e.g., to cover the patient in a blanket or sheet), remove and store outer clothing.[41]

National standards stated by the U.S. Department of Transportation, Emergency Response Guidebook, guide page 163 states under "First Aid," the need to address medical considerations primarily in radiation incidents.

> Medical problems take priority over radiological concerns; Use first aid treatment according to the nature of the injury; Do not delay care and transport of a seriously injured person; Injured persons contaminated by contact with released material are not a serious hazard to health care personnel, equipment or facilities; and Ensure that medical personnel are aware of the material(s) involved, take precautions to protect themselves and prevent spread of contamination.[42]

The California Specialized Training Institute (CSTI) also states that the need to treat and transport critical patients predominates over decontamination concerns. "Exposure to radioactive contamination is very seldom life threatening. Medical attention to injuries should always take precedence over decontamination."[43]

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41 International Atomic Energy Agency, "Generic procedures for response to a radiological emergency," in *Part 1, Manual for First Responders and Local response, Rev. 16.2* (Vienna, Austria: IAEA, 2004): 18.

42 U.S. Department of Transportation, Research and Special Programs Administration, *2004 Emergency Response Guidebook* (n.p., n.d.), 163.

As demonstrated above, the priority of medical treatment radiological victims over decontamination is well defined in guidelines at the international, national and state levels. Training and cooperation at the local level emergency responders will be the key element of developing a regional response protocol that properly addresses contaminated patient issues.

The Sacramento County Emergency Medical System protocols do not have a clear delineation of response in regards to a radiation emergency. Policy number 8029.05 clearly states that pre-hospital care providers, including transporting ambulances will only accept decontaminated patients from the HAZMAT Team. "ALL patients will undergo primary decontamination at the scene. There are no indications to transport contaminated patients."[44]

Sacramento County is not the only area of the state that has language addressing generalized hazardous materials without specifically addressing radiation. The County of Santa Clara Emergency Medical Services Agency, Policy 610 states, "All potentially contaminated patients must be properly decontaminated by the trained HAZMAT responders before emergency medical responders can administer medical treatment or transport the patients to an emergency medical facility." [45]

A. PATIENT TRIAGE

The initial assessment and triage of patients in a radiological environment will be assigned to first arriving emergency units utilizing the Sacramento County mass casualty protocol. Upon detection of a radiation incident, emergency personnel will don appropriate protective clothing at the direction of the incident commander and radiation detection/dosimeter equipment. Patients will be assessed for medical needs, regardless of radiological contamination utilizing the simple triage and rapid treatment (START) triage method.

[43] "Mass Casualty Decontamination, Guidance Document for Field Responders (Working Draft)" (California Specialized Training Institute, 5-14-01), 164.

[44] "Mass Casualty Decontamination," 164.

[45] *Private EMS Response: Hazardous Materials, Policy 610* (San Jose: County of Santa Clara, Emergency Medical Services Agency, 2004), 3. http://www.sccbuilding.org/scc/assets/doc/804278Prehospital%20Care%20Manual%202005-%20050204.pdf. [Accessed July 4, 2005].

B. TREATMENT

Critical patients will be stabilized prior to decontamination efforts. Delayed and minor patients will be decontaminated prior to treatment and/or transportation provided the time delay to facilitate decontamination does not exacerbate their medical condition..

C. TRANSPORTATION

The transport of immediate patients whether contaminated or not will not be delayed for decontamination actions provided that there is not a chemical component to the contamination. (Chemically contaminated patients will be decontaminated prior to treatment or transportation. Unlike radiation contamination, chemical contamination does potentially pose a primary hazard to medical care providers.) Every effort to minimize the spread of radiation contamination will be made so long as the efforts do not delay transportation or medical treatment timelines. Such techniques may include the removal of a patients clothing to remove as much contamination as possible. Patients shall be wrapped in sheets to trap any remaining contamination and transportation assets will be prepared per MERRTT procedures to minimize contamination. The use of an issued radiation dosimeter will be utilized by ambulance crew members, (one per unit) to ensure radiation dose limits do not exceed recommended EPA standards. The dosimeter shall be placed in the treatment area of the ambulance to ensure the device is protecting personnel in the closest proximity to the potential radiation contamination. Ambulance personnel shall don, at a minimum, universal precautions PPE to include eye protection, respiratory protection, gloves and an outer disposable garment to enhance decontamination processes. Utilization of PPE ensembles that have been developed as biological PPE will facilitate the protective requirements for radiation emergencies in addition to biological emergencies. Utilizing the time, distance and shielding principles, personnel will reduce exposure to radiation to ALARA.

Command staff should consider the utilization of dedicated “dirty” ambulances on an on-going basis, providing the contamination level of the resource does not exceed safe radiation exposure levels for personnel. It should be noted that the dedication of “dirty ambulances should only be utilized if it does not delay the transport of critical patients due to a limited response capability. Limiting the number of ambulances and personnel that may require decontamination will ensure continuity of medical transport capability immediately following the incident and is consistent with the ALARA principle. Radiation contamination of an ambulance can be removed during cleanup or remediation efforts. Often ordinary clean-up procedures will remove radioactive contamination.[46] Exposed personnel and equipment will be surveyed for radiological contamination and exposure levels recorded prior to being release from duty, or reassigned.

D. DECONTAMINATION

The nature of each event will dictate a course of action regarding the radiation decontamination procedures necessary. The following are guidelines to be balanced with specific incident considerations. Incident specific considerations may include, but are not limited to; weather conditions, ambient temperature, additional hazardous materials/hazards associated with the incident, and the logistical concerns of decontaminating large volumes of people in an expedient manner, and the geographic magnitude of the area of involvement.

- If resources allow, initial radiological survey procedures should be performed by trained personnel to detect contamination. Personnel surveys can be performed at the direction of hazardous materials response team personnel. Additionally, transportable radiation monitors called "portal monitors" may be used for the screening of large numbers of victims. Portal monitors can be accessed through the U.S. Department of Energy Radiation Assistance Program (RAP) teams or the National Guard Civil Support Teams. Commanders must factor a time delay of specialized detection equipment into response planning processes. Additionally, improvisation may be required to survey large numbers of concerned people. The utilization of radiation detection equipment found in the private sector may be utilized with proper coordination/collaboration with civilian infrastructure. An example would be the use of metal scrap yard radiation monitors. These facilities may become remote radiation survey centers utilized to minimize public hysteria or fear due to the possibility of being contaminated.

[46] Jerrold T. Bushberg, Linda A. Kroger, Marcia B. Hartman, Edwin M. Leidholdt, Jr., Kenneth L. Miller, Robert Derlet, and Cheryl Wraa, "Nuclear/Radiological Terrorism: Emergency Department Management of Radiation Casualties," *Journal of Emergency Medicine* (University of California Davis Health System, in press), 17.

- Decontamination/radiation survey personnel must be made aware of the possibility that there may be people with internal radioactive material that is present because of medical diagnosis or treatment. Radioactive isotopes are often utilized as part of routine medical procedures. Such radionuclides will be detected by survey equipment utilized by emergency personnel. Routine medical history inquiries will illuminate the legitimacy of the presence of these radiopharmaceuticals. Additionally, field personnel will not be able to decontaminate internal radiation contamination. Persons with internal radiation contamination should be referred to medical authorities for follow-up medical treatment.

- Recommendations for decontamination are made by the decontamination unit leader to the hazardous materials group supervisor. These recommendations are to be submitted to the incident commander at the unified command center. Decontamination procedures minimize off-site consequences of radiological contamination. The decision to utilize wet versus dry procedures will incorporate environmental factors, numbers of affected victims, nature of the contamination and resources available to perform decontamination. The following decontamination control procedures are illustrated in the "Pre-Hospital Practices" module from the MERRTT program.[47]

  1. Field Decontamination of Immediate Triaged Patients Who Have Not Undergone a Formal Decontamination Process

  - Initiate ALS care as necessary
  - Remove clothing if appropriate
  - Wrap patient in a blanket to minimize contamination
  - Only expose areas required to assess and treat patient
  - If necessary, cut and remove the patients clothing away from the body being careful to avoid contamination to the unexposed skin
  - Properly contain all removed clothing by placing it in a sealable bag
  - Continue to reassess and monitor vitals while in route to a medical facility

[47] Department of Energy, *Modular Emergency Response,* 16-6.

- Contact with the patient may result in transfer of contamination, so change gloves as necessary

2. Dry Field Decontamination

- Dry field decontamination should be the first line of contamination control, and is performed in the contamination reduction zone, formerly known as the "warm zone," for patients that do not meet "immediate patient criteria.
- Removes the majority of contaminates
- Reduces the risks of contamination spread and inhalation hazard
- Allows contaminates to be left in the affected area

Formalized Decontamination efforts to reduce the spread of decontamination will be done in accordance with the Sacramento Regional Decontamination Protocol.

V. MEDICAL FACILITY PREPARATION AND MEDICAL INTERVENTION FOR CONTAMINATED PATIENTS

A. HOSPITAL POLICIES AND PROCEDURES ADDRESSING RADIATION INCIDENTS

The following guidelines and recommendations are only given to suggest further research. As well, these recommendations will facilitate dissemination of information and development of capability in the medical community in response to a radiation incident of either an accidental nature or one of an intentional terrorist act utilizing a radioactive component. In the aftermath of a large radiation incident in the Sacramento region, it is unlikely that emergency response personnel would maintain control of all victims of the incident. As seen in past mass casualty incidents involving acts of terrorism, including the Oklahoma City bombing in 1995 and the sarin attack in Tokyo, Japan, the majority of patients that are seen at medical facilities in the immediate aftermath of such incidents are self transported.[48] Medical facilities in the area, including hospitals, private medical offices or local clinics, will be impacted by self-initiated or privately transported victims.

The fear and misunderstanding of radiation in the general public also applies to health care professionals, necessitating awareness and training curriculum in addition to policies and procedures. Yet the instances of radiation incidents are very low, leading policy makers to potentially question the allocation of resources to prepare for such a low probability event.

According to the Radiation Emergency Assistance Center Training Site (REAC/TS), only 428 major radiation accidents have been recorded between the years 1944 and 2005, resulting in 126 radiation-related deaths.[49] With such a low prevalence of emergencies resulting from radiation incidents, current policies addressing hazardous materials in general have been considered adequate in dealing with radiation

48 James Smith, Ph.D., *Radiological and Nuclear Terrorism: Medical Response to Mass Casualties, a Self-Study Training Program for Clinicians* (Centers for Disease Control and Prevention, April 17, 2006), 10.

49 Bushberg et al., "Nuclear/Radiological Terrorism," 4.

emergencies. The potential threat of terrorist groups utilizing radioactive or nuclear weapons has prompted the emergency response and medical care providers to reassess their radiation response plans and procedures to address adequately radiation injury/contamination issues.[50]

The coordination and preplanning between first responders, transportation providers and hospitals prior to a response to a large scale radiation event will be necessary to facilitate accurate and timely patient triage, transport and subsequent treatment at the appropriate treatment facility.

A thorough understanding of radiation hazards and cooperation between the regional hospitals will be necessary to initiate patient transportation plans properly, and to distribute appropriately critical patients to regional emergency departments. The current ability of a hospital to treat contaminated patients, and provide for safety of their personnel, may vary by regional hospital. "Larger hospitals may have an active nuclear medicine department with a staff that is familiar with radiation matters, while a small medicine treatment facility may not have such a benefit. Planning and preparedness training/drills are recommended."[51]

The University of California, Davis Medical Center, has established radiation treatment policies in place to treat appropriately immediate patients despite being contaminated with radioactive material.[52] Additionally, Mercy San Juan Hospital has addressed radiation preparedness in their Hospital Emergency Management Plan. "Radiation contamination of the types expected at our facilities is almost never immediately life threatening. Treatment of serious medical problems, therefore, has priority over decontamination. Where feasible, decontamination may be performed simultaneously with medical treatment."[53] A radiation protocol adopted by all area hospitals for care and treatment of contaminated radiation patients is needed to prevent

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50 Bushberg et al., "Nuclear/Radiological Terrorism," 4.

51 *Radiation Emergency Handbook, 9th Edition* (Topeka: Kansas Department of Health and Environment, 2-11-2002.), 8. http://www.kdhe.state.ks.us/bar/download/reh/pdf/ [Accessed July 3, 2005].

52 Dr. Jerrold T. Bushberg, "Emergency Department Management of Radiation Casualties," http://www.emsa.ca.gov/dms2/JTB_clinic.pdf. [Accessed October 14, 2005].

53 *Hospital Emergency Management Plan* (Sacramento, CA: Mercy San Juan Hospital, 2004), 273.

confusion and delay of advanced treatment of immediate patients. Bill Potter from the State of California, Office of Emergency Services, Radiological Coordinator, stated during an interview, that throughout the State of California, identification of pre-identified cleanup procedures, and recovery methods will decrease the likelihood of hospital facilities and private ambulance companies declining participation in treatment of contaminated patients during a mass casualty radiological event.[54] In the author's opinion, the transition of patients from the emergency scene to treatment facilities, in an expedient and organized manner, will likely result in the saving of more lives, and will require that the healthcare facilities and private transport providers are in collaboration with public emergency responders.

B. RECOMMENDED EMERGENCY DEPARTMENT PROCEDURES

The intent of this section is to recommend that all area medical facilities have training and equipment to adequately treat radiological contaminated patients. The specific radiation response procedures for emergency department personnel will not vary widely from those described previously for first responders.

Personnel must keep their exposure levels to radiation as low as reasonably achievable (ALARA) by utilizing time, distance and shielding techniques to minimize exposure. Additionally, protective clothing ensembles, detection/dosimeter equipment and tracking of exposures will be the same requirements as for first responders. Additionally, strict adherence to individual facility protocols to limit the spread of radiological contamination will allow for continuity of operations in the other areas of the facility.

Once the incident is determined to be a mass casualty event, specific communication between the transportation unit leader and the disaster control facility (U.C. Davis) must take place. The allocation of contaminated, critical patients to area trauma centers, utilizing transportation resources that are deemed "dirty" will reduce the potential spread of contamination to only a select number of facilities. As noted

54 Bill Potter (State of California, Office of Emergency Services, Radiological Coordinator), interview by author, Sacramento, CA, July 7, 2005.

previously, the emergency responders will only be handling a minority of patients, the remaining balance will self-dispatch to medical facilities.

C. PERSONAL PROTECTIVE EQUIPMENT FOR HOSPITAL PERSONNEL

Universal precautions can be described as a practice in medicine of avoiding contact with blood-borne pathogens, either from bodily fluids or airborne particulate. Protective ensembles may include at a minimum, protective gowns, gloves, and eye protection.[55] These precautions are appropriate for the treatment of contaminated radiological patients. Additionally, a N95 facemask is adequate respiratory protection for radiological particulate.[56] Individual dosimeters are advised, and accurate personnel exposure tracking with exit radiation surveys being conducted for personnel leaving the exclusion zone (hot zone), or the contamination reduction. (warm zone).[57]

D. PATIENT ASSESSMENT IN THE HOSPITAL SETTING

The stabilization of medical conditions that are immediately life threatening is the primary consideration, prior to addressing radiation contamination concerns. It should be noted this is only applicable to radiation. The possibility of patients having both radiological contaminations in combination with either chemical or biological contamination should be considered. "In situations involving other types of hazardous material, such as chemicals, decontamination of the victims typically occurs prior to transport to the emergency department."[58] A majority of patients might self-report to the emergency department, so hospital decontamination efforts must include decontamination procedures for delayed or minor radiological contaminated patients, or decontamination from chemical or biological agents.

Medical procedures should be ruled out if a person presents with above background radiation reading during a radiation survey. Recent nuclear medicine or oncology procedures may be the source of the radiation.[59]

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55 Wikipedia, "Universal Precautions," http://en.wikipedia.org/wiki/Universal_precautions/ [Accessed June 24, 2006].

56 The Centers for Disease Control and Prevention, "Radiological and Nuclear Terrorism: Medical Response to Mass Casualties," http://www.orau.gov/hsc/RadMassCasualties/ [Accessed June 26, 2006].

57 Ibid.

58 Bushberg et al., "Nuclear/Radiological Terrorism," 8.

59 Bushberg et al., "Nuclear/Radiological Terrorism,"11.

“Hospitals with Nuclear Medicine or Radiation Oncology departments have radiation monitoring instruments.”[60] Additionally, the Sacramento region has acquired radiation detection equipment along with decontamination equipment and training via the Health Resources Services Administration (HRSA) grants, so the resources required to manage a radiological event are available in the regional hospitals. The allocation of these resources may not be available to satellite clinics or physician offices. Therefore a coordinated medical plan will be necessary to develop a treatment procedure to incorporate potential large numbers of victims presenting at local health facilities.

“An exceptionally important triage strategy is that of establishing a secondary assessment center physically separate from the hospital. This is a basic step towards protecting the hospitals from being overwhelmed. It is also useful for pre-clinical screening, assessing exposure and contamination, and conducting triage and decontamination as well as reuniting families.”[61] The staffing of these centers will be a challenge to any municipality. For example, in Goiania, Brazil, approximately 112,000 people were assessed at a local soccer stadium to screen for radiation contamination and associated injuries. The number of personnel to accomplish this screening operation was substantial. The pursuit of a specialized citizen emergency response team (CERT), which would be composed of trained professionals from radiological fields in the region, might be a useful solution to staff these centers during the initial period following a large radiation incident. The “Radiological CERT” team members might be drawn from private industry, power companies, universities or medical institutions from localities that are not directly impacted by the emergency. A civilian radiation expert would be an effective force multiplier to emergency response, or emergency department personnel and assist in the facilitation of screening of large volumes of “concerned” patients that are not necessarily contaminated. Additionally, these “Radiological CERT” members would be able to supervise lay personnel/volunteers providing such services as collection/distribution of contaminated clothing, and distribution of educational material.

60 Bushberg et al., “Nuclear/Radiological Terrorism,” 4.

61 The Centers for Disease Control and Prevention, “Radiological and Nuclear Terrorism: Medical Response to Mass Casualties," 10. http://www.orau.gov/hsc/RadMassCasualties/content/text_version.htm [Accessed June 26, 2006].

Psychological counseling will be an important aspect to minimize the fear aspect of the incident as well. Medical plans should incorporate a psychological response at the secondary assessment sites as well.

E. HOSPITAL DECONTAMINATION PROCEDURES

Each medical facility has a unique layout and internal policies to reduce the spread of contamination within their respective facilities. The author recommends the regional hospitals develop a common standard of practice based on recognized protocols which address radiation decontamination for hospitals. In the interim, all radiological cleanup operations should be facilitated at the direction of the radiological safety officer, per individual hospital policy and procedure.

Portal radiation monitors are often used in medical facilities to survey trash.[62] Portal monitors are useful and will potentially save vast amounts of time to quickly scan material to insure that contamination does not exceed two times the background, which is the EPA standard for radiological contamination. Additionally, portal monitors may be adapted to be used to quickly survey patients, at a central point of entry, to enhance the speed of radiological screening of patients.

Generally, radiation contamination clean up can be facilitated by normal cleaning methods.[63]

F. MEDICAL COUNTERMEASURES

The primary goal for emergency response and medical personnel is to utilize the aforementioned procedures to avoid becoming contaminated during the response to radiation emergencies. However, should internal contamination occur, it is important for the response community to understand the medical interventions/medications that are available for subsequent treatment. Knowledge of available medical interventions may assist in reducing the fear associated with radiation response. Additionally, policy makers must understand the availability of these medications and how to request them if needed.

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62 Bushberg et al., “Nuclear/Radiological Terrorism,” 17.

63 Ibid.

Medications that are designed to prevent radiation damage to human tissues are called radioprotectants.[64] Radioprotectants are intended for pre-exposure use and have very little application after an exposure has taken place.[65] These pharmaceuticals are generally used for pre-cancer therapy so that the invasive radiation therapy does not injure healthy tissue.

Other pharmaceuticals treat post-exposure contaminates by blocking the absorbed dose, such as potassium iodide, or enhances the excretion of contaminates by blocking the absorption of the material in the intestines. These are called decorporation agents and are generally given to internally contaminated victims for a specific isotope exposure.[66]

1. Prussian Blue

"On January 31, 2003, the U.S. Food and Drug Administration (FDA) called on companies to create marketing plans for Prussian blue. The FDA news release stated, 'After a review of cases in published literature, FDA determined that 500-mg Prussian blue capsules would be safe and effective for the treatment of patients with known or suspected internal contamination with radioactive thallium, non-radioactive thallium, or radioactive cesium."67 Prussian blue is stockpiled in the Strategic National Stockpile (SNS), which is a collection of pharmaceuticals and medical supplies strategically located in various parts of the country for deployment in the aftermath of a WMD incident.[68] This drug should not be seen as a cure-all-end-all solution to internal radiation contamination due to it is not suitable for all radioactive substances.[69] Medical professionals can prescribe Prussian blue for a person who is internally contaminated with cesium or thallium. Prussian blue works by binding radioactive materials in the intestines, stopping the absorption of the material into the body. The contamination is

64 Dana A. Shea, "Radiological Dispersal Devices: Select Issues in Consequence Management," Congressional Research Service, Library of Congress, January 26, 2006, 3. www.fas.org/spp/starwars/crs/RS21766.pdf. [Accessed May 2, 2006].

65 Shea, "Radiological Dispersal Devices," 3.

66 Ibid., 4.

67 Ferguson et al., *Four Faces,* 297.

68 Centers for Disease Control and Prevention, Department of Health and Human Services, "Fact Sheet: Prussian Blue," (Centers for Disease Control and Prevention, August 2005), 2.

69 Ferguson et al., *Four Faces*, 298.

excreted by the bowel, reducing the contamination in the body, and thus decreasing the time of radiation exposure to tissues.[70] Side effects include constipation and upset stomach.[71]

2. Diethylenetriaminepentaacetate (DTPA)

DTPA is a calcium or zinc salt that is utilized to treat internally contaminated patients from isotopes such as plutonium, americium, californium, curium, and berkelium.[72] "Both forms are capable of binding to certain radioactive materials and speeding up the release of these materials in the urine, thus reducing the amount of internal contamination."[73] DTPA is stored in the SNS. DTPA can be administered intravenously or inhaled for lung contamination, but is available by prescription only.

3. Potassium Iodide

Potassium iodide (KI) is effective in reducing the concentration of radioiodine in the thyroid gland if administered shortly before or shortly after internal contamination with radioactive iodine. Radioactive iodine is expected in the aftermath of a nuclear power accident. Radioactive iodine is not expected in the aftermath of a RDD due to the absence of radioactive iodine in material that is probable in use as a "dirty bomb." KI is available without a prescription and is readily available. When taken at the direction of public health officials, the benefits of KI greatly outweigh the risks, which include intestinal upset, allergic reactions, rashes, or inflammation of the salivary glands.[74]

Public health providers should anticipate a large demand for KI in the aftermath of a radiation incident, regardless of the efficacy of the treatment, due to the preconditioned expectation of the public as to its effectiveness.[75] This issue can be addressed by an aggressive public education campaign to familiarize the general public with the efficacy of medical treatments for radiation exposure, prior to an actual incident.

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70 Centers for Disease Control and Prevention, "Fact Sheet: Prussian Blue," 2.

71 Ibid.

72 Centers for Disease Control, Department of Health and Human Services, "Fact Sheet: DTPA," (Centers for Disease Control and Prevention, May 2005), 1.

73 Ibid.

74 Centers for Disease Control, Department of Health and Human Services, "Fact Sheet: Potassium Iodide," (Centers for Disease Control and Prevention, May 2005), 3.

75 Ferguson et al., *Four Faces*, 298.

VI. LOCAL, STATE AND FEDERAL AGENCIES

First responding agencies will need to interface with responding state and federal resources. The state resources that will assist in response and recovery of a large radiological incident will include, but not be limited to, the California Department of Health Services, Radiological Health Branch, California National Guard Civil Support Teams, and assistance from the California Office of Emergency Services.

The Radiological Health Branch of the California Department of Health has responsibility to investigate radiation incidents, and the surveillance of radioactive contamination in the environment.[76] There are two California, National Guard, and Civil Support Teams (CST). One team is based in northern California, the other in southern California. The CST's are composed of 22-member teams whose mission is to assist local authorities in the event of an attack involving a weapon of mass destruction.[77]

The federal response would include the Department of Energy's (DOE), National Nuclear Security Administration (NNSA). NNSA's response assets include Atmospheric Release Advisory Capability (ARAC), Accident Response Group (ARG), Federal Radiological Monitoring and Assessment Center (FRMAC), Nuclear Emergency Support Team (NEST), Radiological Assistance Program (RAP), and the Radiation Emergency Assistance Center/Training Site (REAC/TS). "The RAP is usually the first NNSA responder for assessing the emergency situation and deciding what further steps should be taken to minimize the hazards of a radiological emergency. Specific areas of expertise include assessment, area monitoring, air sampling, exposure and contamination control."[78]

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[76] California Department of Health Services, "Radiological Health Branch," http://www.dhs.ca.gov/common/PrinterFriendly.asp/ [Accessed July 9, 2005].

[77] Seth Hettena, "Study Asks: Is California Ready for a Weapon of Mass Destruction," Sfgate.com, September 3, 2002. http://www.sfgate.com/cgi-bin/article.cgi?file=/news/archive/2002/09/03/state1910EDT013/ [Accessed July 2, 2005].

[78] U.S. Department of Energy, National Nuclear Security Administration, "Radiological Assistance Program," http://www.doeal.gov/opa/Emergency%20Public%20Information/RAP_Final_June2002.pdf. [Accessed July 9, 2005].

The author recommends further interaction with the state and federal assets prior to an actual radiation emergency. An increased awareness of stakeholder agency capabilities along with dialog as to developed response plans and individual agency expectations will potentially promote a smooth transition of responsibility, and facilitate a better working relationship with each local, state or federal stakeholder agency..

A. LOCAL POLICY CHALLENGES

The response plans that have been developed since the events of 9/11 have added to the complexity of resource allocation, areas of expertise and oversight responsibility in regards to radiation incidents of national significance. The current California Terrorism Response Plan, which is an appendix to the State Emergency Plan, was last updated in February of 2001. As the events of September 11, 2001, transformed the nation's response plans and capabilities, such as the addition of the California National Guard, Civil Support Teams, development of the National Response Plan, Adoption of NIMS, it is the recommendation of the author that the nation's local and state plans must be updated as well to remain relevant.

In addition to the updating of response policies, the continuous, on-going training and exercise of these plans with local, state and federal agencies is paramount. The emergency response community is undergoing vast changes in leadership as a consequence of retiring senior members. Local, state and federal agency succession planning must incorporate continuous updating of institutional knowledge in regards to planning and responding to radiological incidents and incidents of national significance in general.

B. PHASES OF RADIATION RESPONSE

To understand the contribution of each response agency in context, it is essential to understand the timelines of the incident. A radiation emergency can be described as being a three-phased event in regards to time increments according to the Federal Register.[79]

[79] Department of Homeland Security, "Preparedness directorate; Protective Action Guidelines," 176.

1. Early Phase

The first phase is referred to as the "Early Phase" which is the emergency phase. This period starts at the onset of the emergency and can range in time from several hours up to several days. During the early phase, the initial protective actions by public safety personnel, such as fire, law enforcement and EMS, will be taking appropriate actions such as isolating the scene, denying entry and identification of the nature of the incident. Additional actions including sheltering populations in place, potential evacuation, initial treatment, transportation and decontamination of victims, scene stabilization and public health protective actions will occur during the early stages of the incident measured in hours. "The first people likely to respond to a radiation emergency are the same firemen, hazardous materials teams, emergency medical technicians and law enforcement personnel who respond to other emergencies."[80]

2. Intermediate Phase

The intermediate phase will overlap with the early phase, but is usually assumed to begin once the initial control and protective action decisions have been made. During this time, more technical information is gathered regarding field measurements of total exposure and specific characteristics of the radioactive materials involved. The timeline for the intermediate phase is assumed to be weeks to months until the protective actions of the incident are concluded. This phase will overlap with the final phase of the incident where initial considerations for recovery and cleanup actions are considered.

3. Late Phase

The late phase is the final phase of the radiation incident. During this phase, actions to reduce the radiation levels in the environment to recover the affected area from the incident effects. In this period, there is no longer an "emergency situation." The collaboration of community and regional leaders will be essential to the restoration of the site to encompass sound decisions in making cost-effective decisions. As currently provided by EPA standards, twice the background radiation levels is considered "contamination." During the recovery stage of a radiation incident, it may become cost

80 "The NCRP Releases Report No. 138, Management of Terrorist Events Involving Radioactive Material," *National Council on Radiation Protection and Measurements*, n.d., 2. www.ncrponline.org/138press.html [Accessed March 12, 2006].

prohibitive to clean up a large area to such an exact standard, requiring the input of community stakeholders to make choices based on sound scientific data.[81]

C. AGENCIES HAVING JURISDICTION

It is essential for policy makers in the Sacramento Region to remain familiar with the outside assistance that will become readily available in the event that a radiation incident exceeds the capabilities of the local resources. As part of any protocol, a clear understanding of the responding agencies roles and responsibilities is necessary to understand how each agency will integrate with others, and thus identify who is ultimately responsible during each of the aforementioned response phases. Knowledge of these assisting agencies prior to the incident will enhance coordination and proper utilization of these resources upon arrival. Additionally, the inclusion of anticipated support agencies and timelines of response will be of assistance to local incident commanders and may assist in alleviating political "turf" battles which may arise if outside resources arrive without a thorough, pre-identified plan.

Many of the assisting agencies will require hours if not days to arrive on scene. For this reason, it is paramount for local commanders to recognize the potential for escalation of radiological emergencies beyond the capabilities of local response and request outside resources in the early stages of the emergency. Additionally, technical guidance and expertise can be gleaned from radiation response elements during their response.

D. FEDERAL RESPONSE PLANS

"The Department of Homeland Security (DHS) is responsible for overall coordination of all actual and potential Incidents of National Significance, including terrorist incidents involving nuclear material."[82] This is done in accordance to Presidential Directive-5 and is described in the National Response Plan. Federal response to any specific incident is based on the local agencies ability to respond, identify the amount of material involved, the extent of the impact to the environment, or

[81] Department of Homeland Security, "Preparedness directorate; Protective Action Guidelines," 176.

[82] National Response Plan, *Nuclear/Radiological Incident Annex*, NUC-1. www.hps.org/documents/NRPNuclearAnnex.pdf. [Accessed March 12, 2006].

populations and the overall magnitude of the incident.[83] Local responders must understand that Federal agencies may self-dispatch within their own statutory authority, to assess hazards associated with a radiological event with the intent of decreasing time lags of notification.[84]

National Defense Area (NDA) or National Security Area (NSA) can be established by the U.S. Department of Defense (DOD), U.S. Department of Energy (DOE), or National Aeronautics and Space Administration (NASA) to safeguard classified information. The area involved will fall under Federal control for reasons of national security.[85]

1. National Response Plan

The National Response Plan (NRP) describes how federal agencies and departments will collaborate with each other and with local, state, tribal governments and the private sector during incidents.[86] "It establishes protocols to help protect the nation from terrorist attacks and other natural and manmade hazards; save lives; protect public health, safety, property and the environment; and reduces adverse psychological consequences and disruptions to the American way of life."[87] All incidents are to be handled at the lowest level possible by the jurisdiction having authority. "For those events that rise to the level of an Incident of National Significance, the Department of Homeland Security provides operational and/or resource coordination for Federal support to on-scene incident command structures.[88]

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[83]Nuclear/Radiological Incident Annex, NUC-2.

[84] Ibid., NUC-4.

[85] National Response Plan, *Nuclear/Radiological Incident Annex*, (n.p., n.d.): NUC-5. www.hps.org/documents/NRPNuclearAnnex.pdf. [Accessed March 12, 2006].

[86]Department of Homeland Security, "Nation Response Plan Fact Sheet." www.dhs.gov/dhspublic/interapp/press_release/press/release_0581.xml/ [Accessed March 18, 2006].

[87] Department of Homeland Security, "Preparedness Directorate; Protective Action Guidelines," 176.

[88]Department of Homeland Security, "National Response Plan Local/Federal Response Strategies and Coordination Structures." www.dhs.gov/dhspublic/display?theme=14&content=4263&print=true/ [Accessed March 8, 2006].

For purposes of this document, it is important to note The Nuclear/Radiological Incident Annex of the NRP supersedes the former Federal Radiological Emergency Response Plan from 1996.[89]

2. National Incident Management System (NIMS)

"Provides a nationwide template enabling Federal, State, local and tribal governments and private-sector and nongovernmental organizations to work together effectively and efficiently to prevent, prepare for respond to, and recovery from domestic incidents regardless of cause, size, or complexity."[90]

E. STATE RESPONSE PLANS

The State of California has a robust mutual aid system implemented/managed through the Office of Emergency Services, utilizing a regional system for assistance to areas where capacity to respond has been overwhelmed, requiring additional resources or expertise to handle a particular emergency. The operational areas (OA) utilize all assets within their respective OA's. At such time the resources in the OA are not adequate to mitigate an emergency, a request to the Office of Emergency Services at the Regional Emergency Operational Center is made. OES coordinates a systematic draw-down of resources from other OA's within the state to facilitate the requests for resources.

A state of emergency declaration by the Governor makes available all resources of the state and is outlined in the State Emergency Plan..[91]

State resources that are available for a radiological emergency include:

- Civil Support Teams (CST), (2), the 9th CST in southern California, and the 95th CST in northern California.
- Air Resources Board-air quality within the state.
- California Highway Patrol-Incident commander for HazMat, law enforcement mutual aid.

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89 Nuclear/Radiological Incident Annex, NUC-3.

90 Federal Emergency Management Agency, "National Response Plan," FEMA, August 2004. www.training.fema.gov/EM1Web/IS/ICSResource/assets/NRPPallpages.pdf. [Accessed March 20, 2006].

91 "California Terrorism Response Plan" (California Office of Emergency Services, Updated February 2001), 5.

- Department of Fish and Game-lead agency for petroleum spills, HazMat.
- Department of Food and Agriculture-Pesticides and fertilizer expertise.
- Department of Forestry and Fire Protection-fire protection, arson and explosive ordinance disposal (EOD).
- Department of Health Services-technical expertise, assistance and laboratory support for incidents involving the use or threatened use of CBRN agents
- Department of Industrial Relations-evaluate and advise on health and safety plans during response to WMD/NBC incidents

Additionally, states can send and receive aid to other states via the Emergency Management Assistance Compact (EMAC). All Fifty states, Puerto Rico, the U.S. Virgin Islands and the District of Columbia have ratified EMAC.[92] "EMAC is the primary legal tool that states use to immediately send and receive emergency personnel and equipment during a disaster. Prior to adopting EMAC, the Governor's Office of Emergency Services (OES) negotiated governor-to-governor agreements with other states, often lengthening response time."[93]

Once state resources are overwhelmed, the Governor may request assistance from the Federal government either under the Presidential disaster or emergency declaration.[94]

F. FEDERAL RESPONSE TO A RADIOLOGICAL INCIDENT

1. Coordinating Agencies vs. Cooperating Agencies

Both cooperating agencies and coordinating agencies support DHS during an incident of national significance (INS). Coordinating agencies have the primary responsibility for Federal activities during a radiological event. The coordinating agency is the agency having oversight for the specific material or circumstances involved. Cooperating agencies assist as necessary with support functions, but are subordinate to the coordinating agency, lending support and technical assistance.

92 EMAC, "EMAC FAQ", www.emacweb.org/?10 [Accessed August 19, 2006].

93 Government Technology, "California Joins Emergency Management Assistance Compact," September 2005, www.govtech.net/magazine/channel_story.php/96695/ [Accessed March 22, 2006].

94. Federal Emergency Management Agency, *National Response Plan* (FEMA, August 2004), 8. www.training.fema.gov/EM1Web/IS/ICSResource/assets/NRPPallpages.pdf. [Accessed March 20, 2006].

The following is a brief overview of coordinating areas of responsibility per the National/Radiological Incident Annex:[95]

- Terrorism- DOD or DOE if occurrence happens on their facility or material under their control; NRC if material is licensed by the NRC or a contract with the state.
- For all other terrorism, DOE is the coordinating agency.
- Nuclear Facilities-DOE or DOD if it is their facility; NRC if licensed or agreement with state; unlicensed or not owned by a federal agency, the EPA becomes the coordinating agency.
- Transportation-DOD or DOE for their material; NRC for their material; DHS/USCG for materials in coastal zones for materials not licensed or owned by a Federal agency; all others are under the coordination of the EPA
- Space Vehicles-NASA or DOD; DHS/USCG if not managed by DOD or NASA; all others, are the responsibility of the EPA
- Weapon accident- depending on custody at the time of incident is either the DOD or DOE.

2. U.S. Department of Defense

The DOD has the primary mission of homeland defense and the second priority of supporting civil authorities in recovering from multiple, catastrophic WMD attacks at home.[96] "With few exceptions, DOD's consequence management capabilities are designated for the wartime protection of the Department's personnel and facilities. Nevertheless, civil authorities are likely to call upon these capabilities if a domestic CBRNE catastrophe occurs in the ten-year period of this Strategy."[97]

The DOD began implementing National Guard Civil Support Teams (CST) in 1998 under the Clinton Administration. The CST's were established to deploy rapidly to assist local incident commanders. The CST's mission is to assist in determining the

[95] Nuclear/Radiological Incident Annex, NUC-1.

[96] Department of Defense, *Strategy for Homeland Defense and Civil Support* (Washington, D.C.: Department of Defense, June 2005), 4.

[97] Ibid., 12.

nature and extent of an attack provide technical knowledge and assistance to on scene commanders.[98] “They are a key element of the DoD’s overall program to provide to civil authorities in the event of an incident involving weapons of mass destruction in the United States.[99] The CST provides a WMD response platform that is able to bridge the gap between state and Federal authorities. The teams are federally funded and equipped, being ultimately under federal doctrine, but are located in the command structure under the state adjutant generals.[100] Once a governor asks for federal assistance, the same CST will assist in coordinating additional military support and other federal assets to support local commanders.

[98] GlobalSecurity.org, "Weapons of Mass Destruction Civil Support Teams"(GlobalSecurity.org, n.d.): 1. www.globalsecurity.org/military/agency/army/wmd-cst.htm. [Accessed March 22, 2006].

[99] Ibid.

[100] GlobalSecurity.org, "Weapons of Mass Destruction Civil Support Teams," 2.

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VII. RECOVERY STAGE

The Health Physics Society believes that is unlikely that a radiological terrorist attack (not including a nuclear weapon) will disperse enough radioactive material sufficiently to contaminate the air or ground to harm the public or emergency response workers.[101]

“The Health Physics Society believes that the protective actions and protective action guides following a radiological event should be consistent with the existing federal guidance for nuclear incidents, with appropriate accommodation of unique aspects of a terrorist event.” [102]

A. INFRASTRUCTURE DECONTAMINATION, CLEANUP, REMEDIATION

“In contrast to existing regulations governing the release of radiation at a nuclear facility or industrial waste site, the guidelines for a radiological dispersal devise (RDD) cleanup must anticipate the high likelihood that such an attack would occur in a heavily populated area, where the extensiveness of the decontamination effort will have to be balanced with a community’s need to access the affected zone.”[103] Guidelines will also face the challenge of minimizing the disruptive impact of a dirty bomb attack in the face of intense public fear about exposure to even extremely low levels of radiation.[104] For this reason, it is paramount to include local official into the planning phase regarding recovery of the affected site to insure community approval and “buy in” supports the final decision process in terms of re-occupying or abandoning the site. An additional challenge will be to overcome the fear of the public regarding exposure and associated health effects caused from relatively low levels of radiation. As of this writing, there is no clear guidance on acceptable levels of public exposure levels relative to a RDD attack

[101] "Guidance for Protective Actions Following a Radiological Terrorist Event," *Health Physics Society* (2004), http://hps.org/documents/RDDPAGs.pdf. [Accessed May 3, 2006]. 1.

[102] Ibid.

[103] Elizabeth Eraker, "Cleanup after a Radiological Attack, U.S. Prepares Guidance," *Nonproliferation Review* (Fall-Winter 2004): 167. http://cns.miis.edu/pubs/npr/vol11/113/113eraker.pdf. [Accessed May 3, 2006].

[104] Ibid.

regarding the late phase of the incident.[105] This statement is substantiated by the Health Physics Society which states, “The PAG Manual does not have any protective actions or PAG’s for the late (recovery) phase.”[106]

Anti-nuclear activist groups contend that long-term guidance for acceptable radiation expose guidelines that do not meet the EPA Superfund Levels will significantly weaken requirements, thereby weakening the decontamination and public health efforts.[107]

The EPA’s non-binding recommendation for exposure to radiation is based upon accidental release primarily from power plants. For this reason, the aforementioned dose rates have not been affirmed to being applicable to an intentional terrorist attack. The Department of Homeland Security may utilize the Environmental Protections Agencies guidelines from 1992 in the PAG, for the immediate and intermediate stages of an intentional act.[108]

B. RECOVERY (LATE) PHASE

During the recovery phase of a radiological incident, dose rates will become a potential source of controversy and debate based on the lack of definitive standards or recommendations as to the radiation dose rates. The concept of ALARA (As low as reasonably achievable) will be the basis by which the dose rates will be determined in the late phase. These recommended dose levels will take into consideration both economic and social factors.

The fundamental difference between an intentional radiation attack (e.g., dirty bomb) versus an industrial accident at a nuclear power plant or transportation emergency would be one of geography. An intentional act will be focused on population centers and areas of economic importance. “If no one wants to go back to work in downtown Manhattan, then we’re in trouble,” says James L. Conca, director of the Carlsbad

[105] Eraker, "Cleanup after a Radiological Attack," 168.

[106] Health Physics Society, "Background Information,” 11.

[107] Eraker, "Cleanup after a Radiological Attack," 168.

[108] Ibid.

Environmental Monitoring and Research Center at New Mexico State University.[109] Decontamination techniques currently available, such as sandblasting and demolition are not feasible options to decontaminating areas such as Manhattan or symbolic icons such as the Smithsonian museums, Library of Congress, or the U.S. Capital buildings. Additionally, the enormous length of time that it would require to decontaminate vast urban areas would make this process inapplicable. In various dirty bomb scenarios described by the Federation of American Scientists, an amount of cesium-137 equivalent to that found in medical gauges is detonated with 10 pounds of TNT to disperse the radioactive material into populated areas. In the simulations, the FAS determines from modeling data that in the first five blocks, the risk of getting cancer, above normal levels prevalent in a population ordinarily, will be one more death per each thousand people exposed. This number would equate to 150 mR/year exposure, assuming that individuals would inhale, ingest and be externally exposed to the material.[110]

The EPA decontamination rule of thumb for the cleanup up efforts following a radiation incident is to remediate the site to contamination levels not to exceed the risk of cancer in humans to one person in ten thousand.[111] This level corresponds to a radiation dose of approximately 15 mR/yr dose (accumulated exposure). In the above mentioned scenario, a strip of approximately 40 blocks in an urban area would be contaminated to this level. Some materials that would be used in a RDD may bind with building materials or become lodged in cracks and crevasses creating significant decontamination issues.[112]

In March of 2002, Dr. Henry Kelly, President of the Federation of American Scientists testified before the Senate Committee on Foreign Relations, stated that radiation is a credible threat, and that the contamination would be higher than the EPA health and toxic material guidelines. He further states that there are no effective ways to

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109 Peter Weiss, "Ghost Town Busters: After a dirty-bomb attack, special formulations could counter radioactive contamination," *Science News Online* 168, no. 18 (October, 29 2005): 1. http;//www.sciencenews.org/scripts/printthis.asp?clip=%2Farticles%2F20051029%2Fclip%/ [Accessed May 5, 2006].

110 Eraker, "Cleanup after a Radiological Attack," 169.

111 Senate Committee on Foreign Relations, Testimony of Dr. Henry Kelly, President, Federation of American Scientists, www.fas.org/ssp/doc/kelly_testimony_030602.pdf. [Accessed May 3, 2006].

112 Ibid.

decontaminate buildings that exceed these levels whereby demolition may be the only practical solution. “If such an event were to take place in a city like New York, it would result in losses of potentially trillions of dollars.”[113]

The technology in the radiation cleanup is developing rapidly to include technologies in radiation-binding and radiation-ridding gels, foam products, films and emulsions. The goal of radiation decontamination is to be sensitive to the environmental concerns, health aspects, but to be accomplished with speed and at a price that does not become prohibitive.[114] Specific information pertaining to technical information regarding emerging technologies is closely guarded both from an operational security standpoint and from an industrial patent stance. “We don’t want to expose a vulnerability, “explains biologist Thomas P. McCreery of the Defense Advanced Research Projects Agency.[115]

Policy makers may need to consider alternative avenues or non-traditional procedures to facilitate decontamination procedures in the aftermath of a radiological incident. For example, a company called Isotron has developed a material that provides a polymer coating that can be inserted into firefighting hose streams that would dry in a short time to form a tacky polymer sheet. This material would be able to trap radioactive contamination to reduce the spread and associated radioactive dust hazards. The pre-planning and collaboration of stakeholder agencies would be necessary to facilitate such an operation. Other options may include a thorough deluge of water to wash contaminates into a contained water storage area such as the storm water system.[116] “Alternatively, the wash water could be treated at the outflow points using inexpensive materials such as gabions or zeolitic gravel ($80/ton) which is extremely specific for cesium and other radionuclides.”[117] These strategies would remain highly controversial,

[113] Senate Committee on Foreign Relations, “Testimony of Dr. Henry Kelly.”

[114] Weiss, “Ghost Town Busters,” 2.

[115] Ibid.

[116] Ibid., 6.

[117] Conca and Reynolds, "Dirty Bombs, Practical Plans," 22.

but prior knowledge of the "possibilities" may lead to collaboration rather than friction between stakeholders, leading to imaginative solutions in critical situations.

A comprehensive response to a radiation emergency, especially a dirty bomb scenario, is essential for the safety of the general public and that of the emergency service providers. Secondarily, the protection of the environment is of extreme importance. Perhaps equal to these significant response issues is the importance of efficient mitigation of the catastrophic effects of the attack. "Ultimately, however, there may be no measure more critical to preventing dirty-bomb attacks than cleaning up quickly after the very first one. Should an attack take place, says Conca, its perpetrators will probably be monitoring the speed and efficacy of the cleanup to decide the value of launching another attack."[118] "The number of dirty bombs we face," he predicts, "will be determined by how we deal with the first."[119]

C. PROJECTED DOSE

The method to calculate a dose for a given exposed population of civilians or emergency responders is an essential issue that must be addressed in pre-emergency planning and should reflect the PAG's. Additionally, it is important for policy makers and field commanders to understand that projected doses do not actually equate to actual doses to real individuals. Projected doses are utilized to develop a framework to enhance the decision processes during the incident.[120] At this time, there is no method for calculating projected dose rates for the late phase[121]. It is the recommendation of the Health Physics Society that "…methods for calculating projected doses for comparison to the early and intermediate phase protection action guides should be consistent with those currently existing in the PAG Manual, but should be based on the latest available dose conversion factors. The Health Physics Society recommends that the PAG's should utilize projected dose computer programs or methods that are already in use by federal radiological agencies which use realist scenarios for the actual use of areas in question.[122]

118 Conca and Reynolds, "Dirty Bombs, Practical Plans," 22.

119 Ibid.

120 Health Physics Society, "Background Information," 11.

121 Ibid.

122 Ibid.,12.

The EPA has set an upper limit of acceptable radiation levels following a radiation cleanup operation to be 15 mR a year above the average individual background dose for a lifetime (40 years) [123] As mentioned previously, 360 mR average individual background results from exposure to natural occurring radiation levels caused by the natural and human-made sources.[124]

"In contrast to the EPA, the NRC has consistently enforced a standard of 25 mR per year above background radiation levels for all sources of exposure, and generally considers this risk from excess radiation to be acceptable for the general public."[125] The ramifications of federal agencies having differing views of acceptable radiation standards may result in lack of public trust and confidence in government decision processes, or may delay responders from initiating effective actions during the three phases of the incident (early, intermediate or late phases).[126] The recommendation of the author is for the CDC or other recognized medical authority to make a determination as to what the acceptable risk is so that both the public and responders will have confidence in the dose recommendations prior to an actual incident.

D. VICTIM DECONTAMINATION/POPULATION MONITORING

External monitoring and decontamination efforts for victims are the responsibility of local, state and tribal governments with the assistance of federal resources if so requested.[127] The Emergency Support Function #8 stipulates that the Health and Human Services (HHS) assists and coordinates the monitoring and external decontamination with the local and state officials.[128] Additionally, the HHS supports the state agencies in monitoring for internal radiation contamination as well as assisting in the deployment of pharmaceuticals which are requested by state health officials.[129] The Health and Human Services also assists in the long-term monitoring of victims in order to evaluate the

123 Eraker, "Cleanup after a Radiological Attack," 173.

124 Ibid.

125 Ibid.

126 Ibid., 174.

127 Nuclear/Radiological Incident Annex, NUC-17.

128 Ibid.

129 Ibid.

adverse health effects impacts and will assist in performing dose reconstruction estimates and developing a registry of contaminated patients.[130]

E. RECOVERY ACCORDING TO THE NUCLEAR ANNEX OF THE NRP

The coordinating agency for incidents of national significance is the U.S. Department of Homeland Security (DHS). DHS facilitates the federal activities required to cleanup an incident utilizing the NRP.[131]

The term "recovery" can be defined as any action dedicated to the continued protection of the public and resumption of normal activities in the affected area.[132] The planning phase of the recovery effort is initiated by the state, local or tribal governments and does not usually take place until the initial stabilization of the scene occurs.

The total impact of released radiation will be dependent on variables such as weather conditions, amount and type of radionuclide used, time of exposure and the method in which the radiation is distributed.[133]

F. LONG-TERM HEALTH EFFECTS

"The Environmental Protection Agency supports the approach that radiation related health effects can be extrapolated by radiation exposure and is linearly dependent on the intensity of the radiation and exposure to any amount of radiation causes increased health risks, such as increased probability of developing cancer."[134] An alternative point of view is that there is a minimum threshold of radiation, under which there is no adverse health effects. Supporters of this threshold theory state that regulatory actions for radiation exposures below this level are unnecessary, where as supporters of the linear model feel that in the absence of credible proof, a more cautious model is appropriate.[135] In the aftermath of a large-scale radiation incident, local, state and federal officials will determine the acceptable limits of exposure to reoccupy an area which exceeds the

130 Nuclear/Radiological Incident Annex, NUC-17.

131 Ibid.

132 Ibid.

133 Dana A. Shea, "Radiological Dispersal Devices: Select Issues in Consequence Management," (Congressional Research Service, The Library of Congress, updated January 2006), 1. www.fas.org/spp/starwars/crs/RS21766.pdf. [Accessed May 2, 2006].

134 Ibid., 2.

135 Ibid., 3.

current radiation exposure limits. Clearly, the acceptable tolerance levels may need to be adjusted on a case-by-case basis following a radiation incident to address reasonable health consequences balanced with economic consequences.

VIII. PSYCHOLOGICAL EFFECTS OF RADIOLOGICAL EMERGENCIES

A. RADIATION AS A WEAPON OF FEAR

1. Maximizing the Impact of an Act of Terror

Radiation is a perfect weapon for a terrorist organization to maximize their impact in an act of terror. "Even more than the events of the fall of 2001, an attack using nuclear materials, whether in a nuclear weapon, from a nuclear power plant, or from a radioactive source, would cause a residual fear in the population about their safety and the safety of their environment due to possible physical contamination, their own exposure to radiation, and the long-term effects of radioactive fallout."[136] The opportunity to kill large numbers of Americans, destabilizing public confidence in its leadership, and potentially instilling huge economic devastation, all while exploiting an instilled "irrational fear" of radiation of the American population makes utilization of radiation desirable to terror groups.[137]

2. Characteristics of Radiation Which Accentuate the Fear

Radiation is an effective method to instill terror in a population for several reasons. Since the development and use of the atomic bomb during World War II, followed immediately by the Cold War and the threat of nuclear annihilation, the American public has feared radiation. Additionally, Americans have a pre-conditioned fear of radiation based on an emotional perception and the advertised negative consequences due to radiation exposure, such as cancer, birth defects and the anticipated catastrophic outcomes of a radiological accident or attack. The invisible nature of radiation, undetectable without technical equipment, adds to the hysteria. The terms "nuclear," "radioactive," and "deadly," all contribute instilling an initial feeling of fear regarding radioactive materials. This fear can develop to a phobia which cause

[136] Ferguson et al., *Four Faces,* 27.

[137] Ibid.

individuals to make decisions according to perceived fears of consequences based on "What if?" rather than "What is."[138]

3. Case History, Goiania, Federative Republic of Brazil

"Because of the extreme fears of radiation, it is anticipated that the number of citizens requesting surveys for radiological exposure will be several times greater than the number actually exposed."[139] This proved to be a gross underestimate in Goiania, Brazil, in 1987, following an accidental release of Cesium-137. The Brazilian officials used the Olympic soccer stadium in the city to screen approximately 112,800 people for radiation.[140] Of the 112,800 that were screened, 244 were found to be contaminated and 54 were hospitalized, and only five died.[141] The actual number of individuals contaminated or injured by the radiation exposure was exponentially less that those that were "worried." In addition to the 112,800 people screened for radiation, over eight thousand people requested radiation monitoring so that they might obtain a certificate of "clean." This was necessary due to transportation and hotels refusing to serve individuals from this region of Brazil for fear of radiation contamination.[142] Additionally, the economic impact to the region was significant. A 20 percent reduction in agricultural exports, a decrease in the gross domestic product of 15 percent and a reduction in tourism to almost zero, was a consequence of this accident.[143]

4. Emergency Response Personnel

Fear of radiation is not specific to only civilian populations, but emergency responders as well. To operate effectively in a radiation incident, emergency responders

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[138] Raymond H. Jr. Johnson, "Facing the Terror of Nuclear Terrorism," *Occupational Health & Safety*, 2006, 3. www.stevenspublishing.com/steven/ohspub.nsf/ [Accessed 3/25/2006].

[139] Col. Janet M. Hairington and Col. Dan Jensen, "Assessing National Guard Readiness to Weapons of Mass Destruction Terrorist Events" (Carlisle Barracks, Penn.: U.S. Army War College, n.d.). knxupz.ad.nps.mil/homesec/docs/dtic/ADA415888.pdf [Accessed January 16, 2006].

[140] Robert Johnston, "Goiania Orphaned Source Dispersal, 1987," *Johnston's Archive*, May 11, 2005, www.johnstonsarchive.net/nuclear/radevents/1987BRAZ1.html. [Accessed January 12, 2006].

[141] NBC, "Case Study: Accidental Leakage of Cesium-137 in Goiania, Brazil, in 1987," www.nbc-med.org/SiteContent/MedRef/OnlineRef/CaseStudies/csGoiania.html. [Accessed January 12, 2006].

[142] "Nuclear Nonproliferation: U.S. and International Assistance Efforts to Control Sealed Radioactive Sources Need Strengthening," United States General Accounting Office, May 2003, knxup2.ad.nps.navy.mil/homesec/docs/gao/d03638nukeprolifer.pdf. [Accessed January 16, 2006].

[143] Ibid.

must not only be properly equipped with protective ensembles and detection devices, but prepared mentally to understand and address the hazards of radiation.

- What questions must be asked to reduce fear and increase response to radiation emergencies either accidental or acts of terrorism for first responders?
- What is the nature of radiation- alpha, beta, gamma, neutron or a combination?
- How is the suspected material packaged?
- With the package in place what are the hazards associated with each type of radiation?
- If the material is outside the container, what are the associated risks?
- What are the exposure risks based on time, distance and shielding under the current conditions?
- What are the routes of exposure for personnel working in a radioactive environment, and what are the protective clothing/barrier options to ensure worker safety?

B. PSYCHOLOGICAL EFFECTS

The importance of recognizing the need to consider the psychological effects of terrorism on the general population, and that of emergency responders, is the first step in establishing an effective strategy for counter-terrorism. With respect to terrorism in general, and radiological terrorism specifically, it is important to recognize the psychological effects to the population will be significant, regardless of any adverse health effects which may result.[144] Just the mere threat of a radiological event will have a demonstrable impact on the psyche of the general population.[145]

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144 Eva Hickey and John W. Poston Hickey, Sr, "An Overview of NCRP Report No. 138 on Terrorist Activities," E&ED: American Nuclear Society, Sessions on Radiological Terrorism, 2002, 4. eed.llnl.gov/ans/2002/hickey/hickey_paper.php/ [Accessed 3/30/2006].

145 Ibid.

"Federal efforts in developing medical RDD [radiation dispersal device] countermeasures might serve to reduce the psychological aspects of an RDD attack. Validated medical countermeasures might reduce public panic and concern about the exposure of first responders to radiation during treatment of casualties. Alternatively, a similar reduction in the psychological impact of an RDD attack might be achieved through continuing public outreach campaigns."[146] Additionally, compliance to a strict standard for exposure limits may actually reduce anxieties of the general public due to the skepticism of the credibility of the threshold limit theory mentioned previously. A draft guideline published by the Department of Homeland Security has been characterized as too lenient when assessing long term exposure limits in the aftermath of an RDD attack.[147]

"It is imperative that the public be psychologically immunized against the radiological attack threat, through an extensive public education campaign that leads citizens to understand (1) that such attacks rarely pose immediate threats to life, (2) that the decision to shelter or flee will depend on the circumstances of the event and that minimizing risk to personal health will depend on rapidly receiving and adhering to guidance from government authorities, and (3) that proper treatment can greatly reduce long-term health effects in many cases."[148]

1. Recommendations for Preparation

"Preparatory measures can include education efforts to immunize the public psychologically against panic in the face of an RDD attack, which is unlikely to cause mass casualties; investment in development of technologies for wide-area decontamination; training for first responders and governmental authorities; advanced stockpiling of emergency response equipment and therapeutics."[149]

a. Training

Radiation training must be available for the general public; public officials; emergency response, hospital, and other support personnel. This training must

[146] Shea, "Radiological Dispersal Devices,"1.

[147] Ibid.

[148] Ferguson et al., *Four Faces*, 335.

[149] Ibid., 11.

focus both on the threats from various types of radiation incidents and the treatment, transport, and the evacuation of the injured and/or threatened public or emergency responders.

The development of decontamination and radiation exposure standards, which take into consideration both the economic consequences of a radiation incident and the health risks of exposed populations, must be addressed. This will be exceedingly important to have in place prior to a radiation incident so that the perceptions of government standards by the public are based on scientific principles, not on expediency in the wake of a terrorist attack.[150]

b. Role of Media

Terror groups utilize the media to maximize the desired harm of the terror acts, making the attacks personalized to individual citizens, who may be located thousands of miles from the actual incident. "It is possible that media overreaction could make even a low-level or failed nuclear incident a success in terms of creating fear in the public, causing high-impact economic disruption, and bringing broad attention to the cause of the terrorists."[151] Even a failed attempt at a high yield detonation, resulting in a low yield radiation release, could cause a great deal of fear or economic hardship.

In the aftermath of a radiological incident, the role of the media will play an essential role in the confidence of the public in the ability of community leaders and the government to respond to the incident. The media must seek factual information from credible sources such as the Center for Disease Control and Prevention, the U.S. Surgeon General, public health officials and other agencies having responsibility for response to the incident.[152] "Newspaper editors, columnists, radio talk show personalities and television reporters who are known and respected will be followed carefully. These individuals should reinforce the messages delivered by the anonymous names and faces of government agencies."[153]

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[150] Ferguson, *Four Faces*, 331.

[151] Ibid., 43.

[152] Hugh W. Wyatt, "The Role and Responsibility of the Media in the Event of a Bioterrorist Attack." *Journal of Public Health Management and Practice*, 6, no.4 (July 2000): 64.

[153] Ibid.

The media can assist public officials following a radiological attack in the following ways: by responsible and accurate reporting; facilitating a "heightened vigilance" of the community; provide a forum for informed discussion; and by insuring accountability of government agencies.[154]

Pre-planning with the media is important to establish trust and partnerships. These relationships and partnerships should include media participation in fear management programs developed prior to an incident.[155] The medias expertise will ensure the proper mediums and appropriate themes are utilized to maximize public exposure to accurate information.[156] "Allowing the media some 'ownership' of the program will produce a more effective incident response and management tool."[157]

c. Public Education

Terrorism experts say the "blunting" of the psychological impact of a terrorist attack must begin before an actual incident.[158] Stephen Flynn, a security analyst at the Council on Foreign Relations, believes that a sustained public education campaign is what is needed to decrease the fear of the public regarding terrorism. "'Fear of terrorism,' Flynn said, 'is directly related to a level of ignorance and a sense of hopelessness and inability to control events.' Education is the antidote."[159]

Dr. Boaz Ganor states, "Public education contributes to solutions by reducing the fear and paralysis that terrorism can cause. Furthermore, public information, particularly in a liberal democracy, reinforces trust and disarms terrorists, who seek to undermine society's stability."[160]

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[154] Center for Homeland Defense and Security "Online Book: The Media," Naval Postgraduate School: Monterey, California, n.d., 15. php www.chds.us/courses/mod/book/print.php?id=5313/ [Accessed June 14, 2006].

[155] Ibid., 14.

[156] Ibid.

[157] Ibid.

[158] Siobhan Gorman, "Psychological Stakes Raised by Repeat Attacks," *Baltimore Sun*, July 22, 2005, 1. www.baltimoresun.com/news/custom/attack/bal-te.psychology22jul22,1,4338479/ [Accessed March 25, 2006).

[159] Ibid.

[160] Jeffrey H. Norwitz, "The Counter-terrorism Puzzle: A Guide for Decision Makers, By Boaz Ganor," *Norwitz Review* (Winter 2006). www.nwc.navy.mil/press/Review/2006/winter/br3-w06.htm. [Accessed 3/25/2006].

Unintended or willful errors by the media add to the "terror" of terrorism. A successful public awareness and education campaign must focus on the proper dissemination of facts and allow the community to integrate those facts into their own collective consciousness. These facts may need to be utilized in analogies so that the general public may come to appreciate the science by correlating the information to something within their experience or knowledge. For example, the media might describe the half-life of radiation source in comparison to the amount of time it would take for a given quantity of water to evaporate. What is needed is more aggressive public information campaigns prior to an actual emergency through public broadcasts, posted information in public areas and through educational programs at all levels of the educational system.

The public information and education issues related to nuclear/radiological terrorism include the perceptions of radiation by the public; an appreciation of their information needs so as to address adequately their perceptions which influence their factual understanding; concerns related to their personal and family safety; and an analysis of the proper media to present this information to different groups.

The response from the general public will either greatly benefit the situation, or greatly hamper response efforts to a radiation emergency, depending on their reaction to the hazards or "fear" associated with the incident. Public education strategies must focus on providing accurate, credible information which will decrease the likelihood of general panic or anxiety, but must be done before the incident.[161] "At its best, this education can help to 'psychologically immunize' the public against a radiological attack, making citizens less likely to panic."[162] It should be noted that the general public may be skeptical of even credible information.[163]

d. During the Event

Accurate and expedient information as to shelter, evacuation instructions, and personal protection guidelines, need to be communicated through public broadcast

161 Ferguson et al., *Four Faces*, 308.

162 Ibid.

163 Ibid.

systems, or the emergency alert systems.[164] Information needs to be communicated by trusted community or civic leaders who enjoy the general respect or confidence of the general public. "Equally important to informing the public is teaching the news media, first responders and federal, state, and local officials about the effects of radiation, radioactive materials, and RDD's and how to communicate credibly and effectively with the public."[165] The U.S. National Academy of Sciences recommended in 2002 that "pre-packaged" educational kits be distributed before an event and that the messages to be communicated to the public be pre-rehearsed and delivered by trained spokespersons, such as the Surgeon General, or someone that the public trusts.[166]

C. ISRAELI EXPERIENCE WITH THE PSYCHOLOGICAL EFFECTS OF TERRORISM

The State of Israel has been dealing with the day-to-day threats of terrorism since its creation in 1948. Israel has found the need to develop a public education strategy to strengthen the resolve of the Israeli people with respect to the motivational aspects of terror attacks acts conducted by terrorist organizations. "Terrorism has had a definite strategic effect, primarily because public morale eventually translates into shifts in political stance, which in turn effect changes in the nation's policies."[167] "The greatest danger presented by terrorism is thus not necessarily the direct physical damage that it inflicts, but rather the injury to public morale and the impact on the way policy makers feel, think, and respond."[168]

A campaign to counter the psychological effects of terrorism with the intent of strengthening the public resolve and awareness was undertaken. "Israeli terrorism experts from the International Policy Institute for Counter-Terrorism (ICT) visit schools throughout the country and provide educational programs tailored to students of different age groups. The intent of the ICT educational programs is to educate the civilian population as to the terrorist organizations motivations and to counter the psychological

[164] Ferguson et al., *Four Faces,* 309.

[165] Ibid.

[166] Ibid.

[167] Ganor, "Israel's Counter-Terrorism Policy," 1.

[168] Ibid., 2.

effects of terrorism thereby decreasing the effectiveness of terrorism as a political tool creating a type of "vaccination" against terrorist organizations.[169] These lectures describe the motives and operational strategy of terrorists, with the aim of immunizing students against the personalization of terror."[170] The ICT considers their Education Project to be a great success and has favorable reviews from the Israeli general public.[171]

D. STRATEGIES TO IMPLEMENT IN THE UNITED STATES TO MINIMIZE THE PSYCHOLOGICAL EFFECTS OF TERRORISM

California has been effective in preparing for natural disasters, such as earthquakes, floods, and wildfire. The frequency of these emergencies has necessitated Californians to become familiar with how to prepare and respond to these emergencies.

These same proven strategies must be applied to address terrorism preparedness issues. To date, neither California in particular, nor the United States in general, has done much to educate the general public as to the specific risks of radiological terrorism, nor the appropriate actions to take in case of an attack prior to an event.[172] "Government officials must go beyond systems for informing the public to a robust effort to engage, inform, and educate the public about the nature of the terrorist threat and the policies and programs designed to improve the nation's ability to respond to terrorism, and to help the public understand what it can do to prepare and protect itself."[173] Strategies to educate communities have been passive by nature, requiring individuals to seek out the information needed based on their own motivation.

What is needed is more aggressive public information campaigns prior to an actual emergency through public broadcasts or paid advertisements in mass media, posted information in public areas such as bus stops, bill boards, phone books etc., and through

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169 Israel Counter-terrorism Educational Project, "Immunizing the Public against Terrorism," 1, www.ict.org.il/Projectdet.cfm?ProjectID=1/ [Accessed March 27, 2006].

170 Jonathan B. Tucker, "Strategies for Countering Terrorism: Lessons from the Israeli Experience," March 2003, 7. www.homelandsecurity.org/jounal/articles/tucker-israel.html. [Accessed 11/8/2005].

171 Israel's Counter-terrorism Educational Project, "Immunizing the Public,"1.

172 Michael J. Powers, "What should we know? Whom do we tell?: Leveraging communication and information to counter terrorism and its consequences," The National Memorial Institute for the Prevention of Terrorism, 1. www.mipt.org/pdf/CBACI/LevComm/externalI.pdf. [Accessed March 27, 2006].

173 Ibid.

educational programs at all levels of the educational system similar to the other disaster preparedness programs presented to children in the school systems.

Additional recommendations regarding the psychological aspects of a radiological incident are provided by the National Council Radiation Protection and Measurements which include.[174]

- The building of public trust and the instilling of confidence through accurate information sharing with the media and through them to the general public.
- Training at all levels including the policy makers.
- Psychological aspects must be incorporated into all training exercises and emergency plans for long-term care of a segment of the population.

Accurate information following an incident is important, but the credibility of that information will be more accepted by the general public if the guidelines and recommendations were clearly described prior to the incident. The general population may be in a state of panic and fear, causing doubt as to the reliability of government information after the fact.

[174] Hickey and Poston, "Overview," 4.

IX. STRATEGIC PLAN: RESPONSE TO RADIATION EMERGENCIES IN THE SACRAMENTO REGION

A. FUNDAMENTAL IMPORTANCE OF A REGIONAL RESPONSE PROTOCOL FOR RADIATION EMERGENCIES:

The immediate and long-term ramifications of a coordinated and effective regional emergency response in the aftermath of a radiological accident or intentional weapons of mass destruction (WMD) attack will equate to more lives saved and safer operations for responders in the aftermath of a radiation emergency.

Radiological emergencies will task the Sacramento Region to reevaluate the current procedures to effectively treat critical patients in the aftermath of a radiation event. Pre-planning and prior coordination of local, state and federal resources to mitigate the incident should be addressed in a radiation protocol. The coordination of initial response through the recovery of affected infrastructure and population centers will ensure the effective use of resources, and enhance the efficiency of emergency operations.

The response protocol will address the appropriate use of patient transport assets as well as the appropriate decontamination and recovery of those assets. The exploration of appropriate preplanning and identification of required resources necessary to conduct the decontamination will reduce confusion and anxiety over loses of transport assets due to radiation contamination. Additionally, the effective utilization of protective clothing ensembles and hasty patient packaging techniques to reduce the potential for radiation contamination of the first responders will be important considerations.

As part of the radiation response plan, local, state and federal recovery resources will be pre-identified and, in concert with the associated training, will alleviate concern of cost recovery associated with contaminated transportation assets and fixed facilities. The clarification of recovery stage cost reimbursement, and decontamination procedures, will help reduce the confusion and on-scene debate over which resources will be used.

B. ENVIRONMENTAL SCAN SUPPORTING THE STRATEGIC IDEA

The current understanding of responding and treating victims of a radiation incident falls within the response protocols to generalized hazardous materials. The Sacramento County Emergency Medical Service policy number 8029.05 states medical transportation units will only accept decontaminated patients from a HAZMAT team, and there are no provisions to transport contaminated patients. Unlike decontamination procedures required for generalized hazardous materials, the critically injured patients at a radiological event must be triaged for life threatening injuries prior to initiating time-consuming decontamination processes to remove radiation contamination. The existing procedures for treating critically injured patients at a radiological event, as called for in the current policy, will make it extremely difficult to save the lives of the critically injured patient due to the current policies requiring decontamination of all contaminated patients prior to transportation to treatment facilities.

C. ALTERNATIVE TO A STRATEGIC PLAN TO ADDRESS RADIATION RESPONSE IN THE SACRAMENTO REGION

The Development of a strategic plan addressing radiation response in the Sacramento Region will be a dynamic process that will require initiation of new protocols, training and purchase of equipment. To address this issue properly, the region must weigh alternative courses of action to ensure the radiation response issues have been fully addressed and to insure a "buy in" of stakeholders to the proposed course of actions.

One could debate whether or not a specific radiation response protocol is necessary in the region, as the current hazardous material response teams are capable of responding to radiation emergencies. The Sacramento Metropolitan Fire District, Roseville Fire District, and the Sacramento Fire Department hazardous materials response teams are equipped with radiation detection, and isotope identification equipment. As seen in recent radiation emergencies, the current procedures for responding to radiation emergencies have not endangered the public nor emergency workers by being inadequate. It could be argued that the system is functioning as designed. From the years 2002-2005, the Sacramento Metropolitan Fire District has responded to four separate radiation-related emergencies, finding each of the instances to be well within the response capabilities of the responding units. It should be noted that each of these emergencies did not require decontamination of personnel, nor were there any injuries to the public or emergency responders.

The radiation responses that have been successfully mitigated have not included a human health or environmental impact as part of the response scenario; therefore it would be premature to conclude that current policies are adequate to address radiation incidents. Large scale radiological accidents or terrorist attacks utilizing radiological materials may tax municipalities with sound response protocols in place. The size and scope of large-scale radiation incidents will certainly overwhelm municipalities that have not implemented appropriate protocols, procedures, equipment and training needs to address radiation emergencies. A regional response protocol to address the various aspects of radiation response to include allied stakeholder agencies in a comprehensive plan will reduce confusion, maximize resource allocation, response, and responder safety, but most importantly reduce the delay in transporting critically injured contaminated victims to medical care facilities, thereby potentially saving lives.

D. NEW BUSINESS OR SET OF PROGRAMS NEEDED FOR THE RADIATION RESPONSE PROTOCOL TO BE IMPLEMENTED

The response to radiation events will require the specific training and equipping of personnel to address this particular hazard. A balanced approach insuring duality of purpose in response to both industrial or terrorism emergencies involving radiation is the solution. The maximizing of existing resources at the local, state and federal levels combined with supplemental equipment that is affordable is essential. Additionally, definitive protocols and proper training as to the psychological effects of the "fear" of terrorism will ensure the appropriate allocation of resources addressing the radiological risk.

1. Equipment

The Sacramento Region will need to deploy initial radiation detection equipment, including dosimeter equipment, to stakeholder response agencies to facilitate the initial alert to a radioactively contaminated environment. This equipment will need to account for the long term dose monitoring of personnel working in the contaminated environment as well as alerting personnel when predetermined thresholds of exposure have been exceeded.

2. Training

Training of regional stakeholders as to radiation protective equipment, radiation awareness training and specific regional policies related responding to radiation emergencies will be required. Additionally, addressing the critical element of the "fear" of radiation will be a necessary part of a regional protocol to address radiation emergencies in general and radiological terrorism specifically. A recognized national training program such as the Modular Emergency Response Radiological Transportation Training (MERRTT), which is facilitated through the U.S. Department of Energy (DOE) Transportation Emergency Preparedness Program (TEPP), is needed to educate regional personnel as to national best practices The utilization of recognized national training programs facilitated by lead federal agencies in radiation response will ensure consistency of information across response disciplines and assurance of technical accuracy of information to assist in stakeholder agency "buy-in." An emerging training curriculum that is developing for individual disciplines, such as the Center for Disease Control (CDC) for hospital personnel, should be considered to maximize training resources that are already available thereby reducing effort needed facilitate training.

3. Protocol

Changes to address the specific hazards of radiation which facilitate the appropriate care and treatment of contaminated victims of a radiological incident will need to be developed to treat and transport patients appropriately. A regional protocol that includes all stakeholder agencies will insure each agency is utilizing the same "play book" in the event of a radiation incident, reducing confusion, maximizing resource allocation and ultimately providing safer operations and more lives saved in the aftermath of a radiological incident.

E. STRATEGIC PLAN INPUTS, OUTPUTS AND OUTCOMES

Radiation incidents may include terrorism threats, utilizing improvised nuclear devices; radiological dispersal devices; radiation proximity devices; nuclear attack; or accidental releases caused by industrial accidents in fixed facilities or transportation emergencies. Large radiological incidents likely will exceed the capability of the local resources. The local response will focus on isolating the area, identifying the hazards associated with the emergency, providing first aid and transporting the seriously injured to local medical facilities and calling for state and federal resources to respond which do have the equipment, personnel and expertise to mitigate the incident.

1. Inputs

Future inputs will require training dollars for regional response personnel for initial radiation training, and to maintain currency of radiation response skills. Additionally, funding will be required to facilitate initial equipment purchases, replacement of damaged or lost equipment and continued assessment/procurement of advanced technological equipment that is emerging as innovations occur. Additional expenses will occur in regards to staff hours towards committee work at various levels to develop, approve and implement a regional protocol.

2. Outputs

The outputs will include the production of qualified personnel, utilization of contemporary policies and radiation equipment. A dual-purpose radiation response protocol will be adaptive to both responses to accidental radiation incidents as well as intentional terrorist attacks utilizing radiation.

3. Outcomes

The desired outcome of a regional radiation response protocol will ensure an effective response plan including, triage, treatment, decontamination, transportation of victims, and collaboration with regional, state and federal agencies in a fiscally responsible manner. The improved treatment and transportation of immediate, contaminated patients will improve survival profiles of victims, and reduce the likelihood of agencies being held liable for failure to respond, protect emergency personnel, and treat victims in the aftermath of a radiation event to a level that meets recognized industry standards.

F. STRENGTHS, WEAKNESSES, OPPORTUNITY, AND CHALLENGES (SWOC) ANALYSIS & STRATEGIC ISSUE DEVELOPMENT

The following is a SWOC analysis of the homeland security mission of the Sacramento region in general, with an emphasis on radiation response capability specifically.

1. **Strengths**

- Current fire department WMD capabilities
- Regional cooperation and collaboration of stakeholder agencies
- Local, state, federal and private industry response capabilities
- Local responders being part of state and federal response mechanisms including the State Office of Emergency Services, Federal Emergency Management Agency Urban Search and Rescue (USAR) assets, Joint Terrorism Task Force (JTTF), Terrorism Early Warning Group (TEWG, Urban Area Security Initiative (UASI) region
- Location of the Sacramento region relative to state and federal agencies, (Sacramento being the state capitol of, California, the 5th largest economy in the world.)
- Strong statewide mutual aid plan based on a frequently utilized system to respond to floods, fires, earthquakes and civil unrest through the state office of emergency services.

2. **Weaknesses**

- Compartmentalized training within stakeholder agencies. Homeland security mission and awareness is not widely distributed throughout agencies, but typically is focused in the special operations disciplines within each agency. Often, senior management of stakeholder agencies is not as aware of plans or gaps in capabilities as are the leadership of special operations divisions.
- Current policies do not address radioactively-contaminated patients as a separate group, as opposed to patients contaminated with other hazardous materials in terms of transportation relative to nature of injuries.
- Current equipment of allied stakeholders, including some fire departments, does not facilitate early detection of radiation sources. Only the California Highway Patrol has radiation detection capability, and only then in the commercial enforcement division and its special operations units. Other law enforcement agencies including the Cities of Sacramento, Elk Grove,

Folsom, Roseville and Sacramento County Sheriff Department do not have radiation detection equipment short of the explosive ordinance disposal (EOD) teams.

- Current training of front line personnel is inadequate to address radiation emergencies. Only the regional fire departments regularly train for radiation emergencies based on having detection capability.
- Lack of understanding of the "fear" components of WMD response and its ramification to the public as well as the responder community.

3. Opportunities

- The national WMD threat has facilitated a great deal of interaction between allied agencies that would not have otherwise occurred absent a WMD threat scenario. This interaction has lead to increased communication and shared training which has proved beneficial in ordinary day-to-day emergencies. As an example, the Law Enforcement EOD teams have a good working relationship with regional Hazardous Materials Response Teams. The enhanced relationships have created dialog and operational improvements to disposal of potentially dangerous, explosive hazardous materials such as picric acid during routine emergencies.
- The inclusion of stakeholder agencies that would not ordinarily be involved in regional policy development. One such example is the newly-formed "Consortium of Technical Responders" group which is tasked with development of regional strategies and policies to respond to technical emergencies, such as radiation emergencies, "white powder" incidents and pandemic flue. The expertise from local, state, federal and private industry, including local universities with experts in various disciplines provides multiple view points in which strategies can be developed.
- Federal funding to benefit the Sacramento Region directly for personnel staffing, equipment purchases and training reimbursement.

- Utilization of State and Federal expertise for specific WMD threats. Technical experts include members of the National Guard, Civil Support Teams, U.S. Department of Energy, U.S. Department of Health and Human Services, and Immigration, to only name a few.
- Ability to initiate policies and procedures at the ground level to facilitate specific needs at a regional level.

4. Challenges

- Creating response plans to accommodate multiple disciplines.
- Different shift schedules and training demands.
- Large number of personnel to train/equip.
- Disparate funding sources.
- Potential loss of Urban Area Security Initiative (UASI) funding.
- Interoperability of public agencies and "for profit," private sector including area hospitals, and EMS providers.
- Information sharing, both with external agencies as well as within agencies.
- Dispelling the mind set of "It won't happen here."
- Educating both the public and response community to mitigate the "fear" context of terrorism.
- Maintaining organizational knowledge with a large transitional workforce in varying states of retirements and hiring practices.

G. STRATEGIC ISSUES THAT BECOME APPARENT AFTER EVALUATION OF THE SWOC ANALYSIS INCLUDE

- The consequences of both the public and responders "fear" regarding terrorism response must be addressed and accounted for in terrorism response planning and training.
- Dissemination of information both within agencies and between agencies is necessary to reduce compartmentalized knowledge. A formal protocol to address

radiation issues will strengthen institutional knowledge, and assist in addressing succession planning issues whereby individual knowledge or expertise is lost with separation of employment.

- Capabilities of individuals, or individual disciplines, does not equate to regional capability unless the information/knowledge is shared and appreciated by all stakeholders.
- Development of specific radiation protocols and subsequent training must address all stakeholders including private sector partners and be diverse to meet the differing work schedules of the regional partners.
- The potential loss of funding from the UASI grant will necessitate the utilization of existing training infrastructure and mutual aid agreements to maximize the allocation of equipment and implementation of a radiation response protocol.

H. BENCHMARKING

Benchmarking the transportation policies for radioactively contaminated patients will be an important step in developing a strategic plan for a regional radiation response plan. The Sacramento County Emergency Medical System protocols do not specifically address the transport of radiological contaminated patients, as opposed to contamination by hazardous materials in general. Additionally, other municipalities in the region have not specifically addressed radiation contamination relative to patient transportation or other state entities including Santa Clara County whose policy #610 states, "All potentially contaminated patients must be properly decontaminated by the trained HAZMAT responders before emergency medical responders can administer treatment or transport the patients to an emergency medical facility."

International, national and state guidelines clearly indicate the need to transport patients that meet the "immediate" criterion based on medial triage. The International Atomic Energy Agency states, "In virtually all cases there will be little or no health risk to response personnel provided that, for response actions near any hazardous material, they follow the General part of the Personal Protection Guidelines. There would not be a health hazard to medical staff treating or transporting of contaminated persons provided that they protect themselves against the inadvertent ingestion of radioactive material by the use of normal barrier methods (use of surgical gloves and mask) and take actions to prevent the spread of contamination (e.g. to cover the patient in a blanket or sheet), remove and store outer clothing."[175]

National standards stated by the U.S. Department of Transportation, Emergency Response Guidebook, as well as the California Specialized Training Institute, echoes the importance of transporting critical patients in need of immediate medical intervention having priority over decontamination needs in the aftermath of a radiological incident.

As part of the strategic plan to develop a radiation response protocol, an investigation into recommended "Best Practices" for the response to radiation emergencies including the local, state and federal levels will be essential to identify and develop a comprehensive protocol. The development of the Sacramento Regional Radiation Response Protocol will be developed by a subcommittee of the Consortium of Technical Responders (CTR) and critiqued by the membership to ensure that all stakeholder agencies have input into the process. The outcome of a CTR approved/sponsored policy will provide "tipping point" direction to community policy makers to assist in driving support of the plan based on the credibility of the CTR expertise. The leg work of the protocol development will be composed of a small working group to ensure that the direction of the plan maintains momentum, but quality control and protocol input will be provided by the larger body.

I. RADIATION RESPONSE PROTOCOL DEVELOPMENT WILL INCLUDE

- Fact finding as to current policies.
- Assessment of current capabilities (SWOC).
- Determination of best practices regarding all relative aspects of radiation response for the region.
- Analysis of action steps to meet deficiencies, including equipment, training, staffing, funding and policy considerations.
- Draft a strategic plan addressing a radiation protocol for consideration by the CTR.

[175] International Atomic Energy Agency, "Generic procedures," 18.

- Modify protocol as required to meet the needs of stakeholders.
- Assign responsible/accountable personnel to drive the strategic plan, with measurable goals of implementation.

J. DEVELOPMENT AND IMPLEMENTATION OF THE PROTOCOL

The full participation and "buy in" of stakeholder agencies will be essential to the development and implementation of a radiation response protocol within the Sacramento region. The success of the radiation response protocol will include the inclusion of senior stakeholder agency policy makers in the development of the protocol, thereby gaining not only a commitment to the process, but self directed, voluntary participation by individual agencies.

1. Overview of the Stakeholder Agencies and the Committees Needed for the Development and Implementation of a Radiation Response Protocol.

The stakeholder agencies have been organized into three separate working committees which address operation and strategic issues facing each discipline within the region. It is important to understand the intended mission of each of these groups in terms of planning and implementing of a radiation response protocol.

a. The First Committee to Address is Called the Consortium of Technical Responders (CTR), Sacramento Chapter

The CTR is a strategic committee whose stated mission is to address technical response issues facing the Sacramento Region. The CTR is composed of the following agencies:

- Sacramento Metropolitan Fire District
- Sacramento City Fire District
- Roseville Fire Department
- California Highway Patrol
- Sacramento Sheriff Department
- Sacramento City Police Department
- Roseville Police Department
- Sacramento County Environmental Management Division
- Sacramento County Public Health Department
- Placer County Public Health Department
- Terrorism Early Warning Group
- California National Guard, 95th Civil Support Team
- FBI, Sacramento Office
- California Office of Emergency Services
- Transportation Safety Administration (Sacramento International Airport)
- U.S. Customs and Border Protection
- Port of Sacramento

- Aerojet Corporation
- California State University, Sacramento
- University of California, Davis

b. The Next Committee to Include in the Radiation Protocol Will Be the Regional Terrorist Threat Assessment Center's (RTTAC), "Tactical Commanders Working Group"

This group meets to discuss tactical and operational issues regarding terrorism response. The tactical commanders group has many of the same members in the CTR, but also has lower level operational commanders who discuss cross-discipline scenarios. Managers from emergency response disciplines such as EMS, EOD, Hazmat, Special Weapons and Tactics (SWAT), FBI, Alcohol Tobacco and Firearms (ATF), TEWG and UASI make up this working group.

c. The Weapons of Mass Destruction (WMD) Working Group

The WMD Working Group is principally composed of local fire agency representatives who were originally assimilated to address decontamination issues specific to WMD response. The WMD Working Group was founded in September, 2003. The focus of the group has since been modified to address additional operational areas such as WMD detection/protection issues and has expanded to include the members from the Terrorism Early Warning Group and Urban Area Security Initiative (UASI) representatives. A subgroup of the WMD working group has been tasked with assessing the regional hazardous materials response team's capabilities to reflect the recent changes in the FIRESCOPE, Hazardous Materials Team Typing requirements necessary to meet WMD response compliance.

2. Sequence of Development of the Radiation Response Protocol

The primary development of the radiation response protocol will be the responsibility of the CTR, radiation working group, with a point of contact being Battalion Chief Mark Wells from the Sacramento Metropolitan Fire District with the technical and expert assistance of Dr. Jerrold Bushberg from the University of California, Davis. Additional working group members representing other affiliated CTR agencies will assist in developing the protocol. A background document will be developed based on the research of best practices regarding radiation response. This document will include a gap analysis of current capabilities and deficient policies as compared to local, state, national and international standards and practices.

The periodic drafts/changes to the radiation response protocol will be brought to the CTR members during regular meetings to address stakeholder concerns. By early fall of 2006, the finalized radiation response protocol will be submitted for endorsement to the CTR. The importance of this endorsement is to give the proposed document the authority of the stakeholder agencies in the region, credibility of the document regarding the science and technical nature regarding radiation response and to facilitate multi-discipline "buy in" towards the response protocol.

Once the CTR gives the initial endorsement, the proposed protocol will be submitted to the Sacramento Urban Area Security Initiative (UASI) represented agencies. The Sacramento UASI is composed of regional response agencies within Sacramento County, southern Placer County and eastern Yolo County, all having response responsibilities and agreements within the Sacramento urban area. The individual agencies of the UASI will have the ability to dissent from the proposed protocol, but at this stage of the development process, their dissention will be to the larger body which has both established authority and credibility to make the recommendation. At the same time, the protocol will be presented to the RTTAC "Tactical Commanders," and the WMD working group. The strategy behind this protocol implementation is to initiate dialog at multiple levels within the various response agencies. The momentum generated at the operational level parallel to the strategic/policy level will facilitate the self directed, volunteer spirit within the ranks to ensure that the protocol is successfully implemented.

K. PILOT INITIATIVE TO IMPLEMENT THE PROTOCOL

1. Equipment Acquisition for Response Protocol

The procurement of the necessary equipment will need to be accomplished in a modular format due to the associated costs and funding limitations. The coordination of existing resources will be the primary focus during the initial implementation phase of the response protocol. The fire agencies, hospitals and some law enforcement agencies, have the necessary equipment in current inventories, and are in need of only a protocol to coordinate the necessary response strategies. Additionally, purchase of a minimum number of detection/dosimeter devices will be required to equip supervisory personnel for response agencies which do not currently have the detection/dosimeter capability. This strategy will have several benefits. First, the training of supervisory personnel during the initial phase will create a resource of "train-the-trainers" which will be beneficial during the following phases of implementation. Second, having the "buy in" of supervisors will reinforce the importance of the response protocol to the rank-and-file. Third, the equipment will be available and deployed across all response agencies during the initial stages of an incident which is ultimately a key element in the response protocol. Fourth, the technological advancements in detection and dose monitoring are developing rapidly. The modular purchase of the proposed equipment will ensure that advancements in future technology will be realized locally. The future deployment of said technology may be realigned amongst disciplines having a greater exposure to the radiation hazard during an incident. The greater exposure can be defined as having response responsibilities in the exclusion zones, including resources such as hazmat response teams, decontamination personnel, medical response resources, or tactical elements of law enforcement. Accordingly, the older technology may be redistributed to support zone personnel such as perimeter security, transportation assets or command staff.

2. Training Needs to Implement the Protocol

a. The Initial Training

The Initial training will focus on the leadership positions from the response disciplines to facilitate awareness of the protocol, and to educate supervisors as to the recommendations of the radiation response protocol. This will be facilitated by a comprehensive training video that can be viewed in a short briefing to ensure that busy policy makers have the opportunity view the material. The video will be facilitated by members of the CTR to reinforce the multi-disciplined approach, available on asset web servers or CD distribution.

b. The Second Phase of Training

The second phase training requirements will include awareness level training for all regional responders and hospital emergency personnel. The training will encompass an awareness level training, to ensure personnel who have not received specific radiation training will at least understand that there is a response protocol and have a baseline understanding of the associated hazards of radiation. This will benefit the region by reducing the "fear" component of radiation terrorism and ultimately increase the awareness and response to radiation emergencies. Radiation training will be incorporated into the quarterly WMD training for all regional response agencies to maintain currency in radiation issues.

c. The Third Phase of Training

The third phase of training will be for personnel currently equipped with detection and dosimeter capability in addition to the regional supervisors of agencies with recently acquired radiation detection/dosimeter equipment purchased on the initial equipment purchase. The training of this group will be accomplished by utilizing a shared training curricula facilitated by a multi-disciplined training force. The curricula will be approved by the California National Guard training division to ensure that grant funding can be supplied to facilitate training demands. The UASI will be the point of contact to facilitate this training utilizing the WMD grant funding. Practical exercises to reinforce regional training will be conducted on a routine basis. As equipment becomes available, and is distributed to regional agencies, more advanced training will be facilitated. Phase three will be repeated each time an equipment installment is received. The distribution of received equipment will be facilitated by the CTR in combination with the WMD response coordinator. Agencies will be triaged as to which will receive the necessary equipment first, based on theoretical involvement in a radiation incident.

d. The Fourth Phase of Training

The fourth phase of training will be to initiate a public education campaign to actively distribute the message of hazards and the associated "facts" of radiation. This message will be in conjunction with the regional homeland security office and will have the desired effect of potentially "immunizing" the public from the "fear" of radiological terrorism. This education campaign will be multi-faceted to include public education, civic groups, professional organizations, and the media to mention a few.

e. The Final Phase of Training

The final phase of training will include long-term, re-occurring radiation training based on nationally recognized multi-discipline curricula such as the MERRTT training program for emergency response personnel or curricula developed by the Centers for Disease Prevention for health care providers.

L. SUMMARY

The implementation of the radiation response protocol will rely on credibility of the process and recognized science regarding response capabilities to radiation incidents. Once a protocol is developed, a comprehensive strategy to apply the specifics of the protocol will be necessary to ensure that the regional protocol translates to a regional operational capability. Effective communication, delegation and regional commitment will be essential in the protocol implementation.

X. SACRAMENTO REGION, FIRST RESPONDER, RADIATION RESPONSE PROTOCOL

A. RADIOLOGICAL INCIDENT RESPONSE

1. Purpose

This protocol is designed to provide operational guidance for managing a radiological incident. This document will apply to all aspects of radiological emergency response including day-to-day industrial response as well as response to an intentional radiation release such as a terrorist attack. Due to the nature of a large-scale radiation incident, the protocol is intended for use by allied response stakeholders and can be utilized as a regional guideline for radiation response.

2. Scope

Law enforcement agencies assume responsibility of incident commander for hazardous materials within Sacramento County. As an example, the California Highway Patrol has jurisdiction on roadways in the unincorporated areas of the county, where as the Sacrament Sheriff's Department has jurisdiction on private property in the unincorporated areas. The City of Sacramento is an exception, where the fire department is the incident commander for hazardous materials as provided by the Sacramento City charter. Additionally, the City of Roseville Fire Department has jurisdiction for hazardous materials in the City of Roseville which is in Placer County, but is in the operational area of Sacramento.

The responsibility of the fire departments during a radiological incident include rescue, fire control, limit the spread of radiological contamination, decontamination of victims and equipment, medical triage, medical treatment, medical transportation, hazmat containment/stabilization, and initiation of appropriate notifications up to and including local, state, and federal resources. Additionally, depending on the size and scope of the incident, the fire department will be an integral part of a unified command. Commanders must recognize that all incidents begin as local incidents and must initiate protocols that provide for the life safety of the local population and protect emergency service personnel. These local protocols must incorporate the goals of federal response agencies to provide for a smooth transition from local to federal control, depending on the scope of the incident, and provide for response protocols to ensure timely patient treatment and emergency response. The initial coordination of cleanup or remediation processes following a radiological incident will be facilitated by the County of Sacramento, Environmental Management Division. Stakeholder agencies may be called upon to collaborate in the planning and execution of the cleanup/remediation process.

In addition to incident command responsibilities, law enforcement (LE) agencies will facilitate, but not be limited to, perimeter security, site access/control lines, and provide force protection. Additionally, special operations components of regional LE agencies may participate in joint entries with HMRT personnel to mitigate/identify mutual hazards such as additional explosive devices, on site assailants or provide force protection in the exclusion zone.

B. RADIATION RESPONSE SCENARIOS

The emergency response to a radiation event can be anticipated in several scenarios:

- Industrial accidents during normal day-to-day handling, or transportation of radioactive materials.
- Intentional sabotage of storage or transportation vessels containing radioactive materials for malicious purpose. This may include nuclear facilities such as, power plants or industrial facilities.[176]
- Detonation of a tactical nuclear weapon such as nuclear artillery shells, land mines, “suit case” bombs, etc. Tactical nuclear weapons from the former Warsaw Pact countries arsenal could theoretically be used conventionally by terrorist groups if they fall into the wrong hands. “Russia continues to deploy a number of its most portable nuclear weapons on its front lines, where security controls are the weakest.”[177]
- The distribution of radioactive materials via a “dirty bomb” (Radiation Dispersal Device). The term “dirty bomb” is a slang term, originated by

[176] Ferguson et al., *Four Faces,* 3.

[177] Ibid., 1.

the news media, and used to describe a radioactive material packaged with explosives for the intended purpose of spreading radiation.[178]

- Radiation Exposure Device that consists of a radiation source positioned to expose unsuspecting victims to harmful levels of radiation.
- Improvised Nuclear Device (IND)-the formation of a nuclear-yield reaction that can be an improvised weapon with acquired nuclear materials, or modification to a U.S. or foreign nuclear weapon.[179]
- Improvised methods of distributing radiation by utilizing liquid sprayers or other mechanical means to spread radiation contamination.

C. TYPES OF RADIATION AND THEIR CHARACTERISTICS

Alpha Radiation: Particulate cat ion, consisting of two protons and two neutrons which will not pass through a piece of paper or the dead layer of intact skin. Alpha radiation can travels approximately 1-2 inches in air and is primarily an internal inhalation or absorption hazard.

Beta Radiation: Smaller than alpha particles, beta radiation can, depending on their energy travel up to 10 feet in air, and can penetrate the intact skin, making beta radiation both an external and internal hazard. Shielding can be accomplished with plastic, glass, and foil. (Structural firefighting turnout gear is effective for blocking beta radiation.)

Gamma and X-rays: Electromagnetic radiation, that travels at the speed of light. Gamma radiation can easily penetrate protective clothing; therefore gamma radiation is considered an external and internal exposure hazard. Shielding can be accomplished by lead, steel, and concrete.

Neutron Radiation: High-speed particulate matter traveling at the speed of light. There are only limited numbers of radionuclide that are natural emitters of neutron radiation. Neutron radiation is associated with a nuclear fission event such as a detonation of a nuclear weapon. Deposits energy in hydrogenous materials such, as fat and water and thus, is an external and internal radiation hazard.

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178 Health Physics Society, "Weapon of Mass Destruction."

179 Ibid.

1. Terminology for First Responders Regarding Radiation

Electromagnetic radiation: Is defined by the modular emergency response radiological transportation training program (MERRTT) as visible light, heat, radio waves, and microwaves which are low level radiation energy which is referred to as non-ionizing radiation. High energy radiation is referred to as ionizing radiation. Ionizing radiation is of sufficient energy to eject an electron from an atom, thereby changing the electron configuration of the atom and thus its chemical properties. This is the initiating event that can ultimately lead to biological damage and the potential adverse health consequences of ionizing radiation.

Radiation physical half-life (T_p1/2): the time required for a quantity of a radionuclide to decay (i.e., transform) by one-half. Some radionuclides have a T_p1/2 of a few hours (e.g. Tc-99m used widely in Nuclear Medicine- T_p1/2=6 hrs), or many years (e.g. Cs-137 used in instrument calibration facilities T_p1/2-30 yrs and U-238 found in nature T_p1/2= 4.5 billion years.[180]

Radioactive material: Any material that spontaneously emits ionizing radiation.[181]

Radioactive contamination: Radioactive material where it is not intended.[182]

Total Effective Dose Equivalent (TEDE): The sum of the internal and external doses of radiation exposure.

ALARA: Acronym for "as low as (is) reasonably achievable." Means making every reasonable effort to maintain exposures to ionizing radiation as far below the dose limits as practical, taking into account the state of technology, the cost of incremental reductions in dose, and other societal and socioeconomic considerations, regarding the utilization of radioactive material in the public interest

Inverse Square Law: The relationship that states that electromagnetic radiation intensity is inversely proportional to the square of the distance from a point source. Thus reducing the distance from a radiation source by 1/2 increases the exposure rate four

180 Health Physics Society, "Weapon of Mass Destruction.”

181 Ibid.

182 Ibid., 2-8.

times. The same law works in reverse, whereby increasing the distance from a radiation source by a factor of 2 reduces the exposure rate four fold.

Fissile Material: Any material in which neutrons can cause a fission reaction. The three primary fissile materials are uranium-233, uranium-235, and plutonium-239.

Low Specific Activity (LSA): Radioactive material with limited amounts of radioactivity relative to the amount of the material. An example would be uranium or thorium ores, mill tailings or contaminated earth.[183]

Special form radioactive material: Can be either a single, solid piece of material, or a sealed capsule that can be opened only by destroying the capsule. Special form material is considered to be non-dispersible during accident conditions. [184] Special form material should not be confused with "Special Nuclear Material" which is plutonium, uranium-233, or uranium enriched in isotopes uranium-233 or urnium-235.[185]

Surface contaminated objects: Solid object that is not radioactive in of it self, but has radioactive contamination on its surface.

D. DISPATCH GUIDELINES

The Sacramento Regional Fire Emergency Communication Center (SRFECC) will dispatch resources in accordance with existing policies and procedures unless otherwise requested to modify the response criteria by the incident commander. The initial response to a hazardous materials incident is a Level I hazardous materials dispatch which assigns one fire engine to the incident. The early recognition and subsequent elevation of the incident by the initial arriving unit is the key to effective radiation response.

E. INITIAL RESPONSE ACTIONS FOR FIRST RESPONDERS

Incident commanders must understand that all emergencies start locally and will be managed by local responders until outside resources arrive on scene. The requested radiological resources from state and federal resources may have a delayed arrival of

[183] Department of Energy, *Modular Emergency Response Radiological Transportation Training*, 8-7.

[184] Ibid.

[185] U.S. Nuclear Regulatory Commission, "Special Nuclear Material." http://www.nrc.gov/material/sp-nucmaterials.html [Accessed September 3, 2006].

several hours. Local commanders must initiate notifications and understand the associated roles and responsibilities of all stakeholders as the incident escalates, to function within the response protocol appropriately.

The initial actions by emergency responders will follow established guidelines for hazardous materials response. The initial actions should incorporate the following objectives:

Safety: Utilize time, distance and shielding to protect responders

Isolation: Deny access to the area of involvement

Notifications: Notify the appropriate resources, or response agencies. Declare a level two hazardous material incident which will initiate the response of a hazardous materials response team, overhead special operations personnel, in addition to public health, and Sacramento County hazmat personnel.

Identification of the hazard by utilization of U.S. Department of Transportation (DOT) placards/labels, shipping papers, material data safety sheets and/or dialog with the responsible party. The DOT guidebook is an excellent resource to provide emergency response guides for initial actions until qualified a hazardous materials response team (HMRT) arrives on scene to provide further guidance.

Regional HMRT teams will arrived and develop control zones and identify the radionuclides involved. The early identification of the radiation source will assist in determination of early health care intervention strategies. This information will be forwarded to local, state and federal emergency response agencies having jurisdiction to enhance facilitation of technical information and for use in early strategic planning for the incident.

1. Terrorism Incident

For the safety of first responders, any response to an explosion should alert emergency personnel to a possibility of a potential terrorism incident. The emergency response resources must be aware of the potential for additional explosive devices designed to incapacitate the emergency personnel responding to the scene, operating on scene or commanding the incident.

Items of consideration while in route to the scene should include the time of day; nature of the occupancy of the incident, (i.e. high profile occupancy such as a federal building, courthouse, school, hospital, defense installation, financial center etc.); and the current threat assessment disseminated throughout the region by the Terrorism Early Warning Group. Upon recognition of a suspicious incident, Fire Dispatch will be notified to make the appropriate notifications to the Terrorism Early Warning Group (TEWG), and the Regional Terrorism Threat Assessment Center (RTTAC).

The term "terrorist act" or "terrorism" should not be utilized in the initial stages of the emergency until the terrorism nexus is known, and then disclosed by the appropriate law enforcement agency. A radiation emergency that is deemed to be of an intentional nature, will initiate the immediate involvement of the FBI, who will assume the role of the lead federal agency.

2. Detection/Dosimeter Equipment

To respond safely to a radiation incident, responders must have detection capability to determine if they are working in a radiation area. Stakeholder agency emergency response equipment have been issued electronic dosimeters The purpose of the radiation dosimeter is to enable each unit to utilize the dosimeter to alert for the presence of radiation, and to serve as a dose meter for unit personnel during initial operations requiring personnel to enter radiation fields to perform emergency duties such as rescue, or firefighting operations. The deployment of the dosimeter will be the responsibility of the company officer or senior crew member if an officer is not assigned.

When a dosimeter alarms, the radiation rate/dose should be immediately recorded. This information must be relayed to the incident commander immediately. The dosimeter rate parameters are preset to alert at 1 mR (dose), or 100 mR/hr (rate). An analogy to understand the difference between rate versus dose would be the speedometer on a vehicle. The miles-per-hour would be "Rate"; the odometer would be "Dose." These settings are well below harmful levels of radiation, but indicate a radiological source that would be present well above normal background radiation levels. It should be noted that these dosimeters are not designed to be a field survey instrument for radiation. Their purpose is to show the presence of radiation. If the dosimeter alerts, responders will utilize time, distance and shielding techniques (taught in the First Responder Operations course), isolate and deny entry, and elevate the response to a level two HAZMAT incident at a minimum. The radiation dosimeters currently carried by the Sacramento Metropolitan Fire District will monitor up to 500 R/hr, but do not detect alpha or beta radiation (due to the fact alpha and beta particles are not able to penetrate the housing of the device). Therefore, it is important for first responders not to breathe the smoke or dust in the aftermath of an explosion or fire suspected of containing radioactive materials.

The entry of personnel shall be limited to the absolute minimum number utilizing the ALARA principle. Personnel shall wear full PPE, and SCBA until atmospheric monitoring indicates that downgrading to an APR or N95 filtering mask is appropriate and reduced protective clothing is sufficient for the hazards present. It should be noted that radiation hazards may be associated with chemical or other hazards requiring protective equipment for the associated hazardous of the incident in totality, not just the radiation component.

3. Radiological Contamination vs. Radiation Exposure

First arriving emergency personnel must understand the difference between radiation exposures versus radiation contamination.

- Radiation is energy that is emitted by a radiological material; much like a wave of light illuminates an opaque object. Radiation energy leads to radiation exposure, but once the personnel are removed or shielded from the radioactive source, the exposure is stopped. Additionally, creating distance between the source and the person reduces the exposure by what is know as the inverse square law. (e.g., double the distance form the source; reduce the exposure by four fold.) The related radiation dose that is accumulated (measured in rem) is based on how long the exposure occurred, and at what energy.

- Radiation contamination is radioactive material that is outside of its container or normal state of containment, in or on the surface of an object or distributed in the environment. If objects or personnel have been contaminated by radioactive material, they will continue to be exposed until the contamination is removed.

F. ESTABLISHING CONTROL ZONES

The utilization of the Emergency Response Guidebook (ERG) is appropriate for the initial establishment of isolation and evacuation distances. ERG 2004 recommends isolation or evacuation of:

- 75 feet (25 meters)- isolation from a spill or leak
- 330 feet (100 meters)- down wind evacuation of a large spill or leak
- 1000 feet (300 meters)- evacuation for a large fire

Regional Hazardous Material Response Teams will be tasked with establishing control zones related to radiation exposure rates at specific measurement levels to control personnel access and the spread of contamination.

The U.S. Environmental Protection Agency establishes the radiation contamination threshold at twice the background radiation measurement for a particular area. This value is utilized to measure radiological contamination and should not be confused with the establishment of control lines based on radiation activity.

1. Exclusion Zone (Formerly Referred to as the "Hot Zone")

The exclusion zone is the area in the immediate vicinity of a hazardous material release where there is contamination, or probable contamination will occur for personnel working in the area. Control lines are established to exclude personnel from working in the exclusion zone without the proper protective equipment. The exclusion zone, for radiation, is recommended at 2 mR/hr based on the size and scope of the incident. In a large-scale radiation incident, one that encompasses a large geographic area, or high levels of radiation, commanders must evaluate risk versus gain in the development of control zones. Remaining consistent with the dose rate recommendations, all activities can be performed so long as dose levels remain below 5 rem. The current exclusion zone is established at 2mR/hr. At the rate of 2mR/hr, responders can work in the radiation environment for 3 weeks continually before dose rates reach 1 rem, 15 weeks before exposure levels reach 5 rem. Due to the scope of the incident, commanders may need to move operational areas forward and adjust the exclusion zone threshold to manage an incident properly while remaining consistent with the ALARA principle.

2. Contamination Reduction Zone (Formerly Referred to as the "Warm Zone")

The area where personnel/victims/equipment transition from the exclusion zone to the support zone. Decontamination operations are performed in this area to control the spread of contamination from the exclusion zone.

3. Support Zone (Formerly Referred to as the "Cold Zone")

The area where command and support activities are facilitated to manage the incident.

G. TRIAGE TREATMENT AND TRANSPORT OF RADIATION CASUALTIES

1. Triage

The initial assessment and triage of patients in a radiological environment will be assigned to first arriving emergency units utilizing the Sacramento County mass casualty protocol. Upon detection of a radiation incident, emergency personnel will don appropriate protective clothing at the direction of the incident commander and radiation detection/dosimeter equipment. Patients will be assessed for medical needs, regardless of radiological contamination utilizing the simple triage and rapid treatment (START).

2. Treatment

National standards stated by the Department of Transportation, Emergency Response Guidebook, guide page 163 states under "First Aid". "Medical problems take priority over radiological concerns; Use first aid treatment according to the nature of the injury; Do not delay care and transport of a seriously injured person; Injured persons contaminated by contact with released material are not a serious hazard to health care personnel, equipment or facilities; and ensure that medical personnel are aware of the material(s) involved, take precautions to protect themselves and prevent spread of contamination."[186]

[186] U.S. Department of Transportation, Research and Special Programs Administration, *2004 Emergency Response Guidebook* (Washington, D.C: Department of Transportation, 2004), 163.

3. Transportation

The transport of immediate patients whether contaminated or clean, will not be delayed for decontamination actions provided that there is not a chemical or biological component to the contamination. (Chemically-contaminated patients will be decontaminated prior to treatment or transportation.) Every effort to minimize the spread of radiation contamination will be made so long as the efforts do not delay transportation or medical treatment timelines. Such techniques may include the removal of a patients clothing to remove up to ninety percent of radiation contamination. Patients shall be wrapped in sheets to trap any remaining contamination and transportation assets will be prepared per MERRTT procedures to minimize contamination. Use of an issued radiation dosimeter will be utilized by ambulance crew members, (one per unit) to ensure radiation dose limits do not exceed recommended levels. The dosimeter shall be placed in the treatment area of the ambulance to ensure the device is protecting personnel in the closest proximity to the potential radiation contamination. Ambulance personnel shall don, at minimum, universal precaution personal protective equipment (PPE) to include eye, respiratory protection, gloves and an outer disposable garment to enhance decontamination processes. Utilization of the deployed biological PPE will facilitate the PPE requirements for radiation in addition to biological emergencies. Utilizing the time, distance and shielding principles, personnel will reduce exposure to radiation to ALARA.

Command staff should consider the utilization of dedicated “dirty” ambulances on an on-going basis, providing the contamination level of the ambulance does not exceed safe radiation exposure levels for personnel. Limiting the number of ambulances and personnel that may require decontamination will ensure continuity of medical transport capability immediately following the incident and is consistent with the ALARA principle. It should be noted that the dedication of “dirty ambulances should only be utilized if it does not delay the transport of critical patients due to a limited response capability. Radiation contamination of an ambulance can be removed during cleanup or remediation efforts. Often ordinary clean-up procedures will remove radioactive contamination.[187] Exposed personnel and equipment will be surveyed for radiological contamination and dose levels recorded for documentation purposes prior to being release from duty, or reassignment.

4. Decontamination

The specific nature of each event will dictate a course of action regarding the radiation decontamination procedures. The following are guidelines to be balanced with specific incident considerations. Incident specific considerations may include, but are not limited to; weather conditions, ambient temperature, additional hazardous materials/hazards associated with the incident, the logistical concerns of decontaminating large numbers of people in an expedient manner, and the geographic magnitude of the area of involvement.

If resources allow, initial radiological survey procedures should be performed by trained personnel to detect contamination. Personnel surveys can be performed at the direction of hazardous materials response team personnel. Additionally, portable radiation monitors called "portal monitors" may be used for the screening of large numbers of victims. Portal monitors can be accessed through the department of energy RAP teams or the National Guard Civil Support Teams. Commanders must factor a time delay of specialized detection equipment into planning processes. Additionally, improvisation may be required to survey large volumes of concerned populations. The utilization of radiation detection equipment found in the private sector may be utilized with proper coordination/collaboration with civilian infrastructure. An example would be the portal radiation monitors found at many hospital waste collection areas and at metal scrap yards to survey large numbers of concerned victims. These facilities may become remote radiation survey centers utilized to minimize public hysteria or fear due to the possibility of being contaminated by radiation.

Medical procedures should be ruled out if a person presents with above background radiation reading during a radiation survey. Recent nuclear medicine or oncology procedures may be the source of the radiation.[188] Such radionuclides will be

[187] Bushberg et al., "Nuclear/Radiological Terrorism," 17.

[188] Ibid., 11.

detected by survey equipment utilized by emergency personnel. Routine medical history inquiries should illuminate the legitimate presence these radiopharmaceuticals. Additionally, field personnel will not be able to decontaminate internal radiation contamination. Persons with internal radiation contamination should be referred to medical authorities for follow-up medical treatment.

Recommendations for decontamination are made by the decontamination unit leader to the hazardous materials group supervisor. These recommendations are to be submitted to the incident commander at the unified command center. Consideration of environmental factors, numbers of affected victims, nature of the contamination and resources available to perform decontamination should be evaluated prior to selection of a decontamination method. It should be noted that decreasing off-site radiological contamination is a primary concern for emergency response personnel, but should be balanced with the threat posed and associated complications of the decontamination processes.

Decontamination procedures minimize off-site consequences of radiological contamination. The following decontamination control procedures are illustrated in the "Pre-Hospital Practices" module from the MERRTT program[189]

Minimizing the spread of contamination while treating immediate patients who have not undergone a formal decontamination process:

- Initiate ALS care as necessary
- Remove clothing if appropriate
- Wrap patient in a blanket to minimize contamination
- Only expose areas required to assess and treat patient
- If necessary, cut and remove the patients clothing away from the body being careful to avoid contamination to the unexposed skin
- Properly contain all removed clothing by placing it in a sealable bag
- Continue to reassess and monitor vitals while in route to a medical facility

[189] Department of Energy, *Modular Emergency Response*, 16-6.

- Contact with the patient may result in transfer of contamination, change gloves as necessary

Dry Field Decontamination:

- Dry field decontamination should be the first line of contamination control
- Dry field decontamination is performed in the contamination reduction zone, formerly known as the warm zone
- Removes the majority of contaminates
- Reduces the risks of contamination spread and inhalation hazard
- Allows contaminates to be left in the affected area

Wet Decontamination:

Depending on the nature of the contamination and the recommendation of the decontamination unit leader, wet decontamination may be initiated to contain off-site radiation consequences. Wet decontamination will be facilitated through the regional decontamination guidelines referenced in the Sacramento Regional WMD Working Group decontamination guide.

H. MEDICAL FACILITY ACCEPTANCE OF CRITICALLY CONTAMINATED PATIENTS

The presence of radiological contamination must be communicated throughout all stakeholder agencies associated with the incident. The medical facility receiving patients from a radiological incident must be made aware of decontamination procedures performed prior to transport, or the immediate transport of an immediate patient who remains potentially contaminated.

Current policies remain in effect for transportation of patients to appropriate medical facilities based on injuries, proximity and severity. In a limited incident with a small number of patients, the number of hospitals impacted with contaminated patients should be held to the least number as possible. The selection of these facilities should be coordinated through the disaster control facility, and will be limited to facilities with radiation policies in place. Currently the hospitals of University of California at Davis, and Mercy San Juan hospitals have policies in place to handle radiological contaminated patients appropriately. Additionally, both facilities are regional trauma centers. These facilities should be considered primarily. It will be the goal of all regional hospitals to be able to handle radiation contaminated patients. In a large scale incident, past experience has shown that a majority of patients presenting to medical facilities self present, and are not evaluated by emergency response personnel in the field. The absence of a radiation response policy or lack of adequately trained personnel will not limit the inundation of hospital emergency departments by self reporting victims in the aftermath of a large radiation incident.

1. Communication

The communication between receiving hospitals and patient transportation assets should include the following information according to the MERRTT program:

- Destination of patient and access to the facility.
- Who will be assisting with the patient to include radiation safety personnel from the facility and other medical staff?
- What role will ambulance personnel fulfill in the transfer? The medical facility may want to limit the movement of ambulance personnel, who may be potentially contaminated, within the hospital

2. Return to Service Considerations for Ambulance Personnel According to the MERRTT Program

- Follow hospital and/or Radiation Authority direction upon arrival to the medical facility concerning all aspects of the transport, including dress down procedures and contamination containment
- Ensure survey of ambulance for radiation contamination by appropriate authorities. As noted in previous text, a “dirty” ambulance may be reutilized to transport other critical patients provided the contamination levels are kept ALARA.
- Ensure personnel are surveyed by appropriate authorities and decontaminated as appropriate
- Do not eat, drink, smoke or take anything orally until survey and subsequent clearance is issued by radiation authority.

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