ANNEX 5

WIDE AREA RADIOLOGICAL PLAN

## I. INTRODUCTION

A. This plan is Annex 5, Wide-Area Radiological Response Plan, of the Mass Casualty Plan, Appendix 5 of the South Carolina Emergency Operations Plan. This annex identifies the critical public health response functions to a nuclear event and recognizes that the public health response relies heavily on information and resources of the Division of Environmental Quality Control of the Bureau of Environmental Health Services of the South Carolina Department of Health and Environmental Control (SCSCDHEC).

B. The South Carolina Operational Radiological Emergency Response Plan (SCORERP), Appendix 2 of the South Carolina Emergency Operations Plan addresses response to a major incident at one of the six nuclear power plants that are in, or near, South Carolina. However, in our state there remains the possibility of other large scope nuclear emergencies. This Annex addresses responses of ESF-8 (working jointly with ESF-10) to respond to the public health and medical consequences of a Wide-Area radiological emergency incident.

C. There are three scenarios that could cause a radiological emergency of large scope, including contamination of a metropolitan area or large (tens to hundreds of square miles) area and its inhabitants by long-lived (5-30 + year half-lives) isotopes:

1. Improvised Nuclear Device (IND)

Improvised Nuclear Devices are defined as illicit nuclear weapons bought, stolen, or otherwise originating from a nuclear state, or a weapon fabricated by a terrorist group from illegally obtained fissile nuclear weapons material that produces a nuclear explosion. An IND would be built from the components of a stolen weapon, a weapon diverted from a national stockpile, or built from scratch using nuclear material (plutonium or highly enriched uranium). It would produce same physical and medical effects as nuclear weapon. A successful detonation would result in catastrophic loss of life, destruction of infrastructure, and nuclear contamination of a very large area.

The basic principles of constructing a crude device are well known, although such a device would probably be significantly less powerful than one manufactured by one of the known nuclear power plants.

Scenario 1 of the national planning framework hypothesizes a nuclear device with an effective explosive yield equivalent to 10 kilotons of conventional explosives. Such a device, detonated at or near ground level, would cause extensive physical, economic and social damage:

| | |
|---|---|
| Casualties | 111,967 fatalities |
| Infrastructure Damage | Massive damage in a 1-3 mile area |
| Evacuations/Displaced Persons | Will vary widely. Many citizens impacted by the initial exposure to radiation will shelter-in place and/or may be contained in the area to prevent contamination of other areas |
| Contamination | Long-term within 30-50 miles |
| Economic Impact | Hundreds of millions of dollars |
| Potential for Multiple Events | No |
| Recovery Timeline | Years, in some areas potentially never |

SC Catastrophic Incident Response Plan, Annex 9, Scenario 1

See also Chapter 1 of the National Planning Guidance: http://www.remm.nlm.gov/PlanningGuidanceNuclearDetonation.pdf;

Updated casualty estimates from Radiation Emergency Medical Management (REMM):

http://www.remm.nlm.gov/NuclearDetonationCasualtyModeling_Knebel_DMPHP_Mar_Suppl_2011.pdf

The U.S. Department of Health and Human Services (DHHS), Office of the Assistant Secretary for Preparedness and Response (ASPR) in its State and Local Planners Playbook for Medical Response to a Nuclear Detonation summarizes the key principles of the medical and public health response to the detonation an IND and provides sequential guidance to coordinate the medical response.

2. Catastrophic Release From A Nuclear Reactor

The March 2011, magnitude 9.0 earthquake and ensuing tsunami caused massive destruction along the eastern coast and coastal communities of Japan. Four nuclear reactors at the Fukushima Dai-ichi nuclear plant lost critical safety systems and cooling capacity, resulting in explosions, fires, and release of radioactive material. Although many residents evacuated initially in response to the earthquake and tsunami, the Government of Japan subsequently ordered additional evacuations in response to the releases of radioactive material. As of

November, 2011, the evacuation zone extends for twenty to thirty miles from the reactor site in some directions, and includes urban, suburban, rural, and forest lands.

The long-lasting and extensive public health and environmental issues faced by a catastrophic release of this nature are not addressed in the SCORERP. This document covers long-lasting and extensive public health and environmental issues faced by a catastrophic release of this nature beyond what is addressed in the SCORERP. In October, 2011, an International Atomic Energy Agency survey team issued a preliminary report recommending that the Japanese establish decontamination and reentry criteria and waste disposal options at exposure levels higher than those currently set for non-occupationally exposed individuals; that is, the survey team concluded that insisting on decontamination to the currently allowable contamination levels would be prohibitively expensive, that the current conservative exposure limits would bar reentry and reoccupation for years, and that higher exposure limits should be accepted.

It should also be noted that the physical destruction caused by the tsunami is comparable in extent, if not necessarily in kind, to the destruction expected near a nuclear explosion. Although a nuclear explosion would cause thermal and radiation damage which the tsunami did not, both events completely destroy critical infrastructure, residences, businesses, and agricultural resources and cause extensive damage outside the zones of complete destruction. Many of the areas physically destroyed by the tsunami were subsequently contaminated by the radioactive releases from Dai-ichi and so in some respects, recovery will present challenges similar to those expected for recovery from a nuclear explosion.

3. Radiological Dispersal Device (RDD)

RDDs deliberately disseminate radioactive material with the goal of creating injury, fear, and economic chaos. RDDs may also be referred to as "dirty bombs," although that is only one type of RDD. Other dispersion methods include exposure, aerosolization, burning, or direct introduction into the air, water, soil, or food supply.

The U.S. Department of Health and Human Services (DHHS), Office of the Assistant Secretary for Preparedness and Response (ASPR) in its Radiological Dispersal Device Playbook outlines the health issues that could be associated with the detonation or release of an RDD:

"Explosive RDD: Depending on the size of the explosion, an RDD detonation could generate a modest number of patients with physical trauma, thermal burns, contamination, and (in rare cases) radiation injury. These combined injuries (radiation injury plus trauma) range from mild to severe/fatal. In this instance, the incident will be detected by physical detection devices.

Non-explosive RDD: A non-explosive RDD (e.g., contamination of food or water, aerial dispersal, dispersal in a ventilation system), can potentially expose a modest number of people to moderate doses of radiation and many people to low doses of radiation. The event may be obvious in real time or may be subtle becoming recognized over time. In this instance, the incident can be detected by physical detection devices or by an astute clinician who recognizes the syndromes related to radiation injury. For low exposure (less than ~100 centiGrays (cGy) whole body dose) particularly with protracted exposure, there may be few telltale symptoms to suggest radiation injury."

4. Scenario Response Phases

Response to incidents as described above may be divided into three phases for planning purposes:

| Phase | Tasks and goals |
|---|---|
| Short-term: first days | Survey and identify source; issue protective action guidance, including need to shelter in place and self-decontaminate; evacuate or shelter in place; triage; treat; decontaminate; provide temporary shelter; forensic investigation<br><br>Initial response is a state and local responsibility; federal assistance will not arrive immediately |
| Intermediate: first days to weeks | Risk communication<br><br>Delineate contamination, identify where residents can and cannot return, embargo food and water supplies, deal with domestic, farm animal population;<br><br>Define exposure limits for response workers, residents;<br><br>Prepare to transition to long-term staffing and operations; coordinate and integrate with outside assistance as it arrives |
| Long-term: months to years | Risk communication |

| | |
|---|---|
| | Characterize impacted sites; risk assessment; community agreement on restoration goals, criteria;<br><br>Plan for decontamination, removal, or restricted use designation; source reduction; worker health and safety;<br><br>Settle evacuees into sustainable living situations; rehome medical professionals; recover or reconstruct records; transition to epidemiological study of exposed population;<br><br>Adapt to loss of use of embargoed infrastructure |

See also the State and Local Planners Playbook for Medical Response for additional approaches to phased response -

*http://www.phe.gov/Preparedness/planning/playbooks/stateandlocal/nuclear/Pages/default.aspx#actionsteps*

## II. MISSION

The mission of this plan is to guide public health response to a Wide-Area radiological incident in order to provide assistance for medical surge, sheltering, long-term population monitoring, public and responder safety, crisis communications and the provision of psychosocial needs following an event, and to minimize the short- and long-term effects to the population and responders from a major nuclear event.

## III. SITUATION AND ASSUMPTIONS

### A. SITUATION

1. There are four commercial fixed nuclear facilities and one federal facility located within South Carolina: Oconee Nuclear Station (Oconee County); H.B. Robinson Steam Electric Plant (Darlington County); V.C. Summer Nuclear Station (Fairfield County); and Catawba Nuclear Station (York County); and Savannah River Site, the federal facility (encompasses parts of Aiken, Barnwell and Allendale counties). Additionally, there are three nuclear power plants in neighboring states that could impact South

Carolina: Vogtle Electric Generating Plant in Georgia, and Brunswick and McGuire Nuclear Stations in North Carolina.

2. All but four (Beaufort, Berkeley, Charleston, and Georgetown) of the state's counties fall within the 10-mile or 50-mile emergency-planning zone of at least one nuclear facility. However, these counties are not immune from an incident involving an IND or RDD.

3. In order to provide for sustained operations and generally accepted recovery goals and criteria, stakeholder and public participation is required.

4. Exact damage and casualty figures from a nuclear event depend on the location, time, weather, and yield of the weapon. Planning tools are available to make reasonable estimates.

5. Situation Expected from Improvised Nuclear Device

   a. Damage expectations include the destruction of critical infrastructure within a couple of miles of ground zero. Electric power distribution systems outside the central zone will be knocked off line, at least initially. Critical infrastructure outside the zone of complete destruction is adversely affected by the loss of power, loss of dependencies, and mass absenteeism of workers.

   b. In regards to casualties, individuals closest to ground zero are killed. Individuals at increasing distances from ground zero are killed or wounded; the injured present with burns, lacerations, penetrating wounds, fractures, loss of vision and hearing, radiation exposure, and radioactive contamination. Demand for medical attention exceeds medical capacity by factors of 150 to 1 or more. Many "emotionally distressed" present for treatment or reassurance, may require behavior health evaluation or treatment, and may exceed trauma and radiation casualty numbers by 100 to 1or more. Pets and service animals within the Dangerous Fallout Zone may require veterinary care.

   c. Radiation impacts of the explosion include prompt direct radiation which dissipates quickly and the effect of which diminishes with distance from ground zero, and fallout.

6. Situation Expected from Radiological Disbursement Device (RDD)

   a. Most scenarios assume the RDD consists of a radioactive source dispersed by conventional explosives, although dispersal as an aerosol or dust is conceivable.

b. The fallout plume is highly dependent on weather conditions at and shortly after the blast. Individuals and equipment under the plume before its radioactivity is recognized will be contaminated.

c. The majority of casualties and trauma will be from the blast itself with few people actually having significant radiation exposure.

7. Specific to Fixed Nuclear Facility

a. During an event of release of radioactive material from a fixed nuclear facility, evacuation of one or more sectors of the Emergency Planning Zones (EPZ) around the affected nuclear facility would be initiated.

b. In an event of this nature, the initial evacuation zones would be expanded, resulting in displacement of large populations, loss of use of businesses and infrastructure inside the evacuation zone, and loss of agricultural capacity. Large numbers of evacuees would require monitoring, possible decontamination, and relocation.

B. ASSUMPTIONS

1. This plan assumes an event has contaminated a metropolitan center or a large (tens to hundreds of square miles) area with long-lived radioactive isotopes requiring the evacuation and displacement of a large population for months to years.

2. An event contemplated by this plan will overwhelm governmental agencies and present situations not specifically addressed herein.

3. The lessons from multi-hazard planning and response will be applicable to response to a nuclear detonation.

4. Given the magnitude of the incident and the limited size of the EMS response assets available, most people will reach medical care without having been screened or decontaminated in the field.

5. In any radiological event, the numbers of "emotionally distressed" may overwhelm medical facilities.

6. Because major emergencies are infrequent, specific models or tools designed in advance will likely be out of date and inappropriate when needed; therefore, this plan describes a general methodology to be applied for prioritization purposes.

7. A disaster may occur with little or no warning, and may escalate far more rapidly than the ability of any single local response organization or jurisdiction to handle.

8. Rescue efforts after a nuclear detonation will be complex due to potentially high radiation levels, severe infrastructural damage, the number and severity of casualties, and the inaccessibility of many victims, at least initially.

9. Disasters covered by this plan will exceed the capability of local and regional governments, utilizing resources within their jurisdictions, to respond completely.

10. Response to a wide-area radiological emergency will require coordinated responses from all levels of government and the private sector.

11. There will be no significant federal response at the scene for 24 to 72 hours and the full extent of federal assets will not be available for several days.

12. Response, reentry, recovery, and restoration will take months to years. Response activities will transition from an initial crisis reaction to mid- and long-term activities.

13. Both local government and state agencies will utilize resources obtained by pre-arranged agreements with neighboring jurisdictions, state and federal entities, and the local private sector.

14. The State will request assistance from other signatory states in the Southern Mutual Radiological Assistance Pact.

15. The Federal Government will be available with financial and additional resources in accordance with a presidentially declared disaster or emergency. In some instances, federal agencies may provide direct assistance without a Presidential Declaration. However, federal assistance may not be available until several days after the initiating event. The doctrine governing federal assistance will be the Nuclear/Radiation Incident Annex under the National Response Framework (NRF).

16. Many activities during the course of response and recovery will have to be delegated or conducted on a volunteer, self-help basis, in accordance with guidance developed pursuant to this plan.

17. Participation by volunteer organizations, non-governmental organizations, private enterprises, public and private educational institutions, and citizens will be required to arrive at consensus decisions on many issues, to include but not be limited to: contamination limits; clean-up standards;

disposal options for contaminated materials; recovery and reuse or replacement of contaminated facilities; radiation protection standards for reentry and reoccupation of contaminated areas.

18. State and federal critical infrastructure databases have been kept up to date and are available for consultation.

19. Sampling and radiological surveys will be required for the duration of the recovery and restoration phase. Epidemiological surveillance of the impacted population will be required for years.

20. Specific to Improvised Nuclear Device (IND)

    a. Evacuation will begin spontaneously before evacuation plans can be put into effect. Evacuation will be hampered by blast damage, loss of traffic signals and communication, and counterflow (individuals originally outside the impacted area trying to return for family members or to help).

    b. Fallout from a ground level nuclear explosion may be the most significant short-term and long-term effect for several reasons:

        1. The fallout plume is highly dependent on weather conditions at the time of and shortly after the blast.

        2. Fallout is expected to extend for miles downwind in variable patterns, causing surface contamination of land, buildings, exposed equipment, crops and farm animals, and surface water supplies.

        3. Although fallout from a nuclear explosion diminishes rapidly at first, allowing reduction of the fallout zone within 12 to 24 hours, complete reduction in exposure levels to levels comparable to current regulatory limits will take months to years.

21. Specific to Radiological Dispersal Device (RDD)

    a. The fallout plume is highly dependent on weather conditions at the time of and shortly after the blast. Individuals and equipment under the plume before its radioactivity is recognized will be contaminated.

    b. Fallout is expected to extend for miles downwind in variable patterns, causing surface contamination of land, buildings, exposed equipment, crops and farm animals, and surface water supplies.

22. Specific to Fixed Nuclear Facility (FNF)

a. Physical impacts to offsite infrastructure from a reactor incident are expected to be limited to any effects from loss of the station's generating capacity. However if a major earthquake were the precipitating event, extensive physical damage on a wide scale is expected:

Building damage over $14 billion

Economic loss from building damage, $4.2 billion

900 fatalities, 9,000 major injuries, 45,000 casualties

200,000 individuals displaced

250 fires, hampered by lack of firefighting equipment and water

30 hospitals rendered nonfunctional

Damage to bridges and roads

b. Assumption for this plan is that facility operators would be unable to restore safety systems or cooling capacity and the release would continue for several days or weeks.

## IV. ORGANIZATION AND ASSIGNMENT OF RESPONSIBILITIES

A. Responsibilities and authorities of local, state and federal agencies are defined in other plans, including but not limited to:

SC Emergency Operations Plan
SC Operational Radiological Emergency Response Plan
SC Terrorism Operations Plan
SC Catastrophic Incident Response Plan
SC Mass Casualty Plan
SC Recovery Plan
National Framework for Emergency Response
Presidential Policy Directive 8

B. The execution of this plan will require a high degree of cooperation and knowledge sharing among all areas of SCDHEC, including the Health and Medical areas of SCDHEC (ESF-8), the Environmental Quality Control Division

(ESF-10), the Bureau of Radiological Health, and other SCDHEC staff who may be tasked to respond to an incident.

## V. REFERENCES

South Carolina Operational Radiological Emergency Response Plan, Appendix 2, South Carolina Emergency Operations Plan

"Age-Dependent Doses to Members of the Public from Intake of Radionuclides: Part 1," ICRP Publication 56 (1989); "Age-Dependent Doses to Members of the Public from Intake of Radionuclides: Part 2," ICRP Publication 67 (1993); "Age-Dependent Doses to Members of the Public from Intake of Radionuclides: Part 3," ICRP Publication 69 (1995); "Age-Dependent Doses to Members of the Public from Intake of Radionuclides: Part 4," ICRP Publication 71 (1995); "Age-Dependent Doses to Members of the Public from Intake of Radionuclides: Part 5," ICRP Publication 72 (1996)

"Enhancing Personal Readiness and Resilience for Radiation Disasters: A Guide for all Citizens"; http://www.radiationready.org/wp/wp-content/uploads/2011/11/Readiness-and-Resilience-Citizens-Guide.pdf, Center for Public Health Preparedness and Disaster Response (2011)

"Guidelines for Handling Decedents Contaminated with Radioactive Materials," (Centers for Disease Control, 2011), http://emergency.cdc.gov/radiation/pdf/radiation-decedent-guidelines.pdf

"HANDBOOK FOR RESPONDING TO A RADIOLOGICAL DISPERSAL DEVICE: First Responder's Guide – The First 12 Hours," (Conference of Radiation Control Program Directors, Inc., Sept 2006)

"Healthcare System Planning for and Response to a Nuclear Detonation," 5 Disaster Medicine and Public Health Preparedness Supp. 1, pp. S73-S88

"Interim Consequence Management Guidance for a Wide-Area Biological Attack," Lawrence Livermore National Laboratory, May 24, 2011, LLNL-TR-484706

"Management of Terrorist Events Involving Radioactive Material," National Council on Radiation Protection Report No. 138 (2001)

"MANUAL OF PROTECTIVE ACTION GUIDES AND PROTECTIVE ACTIONS FOR NUCLEAR INCIDENTS," EPA Report 400-R-92-001, 1991 [http://www.epa.gov/radiation/rert/pags.html]

State and Local Planners Playbook for Medical Response: http://www.phe.gov/Preparedness/planning/playbooks/stateandlocal/nuclear/Pages/default.aspx#actionsteps

"Medical Management of Radiological Casualties," AFRRI Special Publication 10-1, June 2010, http://www.usuhs.mil/afrri/outreach/pdf/3edmmrchandbook.pdf

"Planning Guidance for Response to a Nuclear Detonation," National Security Staff Interagency Policy Coordination Subcommittee for Preparedness and Response to Radiological and Nuclear Threats, (Second Ed., 2010) (link www.epa.gov/radiation/docs/er/planning-guidance-for-response-to-nuclear-detonation-2-edition-final.pdf)

"Quick Reference Information: Management of Persons Accidentally Contaminated With Radionuclides," adapted from NCRP Report No. 65, http://www.usuhs.mil/afrri/outreach/pdf/ncrp65section2_may2005_1.pdf

"Rad Resilient City: A Preparedness Checklist for Cities To Diminish Lives Lost From Radiation After A Nuclear Terrorist Attack"; http://issuu.com/centerforbiosecurity/docs/radresilientcity?mode=window&backgroundColor=%23222222**,** Center for Biosecurity of UPMC

"Responding to a Radiological or Nuclear Terrorism Incident: A Guide for Decision Makers," National Council on Radiation Protection Report No. 165, (2010)

"The Medical Aspects of Radiation Incidents," Oak Ridge Institute for Science and Education, Contract DE-AC05-060R23100, Rev. 7/29/13, http://www.orise.orau.gov/files/reacts/medical-aspects-of-radiation-incidents.pdf

## VI. CONCEPT OF OPERATIONS

A. The Department of Health and Environmental Control is responsible for the coordination of all Public Health measures in South Carolina, including coordination of Emergency Support Function-8 (Health and Medical Services). Beyond the traditional scope of medical care outlined in the Health and Medical Services Emergency Support Function (Annex 8), the priorities in nuclear emergencies will be:

1. public information;
2. protective action strategies (remain-in-place, evacuation, self-decontamination);
3. worker safety and health;
4. implementation of adequate triage systems;
5. population monitoring;
6. decisions regarding allocation of scarce medical resources;

7. management of medical surge;
8. provision of crisis counseling;
9. shelter issues;
10. restoration of medical facilities and accommodation of displaced medical professionals;
11. community participation in healthcare and protective measure decision making;
12. fatality management; and
13. recovery and resilience.

B. ESF-8 will depend heavily on the guidance, expertise and manpower of the Environmental Quality Control division of SCDHEC (ESF-10) for assistance in public messaging and food and potable water safety. ESF-10 will be assisted by the Bureau of Radiological Health to survey and monitor radiation and contamination.

C. Annex 5 operations will include management of medical surge and the emotionally distressed, medical evacuation and shelter-in-place options, responder health and safety, public notification and messaging, assistance in short- and long-term radiological management, short- and long-term population monitoring, support to radiological decontamination, support for mental health assistance, support to monitoring of affected food and water sources, and mass fatality management.

D. Initial response will be local and regional. While some federal resources may start arriving by 12-24 hours, they are not likely to arrive in significant numbers until 48-72 hours.

E. Initial federal resources will include weather information and plume modeling (from Federal Radiological Monitoring and Assessment Center (FRMAC)), some supplies from Strategic National Stockpile, emergency declarations and subject matter experts on scene or available (e.g., DOE Consequence Management Response Team (CMRT) and HHS Incident Response Coordination Teams (IRCT)).

F. Directing people to shelter-in-place and where to go for medical care and for assembly centers will have major impact on survivability, and must be done in the first minutes to hours after an incident – requiring pre-incident scripting.

G. Adequate provisions and training for protecting safety and health of responders is a strategic objective. Exposure limits should be predetermined by the locality in an effort to optimize exposure risk versus mission necessity and requirements.

H. Electromagnetic Pulse (EMP) and physical damage to electric grid and communications equipment will impact response up to a few miles but much of surrounding infrastructure will be intact. EMP is instantaneous. It will not impact any equipment brought into the area which will work, but is likely to limit availability of directly impacted medical equipment and vehicles.

I. Activation

1. Scarcity of radiological monitoring equipment, subject matter experts and knowledge of medical care for radiologically contaminated victims will cause this plan to be activated sooner following an event than for other mass casualty events. Local resources and responders may be immediately overwhelmed.

2. This plan will be activated immediately upon notification of an Improvised Nuclear Device (IND) event.

3. Activation will occur upon awareness of a Radiological Disbursement Device (RDD) event. Awareness of an RDD event may not occur until notifications by hospitals or other healthcare professionals of unusual patterns of illness, or until detection by other surveillance methods, including monitoring of water, soil, crops or air. This awareness may be immediate or may be delayed by hours or days.

4. In response to a release from a Fixed Nuclear Facility (FNF), the SC Operational Radiological Emergency Response Plan and the SC Technical Radiological Operating Procedures will be activated prior to the activation of this plan. SCDHEC will be notified to activate Annex 5 Wide-Area Radiological Response Plan by the State Warning Point.

J. In this plan, response to a nuclear event is outlined in three stages:

1. Phase 0: Pre-incident preparation

2. Phase I: Early phase, 0-72 hours

3. Phase II: Later phase, >72 hours

K. Response actions in this Annex are organized in the following categories, suggested by:

1. Recognize, Identify and Monitor:

The initial recognition and identification (surveillance) of a nuclear event or radiological contamination will be an early action of SCDHEC response. A radiological exposure device such as a radiography source left exposed in a public venue may go undetected for some time. Individuals exposed to the source will probably not notice the exposure immediately; unless an individual suffers exposure sufficient to cause acute radiation syndrome he or she may not realize the exposure until the device is discovered and publicized.

In any radiological event, surveillance activities will require the participation and training of healthcare partners.

Identification and survey results will guide the refinement of protective action recommendations.

Surveys of real property contamination will focus on the delineation of safe zones and identification of locations and facilities too contaminated for normal use. Working closely with all available resources, ESF-10 and ESF-8 will need to define dangerous fallout areas and develop recommendations for protective actions in those areas.

Population monitoring is the process of identifying, screening, and monitoring people for exposure to radiation or contamination with radioactive materials.

Population monitoring activities and decontamination services offered should remain flexible and scalable to reflect the prioritized needs of individuals and availability of resources at any given time and location. The immediate priority of any population monitoring activity is identification of individuals whose health is in immediate danger and requires urgent care.

According to DHHS' "Planning Guidance for Response to a Nuclear Detonation," population monitoring begins soon after a nuclear emergency and continues until all potentially affected people have been monitored and evaluated as appropriate for the following:

- Needed medical treatment
- Presence of radioactive contamination on the body or clothing
- Intake of radioactive materials into the body
- Removal of external or internal contamination (decontamination)
- Radiation dose received and the resulting health risk from the exposure
- Long-term health effects.

Recognition and identification of victims of a nuclear event is hindered because of the lack of radiation survey instruments and dosimeters in hospitals and other healthcare providers although good patient history, physical examination, lymphocyte counts, and time-to- onset of vomiting are very useful indicators early in the response.

Sampling and radiological surveys will be required for the duration of the recovery and restoration phase in an event. Long-term health effects of a radiological event are determined through a population registry and an epidemiological surveillance of the impacted population will be required for years.

2. Public Information:

A radiological incident will require strategic, rapid communication to healthcare providers and the public. SCDHEC Media Relations, the Division of Environmental Quality Control and the Division of Acute Disease Epidemiology will work together to develop a communications strategy for quick information dissemination, such as identifying, establishing and training a network of credible communications staff and developing public messages about radiation exposure.

Pre-incident messaging is critical to ensure that people know how to minimize their exposure in the event of a radiological incident.

Messages to the public on how people should respond (i.e. evacuate or shelter in place) and messages to the media on incident details and response efforts can have a significant effect on the health and safety of a large number of people, and must be issued immediately.

Long-term messaging related to steps to take when repopulating a contaminated zone, long-term potential health effects and food safety may be necessary for years.

3. Sheltering and reception centers:

During any nuclear event, sheltering, whether in-place or community sheltering, or reception centers will be needed. Recommendations regarding sheltering in place or evacuation will be determined and communicated to the general public by as many means as possible, to include but not be limited to news media, social media, emergency radio, public safety vehicle-mounted loudspeakers (the "Paul Revere" method).

Reception Centers are locations established to identify people who may need immediate assistance – decontamination and the use of washing facilities, medical attention, psychosocial needs or other special assistance.

These services must be provided quickly for large numbers of people including those that may be medically fragile or are otherwise "at risk" individuals (dialysis, colostomy, elderly, etc.).

The community reception center will need sufficient staff, both technical and non-technical, to manage the center for up to several days or weeks. A technical staff that is competent in the use of radiological survey equipment must be available for monitoring, but having additional staff members to process affected individuals and help with decontamination is critical. Additionally, centers will likely need one or more clinicians to assess and refer individuals who need medical follow-up or to administer pharmaceutical countermeasures.

The locations of reception centers have been established in counties with fixed nuclear facilities and, in cases of releases from fixed nuclear facilities, the establishment and operations of those centers are the responsibility of the Department of Social Services (DSS) in conjunction with local government. SCDHEC may be called upon to assist at the reception centers with monitoring contamination and to provide health related information. Other locations may be needed if the event is not associated with an existing fixed nuclear facility. Reception centers are not designed to serve as locations that provide long-term sheltering or as primary locations for medical care.

The detonation of a nuclear device may require, per CDC, "a multitude of community reception centers" to be established "in surrounding communities, perhaps stretching as far as hundreds of miles away, to address the needs of people who have been displaced because of the blast or evacuated because of the fallout."

Pre-incident planning must include discussions with local authorities regarding possible venues for reception centers and contingency plans for establishing and staffing them.

Shelter-in-place may be the preferred action immediately after detonation of a nuclear device to limit exposure to high dose-rate fallout until safe evacuation is possible (12 to 24 hours, depending on the shielding provided by the structure). Shelter-in-place may be recommended for days. Therefore, pre-event communication about appropriate locations within the home for sheltering in place and the supplies needed to do so is critical.

Shelters, similar to those established during hurricanes, will be needed. However, shelters established in response to a nuclear event may be needed for months. These shelters will most likely need to be in larger

scale than those traditionally used for hurricanes. ESF-6 will be responsible for the establishment and staffing of these shelters. SCDHEC will open Special Medical Needs Shelters at the same time as public shelters.

Response and initial recovery planning and operation activities will consider medical evacuation and shelter-in-place options and resources for individuals with medical needs in hospitals, nursing homes, assisted living facilities, and persons living at home. Individuals with functional needs, including individuals with disabilities and individuals with limited English proficiency, that do not require medical support/intervention but do require other means of support such as the assistance of an interpreter, the assistance of a personal caregiver to accomplish activities of daily living or the assistance of a caregiver to provide guidance in daily decision-making, or other auxiliary aid or service is a shared responsibility between ESF-6 Mass Care and ESF-8 Health and Medical.

It is important to note that messaging and instruction regarding self-decontamination for the population will be critical to limiting exposure. Most decontamination will need to happen within hours to limit lethal or significant doses and that will be long before emergency systems are operating or people arrive at healthcare facilities.

An issue that will arise at sheltering and reception center sites is the need for some of the population to obtain oxygen, dialysis treatment and medications during their stay. Public health will provide a role in coordination of pharmaceuticals.

Depending on the event, it will be initially unknown how long sheltering may need to be sustained.

4. Medical Countermeasures and Non-pharmaceutical Interventions:

Medical countermeasures during a radiological event refer to preventatives and treatments for radiation. Non-pharmaceutical interventions during a radiological event includes personal protective equipment to prevent decontamination, such as Tyvek suits, PAPRS, and other protective equipment.

The Centers for Disease Control and Prevention have established a program to stockpile chelating and decorporation agents for the treatment of individuals who are known or suspected to be internally contaminated with cesium plutonium, americium or curium following deployment of an RDD. These agents will become the property of the State of South Carolina upon receipt and will be used to augment local supplies during a radiologic event in South Carolina. These agents will be shipped to South

Carolina. This plan provides for the storage and distribution of these assets to the treatment facilities pre-identified to receive radiologically contaminated/injured individuals in the South Carolina Operational Radiological Emergency Response Plan (SCORERP).

For an IND, the SNS contains surge quantities of medications to treat Acute Radiation Syndrome and other radiation or trauma-induced injury. These include: antibiotics, cytokines, antiemetics, fluids, etc.

A limited amount of personal protective equipment and radiation detecting equipment is available within SCDHEC. Additionally, the SCDHEC Hospital Preparedness Program has provided support to the hospitals and SC Coroners Association for stockpiling of appropriate PPE and monitoring devices.

5. Medical Surge and Restoration of Medical Infrastructure:

Reports from South Carolina's healthcare facilities indicate that most have the equipment, training and resources to handle only limited numbers of patients exposed to radiation. Additionally, in a radiological event, some facilities may be rendered unusable by the initiating event or its aftermath. Surviving staff from these facilities may be integrated into other facilities in surrounding communities.

Medical surge during a large scale event is a certainty. Surge issues will be compounded by the inevitability of the appearance in healthcare facilities of large numbers of the emotionally distressed, seeking decontamination and examination.

In addition to local medical surge and additional support from the EMAC and the National Disaster Medical System (NDMS) Teams and Hospitals, HHS/ASPR has an agreement with the Radiation Injury Treatment Network (RITN) to provide consultation and definitive care for radiation casualties. Although all national centers would be available, Regional RITN Centers are found in SC (Medical University of South Carolina), NC (UNC Hospitals, Wake Forest University Baptist Medical Center, and Duke University Medical Center), FL (Shands Hospital at the University of Florida, University of Miami, H. Lee Moffitt Cancer Center), and GA (Northside Hospital).

Medical volunteers may be integrated into the personnel pool of healthcare facilities. The Medical Reserve Corps recruited through the Emergency System for Advance Registration of Volunteer Health Professionals may be a resource. The long-term effects of a radiological event and possible displacements of healthcare staff will require support.

Evacuation of a metropolitan area will likely preclude use of healthcare facilities in the affected area and the healthcare staff will be evacuated, possibly for months, with the citizenry. Health licensing personnel, insurers, and the healthcare community should be encouraged to discuss integration of staff from closed facilities into staff at supporting facilities.

6. Volunteers:

The availability and use of volunteers may become critical during a wide-area radiological event. Because of the potentially far-reaching and long-term response to a radiological event, volunteers will be needed to supplement public health staff throughout the event and the recovery period.

Volunteers such health physicists, HP techs, radiation-related medical professionals, and others specifically familiar with radiation protection activities will be needed. Even volunteers with no or limited knowledge of medical or radiological response can assist in shelters.

Volunteers may be used to assist with:

- radiological screening and monitoring the public;
- provision or coordination of medical care;
- field monitoring; and
- distribution of supplies and medications.

Volunteers with special radiological training may be recruited to form special Radiological Response Teams.

7. Behavioral Health:

The threat of radiological exposure from terrorist attacks poses unique challenges for this system because of the unconventional form of such attacks; this lack of knowledge serves to accentuate public fear. Adding the potential for nuclear accidents raises public apprehension about the risk of exposure to toxic substances that are neither visible nor avoidable in such circumstances. Psychosocial issues that arise during a radiological event include: fear, including concerns of danger to unborn generations and genetic mutations; anxiety and uncertainty about whether the individual was exposed to radiation and ultimate health concerns; lack of control, including a personal vulnerability because of the invisible nature of a radiological event; contamination and stigmatization; and disruption of social networks due to evacuation of homes, overwhelmed medical

facilities, shelter-in-place requirements and media reports that may heighten fear.

The already overburdened behavioral health resources and teams will be challenged to meet the needs of a disrupted society. In a radiological event, the need for psychosocial intervention for the public and responders is likely to last for many months or years. ESF-8 will request federal behavioral health surge assistance and funding.

8. Fatality Management:

Mass Fatality support will include support to victim decontamination and for catastrophic casualty numbers. A radiological incident may result in fatalities from an initial blast or as a result of long-term exposure to radioactive materials. Medical examiners, coroners and morticians should properly handle human remains, which may be externally or internally contaminated, to prevent the spread of radioactive contamination to themselves, to other individuals, or to the environment. Support will be provided to ensure that fatality management personnel have appropriate expertise, equipment, and procedures to limit their radiation exposure.

**Phase 0: Pre-incident preparation**

1. General

   a. Identify subject matter experts.

   b. Promote community discussion of radiological preparedness and education.

   c. Determine the health related risks of at-risk populations during a radiological event.

   d. Identify resources that may be used for radiological detection in victims.

2. Recognize, Identify and Monitor

   a. Develop a system to map and monitor dangerous fallout zone (ESF-10 lead with Bureau of Radiological Health assistance); link to MedMap per HHS guidance.

   b. Develop system for long-term population monitoring, including data fields and determine how a registry can be implemented.

   c. Determine strategies for public warning system specific to radiological incident.

d. Determine the appropriate response if the radiological contamination is due to a release of contamination at a licensed radiological source facility (Bureau of Radiological Health lead with ESF-10 assistance).

e. Work with federal agencies and neighboring states to determine response and monitoring resources that may be offered or requested to assist in the identification, monitoring, and cleanup of the radiological contamination.

3. Public Information

a. Prepare radiological information sheets that can be generated for any radiological response. Possible pre-scripted messages can include information on:

i. what it is;
ii. what it does;
iii. what SCDHEC is doing;
iv. what we want the public to do; and
v. additional message concerns places the public can turn for more information -- such as the Internet.

b. Develop pre-event talking points related to radiological issues, public/personnel exposure control efforts and related subject matters.

c. Develop messages on protective actions.

4. Sheltering and reception centers

Shelters and SMNS:

a. Maintain listing of SMNS within the state.

b. Provide training to staff addressing sheltering during radiological event.

c. Identify potential PPE needs for shelter staffing.

d. Coordinate with ESF 6 regarding health aspects of sheltering during a radiological event.

e. Develop just-in-time training for SMNS shelter operations.

Reception Centers:

Identify the role(s) that SCDHEC staff will fill at Reception Centers.

5. Decontamination, Medical Countermeasures and Non-pharmaceutical Interventions

a. Identify agents for treatment of internally radiologic contaminated patients that hospitals will require.

b. Identify sources and contact information to obtain radiologic antidotes as most are not carried by local pharmaceutical vendors.

c. Maintain contact lists of chief pharmacists and emergency managers for hospitals.

d. Inventory the most current annual assessment of REMM-recommended PPE supplies and locally available equipment.

e. Communication with the public must emphasize the need for prompt self-decontamination.

f. Work with other agencies to determine strategy for large scale decontamination.

g. Develop pre-event technical assistance and regulatory guidance for industries/vendors involved in the decontamination and cleanup of the environment due to the contamination.

h. Provide training and training modules to Bureau of Radiological Health staff by EQC staff to assist EQC with responding to a wide area event.

i. Provide training to SCDHEC staff specifically on equipment and personal protective equipment used during assessment in contaminated areas.

j. Provide training to SCDHEC staff on protective action recommendations such as sheltering in place, embargos on food supplies, changing clothes, evacuation and Protective Action Guides.

6. Medical Surge and Restoration of Medical Infrastructure

a. Gather information about radiological response capabilities at hospitals and other healthcare providers. Contact facilities without completed surveys. Coordinate with RITN national office and Regional RITN Centers.

b. Encourage hospitals and other healthcare providers to participate in radiological trainings and exercises when available.

c. Estimate number of additional healthcare personnel needed to support medical surge.

d. Determine types and estimate the quantity of PPE needed for current and additional healthcare personnel to support medical surge.

e. Implement the Radiation TReatment, TRiage, and TRansport system (RTR). Assure crisis operations plans for agency/system are accomplished including triage of calls at local Public Safety Answering Point (PSAP), medical dispatch centers, and on-scene, and also including staffing configurations, transport destinations (e.g., delivering patients to non-hospital locations such as RTR3 / Medical Care locations)

f. Develop pre-event technical assistance and regulatory guidance for healthcare facilities impacted by radiological contamination.

g. Develop system to surge and coordinate biodosimetry (lymphocyte counts, dose estimation, etc.) and ensure continuity in data management and fidelity in data interpretation.

h. Attend regional planning meetings to provide guidance. Encourage hospitals to purchase adequate PPE to support current and additional healthcare personnel as determined.

i. Determine numbers of EMS services that have EMTs or teams with training in CBRN.

7. SCDHEC Volunteers

a. Identify subject matter experts and trained personnel (radiological technicians and technologists, medical physicists, and others) who may serve as volunteers on radiological assessment teams or to assist hospitals with surge.

b. Develop strategies to use for volunteers to support large scale decontamination.

c. Develop just-in-time training for volunteers to assist in shelter and reception center screenings.

8. Behavioral Health

a. Provide training to behavioral health teams specifically addressing psycho-social needs during a radiological event.

b. Develop materials addressing psycho-social concerns specific to a radiological event.

9. Fatality Management

a. Promote radiological training for coroners.

b. Identify subject matter experts to assist in a radiological mass fatality event.

c. Identify resources needed to manage mass fatalities in a radiological event.

**Phase I: Early phase, 0-72 hours**

1. Recognize, Identify and Monitor

a. Conduct damage assessment and residual capability analysis of medical systems, EMS equipment, and available responders and receivers.

b. Implement registry.

i. Work with healthcare providers to gather data for registry.

ii. Record information on shelter workers, volunteers and responders.

c. Provide ambient environmental monitoring for determination of appropriate Protective Action Recommendations (PARs).

i. Monitor potable water quality.

ii. Define appropriate exclusion zones for citizens.

iii. Assist local and state governments in determination of the safe radiological exposure levels for their public safety personnel.

iv. Work with federal and state agricultural officials to make the appropriate determination of agricultural product contamination.

d. Provide technical assistance to local government officials in determination of extent of threats/safety concerns from the radiological event.

i. Assist congregate care facilities in determining the safety of their operations.

ii. Assist local government officials in technical issues involved with decontamination of people and emergency vehicles.

iii. Interpretation of radiological monitoring data for governmental officials.

iv. Support law enforcement officials in determination of appropriate security measures to eliminate spread of contamination through movement of contaminated materials/debris.

e. Assist law enforcement officials with radiological and chemical contamination surveys of contaminated areas that may now become a crime scene.

f. Provide support to Office of Media Relations and local media sources to explain radiological issues, sampling efforts, public/personnel exposure control efforts, and related subject matters.

2. Public Information

a. Immediately following the event, distribute messages that are intended to help stabilize the situation and prevent further confusion. Messages may include, but are not limited to:

i. information about the event (i.e., what it is / what it does);
ii. actions needed to protect people right now;
iii. evacuate or shelter-in-place;
iv. only for a nuclear plant incident, take KI, if available and appropriate;
v. whether it is safe to go outside;
vi. whether the danger is restricted to a specific area;
vii. if in the immediate area of the explosion/release, the possibility of endangering others unintentionally by leaving the area;
viii. minimizing the danger by carefully removing and bagging clothing, then showering; and
ix. which foods are safe to consume.

b. Over the course of the 72 hours following the blast/release, the public needs to be instructed on:

i. additional actions to take to prevent exposure;
ii. where to go to receive treatment (this message could include messages to avoid over burdening healthcare facilities);
iii. how to dispose of clothing and other materials that could be contaminated;
iv. how to decontaminate pets;
v. if unable to dispose of contaminated materials, who to call for help;
vi. the extent of the danger by exposure; and
vii. more on SCDHEC's and the state's remedial efforts (i.e. what SCDHEC is doing).

3. Sheltering and reception centers

Shelters and SMNS:

a. Deploy shelter teams from around the state to continue SMNS shelter operations.

b. Provide just-in-time training for volunteers and other shelter team resources.

c. Identify priority public health services in light of diminished nursing capacity.

Reception Centers:

a. Provide staff or volunteers to reception centers to begin population monitoring.

b. Provide public information messages on health concerns to the reception centers.

4. Decontamination, Medical Countermeasures and Non-pharmaceutical Interventions

a. Push forward state supplies of radiologic antidotes, if it is the appropriate antidote, to facilities receiving exposed patients.

b. Alert statewide private and hospital pharmacies to the need for radiologic antidotes and work with the South Carolina Pharmacy Association to gather the antidotes for distribution to the population in need.

c. Determine the approximate numbers of exposed patients requiring treatment for internal contamination and contact suppliers to distribute the required antidotes. If source is non-commercial assist facility with request process.

d. Assist hospitals by initiating mobilization of additional decontamination teams and equipment, if needed.

e. Coordinate assistance and response with the SCDHEC's Bureau of Land and Waste Management's Nuclear Response and Emergency Environmental Surveillance Section (NREES), the Department of Energy, and other qualified state or governmental agencies.

f. Provide technical assistance and regulatory guidance to industries/vendors involved in the decontamination and cleanup of the environment due to the contamination.

5. Medical Surge and Restoration of Medical Infrastructure

a. Identify vacancies at hospitals, healthcare facilities and Community Residential Care Facilities (CRCFs) statewide in conjunction with the S.C. Hospital Association (SCHA) and other appropriate organizations.

b. Request Social Security Act Section 1135 waiver for alternate care facilities from the Secretary of Health and Human Services. Social Security Act Section 1135 waivers require both a declaration of national emergency or disaster by the president under the National Emergencies Act or the Stafford Act and a public health emergency determination by the HHS secretary under Section 319 of the Public Health Service Act (PHSA).

c. Provide support for hospitals and other healthcare facilities.

d. Notify licensed EMS providers in order to coordinate available resources as needed. The resources will include ambulances with crews, pre-positioned disaster trailers, both light and heavy rescue teams, confined space rescue, air ambulances, dive teams and body recovery teams. Request activation of the National Ambulance Contract.

e. Obtain ambulance services information, contact the ambulances, make decisions regarding the staging of ambulances, coordinate staging at the staging area, deploy to the local EOC of the affected county(ies) if applicable, and set up local ambulance staging areas if needed. Deploy liaison or technical assistance teams to ambulance staging area or county EOC as needed.

f. Assist with the coordination of patient/resident evacuation and relocation.

g. Communicate with SCDHEC EOC staff regarding the status of patient/resident evacuation and relocation.

h. Coordinate assistance and response with the Bureau of Health Facilities Regulation regarding the damage and safety of licensed healthcare facilities.

i. Utilize NDMS teams and transportation; use RITN system.

j. Consider the need to request a Federal Medical Station.

6. Volunteers

a. Identify needs in which volunteers may assist at reception centers or other response activities.
b. Generate a list of radiological professionals who have registered as volunteers.
c. Provide just-in-time training as needed to volunteers to assist in the identified roles.

7. Behavioral Health

a. Review and distribute appropriate psycho-educational materials to individuals and/or communities.
b. Provide proper assessment and triage of victims to insure the appropriate intervention/treatment.
c. Provide emergency supportive psychological/emotional support to affected citizens and responders.

8. Fatality Management

a. Activate the state mass fatality plan.

b. Inform the public that saving lives and providing care to the living are first priorities.

c. Support the local coroners in locating appropriate caskets and transport for radiologically contaminated victims.

**Phase II: Later phase, >72 hours**

1. Recognize, Identify and Monitor

a. Assist dairies and bottling facilities regulated by the SCDHEC in an assessment of the radiological contamination of their facilities to include technical assistance in the removal and disposal of contaminated food products.

b. Assist industrial and local officials with appropriate monitoring and disposal of any contaminated debris and/or solid waste.

c. Coordinate federal and neighboring state (EPA, DOE, N.C, Fl., Ga., etc.) response and monitoring resources that will be offered or requested to assist in the identification, monitoring, and cleanup of the radiological contamination.

d. Assess the protection level needed and exposure and dosage rates of the radiation source on the food.

e. Coordinate with SCDA and Clemson University Meat and Poultry Services, to advise dairies on what steps to take to prevent fallout contamination and shielding requirements, as well as source information on acceptable or allowable rates on feed supplies.

f. Assess the state of radiological contamination of food provided to restaurants, markets, grocery stores, and schools.

g. Evaluate buildings such as schools for contamination and assess clean up and sanitation procedures.

h. Continue to assess the situation and define the damage and fallout zones and prioritize access restoration.

i. Consider returning people to habitable zone in conjunction with federal guidance.

j. Continue population monitoring and provide information on who should and should not participate in long-term registry.

2. Public Information

a. Provide easily understood information about relative risk for future malignancies and impact on property to those in fallout areas.

b. Continue addressing the concerns of the public with messages about safety, health and avoiding contamination.

3. Sheltering and reception centers

Shelters and SMNS:

a. Continue to coordinate SMNS operations.

b. As additional volunteers are recruited to support SMNS operations, provide just-in-time training.

c. Continue to manage and provide priority public health services in light of diminished nursing capacity.

Reception Centers:

a. Continue to conduct population monitoring at reception centers.

b. Continue to address health concerns and questions that arise at the reception centers.

4. Decontamination, Medical Countermeasures and Non-pharmaceutical Interventions

a. Continue to distribute federal and state supplies of radiologic antidotes, as available and if it is the appropriate antidote, to facilities receiving contaminated patients.

b. Continue to determine the approximate numbers of exposed patients requiring treatment for internal contamination or Acute Radiation Syndrome and contact suppliers of required antidotes.

c. Continue to coordinate assistance and response with SCDHEC's Bureau of Land and Waste Management's Nuclear Response and Emergency Environmental Surveillance Section (NREES), DOE, and other qualified state or governmental agencies.

d. Define exposure limits for response workers and residents.

e. Continue to provide technical assistance and regulatory guidance to industries/vendors involved in the decontamination and cleanup of the environment due to the contamination.

5. Medical Surge and Restoration of Medical Infrastructure

a. Continue to identify vacancies at hospitals, healthcare facilities and Community Residential Care Facilities (CRCFs) statewide in conjunction with the S.C. Hospital Association (SCHA) and other appropriate organizations.

b. Continue to provide support for hospitals and other healthcare facilities.

c. Continue to coordinate EMS response. Seek mutual aid or federal response to relieve state EMS providers. Regularly monitor EMS providers for contamination.

d. Continue to assist with the coordination of patient/resident evacuation and relocation.

e. Continue to communicate with SCDHEC EOC staff regarding the status of patient/resident evacuation and relocation.

f. Coordinate assistance and response with the Bureau of Health Facilities Regulation regarding the damage and safety of licensed healthcare facilities.

g. Determine when or if damaged facilities may be reopened.

h. Use RITN system.

6. Volunteers

Continue to recruit volunteers to support the long-term response.

7. Behavioral Health

Establish teams, timelines, and goals for medium- and long-term psychological support to help resilience.

8. Fatality Management

a. Continue to inform the public that saving lives and providing care to the living are first priorities.

b. Continue to support the local coroners in locating appropriate caskets and transport for radiologically contaminated victims.

c. Monitor fatality management responders for contamination.

## VII. RESPONSIBILITIES

A. Responsibilities and authorities of local, state and federal agencies are defined in other plans, including but not limited to:

SC Emergency Operations Plan
SC Operational Radiological Emergency Response Plan
SC Terrorism Operations Plan
SC Catastrophic Incident Response Plan
SC Mass Casualty Plan
SC Recovery Plan
National Framework for Emergency Response
Presidential Policy Directive 8

B. The execution of this plan will require a high degree of cooperation and knowledge sharing among all areas of SCDHEC, including the Health and

Medical areas of SCDHEC (ESF-8), the Environmental Quality Control area of SCDHEC (ESF-10), the Bureau of Radiological Health, and other SCDHEC staff who may be tasked to respond to an incident.

C. SCDHEC

1. Identify subject matter experts within the agency and outside the agency.

2. Promote community discussion of radiological preparedness and education.

3. Identify health-related risks for all populations during and after a radiological event.

4. Identify resources that may be used for radiological detection in victims.

5. Develop a system to map and monitor dangerous fallout zones.

6. Develop a system for long-term population monitoring, including data fields, who to monitor and how long to monitor. Implement such a registry.

7. Determine and write procedures for the appropriate response if the radiological contamination is due to a release of contamination at a licensed radiological source facility.

8. Work with federal agencies and neighboring states to determine response and monitoring resources that may be offered or requested to assist in the identification, monitoring, and cleanup of the radiological contamination.

9. Work with ESF 10 and SCDHEC Media Relations to prepare pre-event and post-event radiological information sheets, protective actions, and talking points that can be generated for any radiological response.

10. Provide training to staff and volunteers addressing sheltering during radiological event.

11. Identify potential PPE needs for shelter staffing.

12. Coordinate with ESF 6 regarding health aspects of sheltering during a radiological event.

13. Develop just-in-time training for SMNS shelter operations.

14. Identify the role(s) that SCDHEC staff will fill at Reception Centers, identify personnel who will fill those roles and provide appropriate training to those personnel.

15. Identify agents for treatment of internally radiologic contaminated patients that hospitals will require.

16. Identify sources and contact information to obtain radiologic antidotes as most are not carried by local pharmaceutical vendors.

17. Inventory the most current annual assessment of REMM-recommended PPE supplies and locally available equipment.

18. Work with other agencies to determine strategy for large scale decontamination.

19. Gather information about radiological response capabilities at hospitals and other healthcare providers.

20. Encourage hospitals and other healthcare providers to participate in radiological trainings and exercises when available.

21. Determine types and estimate the quantity of PPE needed for current and additional healthcare personnel to support medical surge.

22. Encourage the implementation of the Radiation TReatment, TRiage, and TRansport system (RTR). Assure crisis operations plans for agency/system are accomplished including triage of calls at local Public Safety Answering Point (PSAP), medical dispatch centers, and on-scene, and also including staffing configurations, transport destinations (e.g., delivering patients to non-hospital locations such as RTR3 / Medical Care locations)

23. Work with subject matter experts to develop pre-event technical assistance and regulatory guidance for healthcare facilities impacted by radiological contamination.

24. Work with subject matter experts to develop a system to surge and coordinate biodosimetry (lymphocyte counts, dose estimation, etc.) and ensure continuity in data management and fidelity in data interpretation.

25. Attend regional planning meetings to provide guidance. Direct hospitals to purchase adequate PPE to support current and additional healthcare personnel as determined.

26. Determine numbers of EMS services that have EMTs or teams with training in CBRN.

27. Identify subject matter experts and trained personnel (radiological technicians and technologists, medical physicists, and others) who may serve as volunteers on radiological assessment teams or to assist hospitals with surge.

28. Develop strategies to use for volunteers to support large scale decontamination.

29. Develop just-in-time training for volunteers to assist in shelter and reception center screenings.

30. Provide training to behavioral health teams specifically addressing psycho-social needs during a radiological event.

31. Develop materials addressing psycho-social concerns specific to a radiological event.

32. Promote radiological training for coroners.

33. Identify resources needed to manage mass fatalities in a radiological event.

34. Provide ambient environmental monitoring for determination of appropriate Protective Action Recommendations (PARs).

35. Obtain information from ESF-10 regarding potable water quality, to create health messages and to monitor the health risks.

36. Obtain information from ESF-10, regarding the definition of appropriate exclusion zones for citizens to direct sheltering operations.

37. Assist local and state governments in determination of the safe radiological exposure levels for their public safety personnel.

38. Work with federal and state agricultural officials to make the appropriate determination of agricultural product contamination.

39. Provide technical assistance to local government officials in determination of extent of threats/safety concerns from the radiological event.

40. Assist licensed healthcare facilities in determining the safety of their operations.

41. With guidance from ESF 10, Assist local government officials in technical issues involved with decontamination of people and emergency vehicles.

42. Provide radiological monitoring data for governmental officials.

43. Working with ESF 10, support law enforcement officials in determination of appropriate security measures to eliminate spread of contamination through movement of contaminated materials/debris.

44. Working with ESF 10, assist law enforcement officials with radiological and chemical contamination surveys of contaminated areas that may now become a crime scene.

45. In conjunction with ESF 10, provide support to Division of Media Relations to explain radiological issues, sampling efforts, public/personnel exposure control efforts, and related subject matters.

46. Push forward state supplies of radiologic antidotes, if it is the appropriate antidote, to facilities receiving exposed patients.

47. Determine the approximate numbers of exposed patients requiring treatment for internal contamination and contact suppliers of required antidotes. If source is non-commercial assist facility with request process.

48. Coordinate assistance and response with the Bureau of Land and Waste Management's Nuclear Response and Emergency Environmental Surveillance Section (NREES), the Department of Energy, and other qualified state or governmental agencies.

49. Provide technical assistance and regulatory guidance to industries/vendors involved in the decontamination and cleanup of the environment due to the contamination.

50. Track status and patient census of licensed healthcare facilities.

51. Assist hospitals in establishing alternate care sites and/or managing surge.

52. Coordinate assistance and response with the Bureau of Health Facilities Regulation regarding the damage and safety of licensed healthcare facilities.

53. Utilize NDMS teams and transportation; use RITN system.

54. Identify needs in which volunteers may assist at reception centers or other response activities.

55. Generate a list of radiological professionals who have registered as volunteers.

56. Provide just-in-time training as needed to volunteers to assist in the identified roles.

57. Review and distribute appropriate psycho-educational materials to individuals and/or communities.

58. Provide proper assessment and triage of victims to insure the appropriate intervention/treatment.

59. Provide emergency supportive psychological/emotional support to affected citizens and responders.

60. Support the local coroners in locating appropriate caskets and transport for radiologically contaminated victims.

61. Assist dairies and bottling facilities regulated by the SCDHEC in an assessment of the radiological contamination of their facilities to include technical assistance in the removal and disposal of contaminated food products.

62. Coordinate federal and neighboring state (EPA, DOE, NC, FL, GA, etc.) response and monitoring resources that will be offered or requested to assist in the identification, monitoring, and cleanup of the radiological contamination.

63. Assess the protection level needed and exposure and dosage rates of the radiation source on the food.

64. Coordinate with SCDA and Clemson University Meat and Poultry Services, to advise dairies on what steps to take to prevent fallout contamination and shielding requirements, as well as source information on acceptable or allowable rates on feed supplies.

65. Assess the state of radiological contamination of food provided to restaurants, markets, grocery stores, and schools.

66. Evaluate buildings such as schools for contamination and assess and recommend clean up and sanitation procedures.

67. In conjunction with ESF 10, continue to assess the situation and define the damage and fallout zones and prioritize access restoration.

68. Under the direction of ESF 10, determine when a zone is habitable and people may return in conjunction with federal guidance.

69. Provide easily understood information about relative risk for future malignancies and impact on property to those in fallout areas.

70. Address health concerns and questions that arise at the reception centers.

71. Determine the approximate numbers of exposed patients requiring treatment for internal contamination or Acute Radiation Syndrome and contact suppliers of required antidotes.

72. Define exposure limits for response workers and residents.

73. Determine when or if damaged healthcare facilities may be reopened.

74. Establish teams, timelines, and goals for medium- and long-term support to help resilience.

75. Monitor fatality management responders for contamination.

D. Governor's Office, Office of Veterans' Affairs

Work with local coroner to ensure that deceased veterans have been decontaminated and safe burial arrangements are made.

E. SC National Guard

1. Provide subject matter experts.

2. Assist with evacuation.

3. Assist with enforcement of exclusion zones.

4. Assist with assessment of situation.

5. Assist with push forward of radiological antidote supplies.

6. Assist with decontamination efforts.

F. SC Law Enforcement Division

1. Assist with enforcement of exclusion zones.

2. Assist with assessment of situation.

G. Department of Mental Health

1. Provide training to behavioral health teams specifically addressing psycho-social needs during a radiological event.

2. Develop materials addressing psycho-social concerns specific to a radiological event.

3. Provide emergency supportive psychological/emotional support to affected citizens and responders.

4. Establish teams, timelines, and goals for medium- and long-term psychological support to help resilience.

J. Vocational Rehabilitation Department

1. Assist with the provision of training to behavioral health teams specifically addressing psycho-social needs during a radiological event.

2. Assist with the development of materials addressing psycho-social concerns specific to a radiological event.

3. Assist with the provision of emergency supportive psychological/emotional support to affected citizens and responders.

4. Assist with the establishment of teams, timelines, and goals for medium- and long-term psychological support to help resilience.

L. Department of Alcohol and Other Drug Abuse Services

1. Assist with the provision of training to behavioral health teams specifically addressing psycho-social needs during a radiological event.

2. Assist with the development of materials addressing psycho-social concerns specific to a radiological event.

3. Assist with the provision of emergency supportive psychological/emotional support to affected citizens and responders.

4. Assist with the establishment of teams, timelines, and goals for medium- and long-term psychological support to help resilience.

M. Department of Social Services

1. Identify reception centers; staff and operate reception centers.

2. Support shelter operations.

N. SC Morticians Association

1. Promote radiological training for morticians.

2. Identify resources needed to manage mass fatalities in a radiological event.

3. Support the local coroners in locating appropriate caskets and transport for radiologically contaminated victims.

O. SC Funeral Directors Association

1. Promote radiological training for funeral directors.

2. Identify resources needed to manage mass fatalities in a radiological event.

3. Support the local coroners in locating appropriate caskets and transport for radiologically contaminated victims.

P. SC Coroners Association

1. Promote radiological training for coroners.

2. Maintain radiological monitoring equipment for ready use.

3. Identify resources needed to manage mass fatalities in a radiological event.

4. Support the local coroners in locating appropriate caskets and transport for radiologically contaminated victims.

5. Monitor fatality management responders for contamination.

6. Identify, survey, and release bodies in accordance with applicable radiation protection guidelines.

Q. SC Hospital Association

1. Following SCDHEC's identification of agents needed for treatment of internally radiologic contaminated patients that hospitals will require, provide this information to hospitals and assist them in obtaining these agents.

2. Assist SCDHEC in gathering information about radiological response capabilities at hospitals and other healthcare providers.

3. Encourage hospitals and other healthcare providers to participate in radiological trainings and exercises when available.

4. Assist SCDHEC in determining types and estimating the quantity of PPE needed for current and additional healthcare personnel to support medical surge.

5. Work with subject matter experts to develop pre-event technical assistance and regulatory guidance for healthcare facilities impacted by radiological contamination.

6. Work with subject matter experts to develop a system to surge and coordinate biodosimetry (lymphocyte counts, dose estimation, etc.) and ensure continuity in data management and fidelity in data interpretation.

7. Encourage hospitals to purchase adequate PPE to support current and additional healthcare personnel as determined.

8. After the approximate numbers of exposed patients requiring treatment for internal contamination is determined, assist SCDHEC and hospitals in contacting suppliers of required antidotes. If source is non-commercial assist facilities with request process.

9. Assist SCDHEC in tracking status and patient census of licensed healthcare facilities.

10. Assist hospitals in establishing alternate care sites and/or managing surge.

R. SC Medical Association

1. Assist in the identification of subject matter experts.

2. Encourage physicians to participate in radiological trainings and exercises when available.

3. Work with subject matter experts to develop a system to surge and coordinate biodosimetry (lymphocyte counts, dose estimation, etc.) and ensure continuity in and fidelity in data interpretation.

S. SC Pharmacy Association

1. Identify sources and contact information to obtain radiologic antidotes as most are not carried by local pharmaceutical vendors.

2. Assist DHEC in gathering and distributing the antidotes for the population in need.

T. American Red Cross

1. Assist SCDHEC in implementing a population monitoring registry.

2. Provide training to staff and volunteers addressing sheltering during radiological event.

3. Identify potential PPE needs for shelter staffing.

4. Coordinate with SCDHEC regarding health aspects of sheltering during a radiological event.

5. Provide training to behavioral health personnel specifically addressing psycho-social needs during a radiological event.

6. Develop and/or disseminate materials addressing psycho-social concerns specific to a radiological event.

V. SC Baptist Disaster Relief

Provide training to behavioral health personnel specifically addressing psycho-social needs during a radiological event.

**ATTACHMENTS:**

Appendix 1: Definitions

Appendix 2: Acronyms

Appendix 3: Units of Measure

Appendix 4: Available Radiation Monitoring Equipment

Appendix 5: Relative protection factors afforded by homes, workplaces and nearby buildings

Appendix 6: List and description of drugs used to treat radiation exposure

# APPENDIX 1

## DEFINITIONS

Acute Radiation Syndrome:
a serious illness caused by receiving a dose greater than 50 rads of penetrating radiation to the body in a short time (usually minutes). The earliest symptoms are nausea, fatigue, vomiting, and diarrhea. Hair loss, bleeding, swelling of the mouth and throat, and general loss of energy may follow. If the exposure has been approximately 1,000 rads or more, death may occur within 2 – 4 weeks.

Americium (Am):
a silvery metal; it is a man-made element whose isotopes Am-237 through Am-246 are all radioactive. Am-241 is formed spontaneously by the beta decay of plutonium-241. Trace quantities of americium are widely used in smoke detectors, and as neutron sources in neutron moisture gauges.

Antiemetics:
a drug that is effective against vomiting and nausea

Biodosimetry:
a measurement of biological response as a surrogate for radiation dose

CentiGrays:
The gray (symbol: Gy) is the SI derived unit of absorbed dose, specific energy (imparted) and of kerma. Such energies are typically associated with ionizing radiation such as X-rays or gamma particles or with other nuclear particles. It is defined as the absorption of one joule of such energy by one kilogram of matter.

Cesium**:**

Chemical symbol Cs is a metal that may be stable (nonradioactive) or unstable (radioactive). The most common radioactive form of cesium is cesium-137. Another fairly common radioisotope is cesium-134. Cesium-137 is much more significant as an environmental contaminant than cesium-134. It is also very useful in industry for its strong radioactivity.

Chelating:

Chelating describes a particular way that ions and molecules bind metal ions.[1] According to the International Union of Pure and Applied Chemistry (IUPAC), chelation involves the formation or presence of two or more separate coordinate bonds between a polydentate (multiple bonded) ligand and a single central atom.[2] Usually these ligands are organic compounds, and are called chelants, chelators, chelating agents, or sequestering agents.

Curium:

a transuranic radioactive chemical element with the symbol Cm**.** Most curium is produced by bombarding uranium or plutonium with neutrons in nuclear reactors – one tonne of spent nuclear fuel contains about 20 grams of curium.

Cytokines:

are small signaling molecules used for cell signaling. Cytokines can be classified as proteins, peptides, or glycoproteins; the term "cytokine" encompasses a large and diverse family of regulators produced throughout the body by cells of diverse embryological origin.

Decorporation:
act of using drugs and procedures that will eliminate some or most internal radioactive contamination from the body.

Electromagnetic Pulse (EMP):

a burst of electromagnetic energy. It may occur in the form of a radiated, electric or magnetic pulse depending on the source. EMP is generally damaging to electronic equipment, and its management is an important branch of electromagnetic compatibility engineering.

Emergency Planning Zone:
to facilitate a preplanned strategy for protective actions during an emergency at a fixed nuclear facility, there are two emergency planning zones (EPZs) around each nuclear power plant, the plume exposure pathway and the ingestion exposure pathway.

Fallout plume (or plume):
minute particles of radioactive debris that descend slowly from the atmosphere after a nuclear explosion. The plume is the material spreading from a particular source and traveling through environmental media, such as air or ground water.

Kilotons (Kt):
the energy of an explosion that is equivalent to an explosion of 1,000 tons of TNT. One kiloton equals 1 trillion ($10^{12}$) calories.

Protective Action Guide:
a guide that tells state and local authorities at what projected dose they should take action to protect people from exposure to unplanned releases of radioactive material into the environment.

Radiation:
energy moving in the form of particles or waves. Familiar radiations are heat, light, radio waves, and microwaves. Ionizing radiation is a very high-energy form of electromagnetic radiation.

Radioactive Isotopes (radioisotope):
isotopes of an element that have an unstable nucleus. Radioactive isotopes are commonly used in science, industry, and medicine. The nucleus eventually reaches a stable number of protons and neutrons through one or more radioactive decays. Approximately 3,700 natural and artificial radioisotopes have been identified.

Southern Mutual Radiological Assistance Pact**:**
The Southern Mutual Radiation Assistance Plan (SMRAP) provides a mechanism for coordinating radiological emergency assistance capabilities among participating states. The authority for entering into supplemental agreements by any of the southern states is provided by Public Law 87-563, which grants U.S. Congressional approval of the Southern Interstate Nuclear Compact. The plan contains general provisions and detailed resource information and is designed to serve the needs of state administrators as well as state radiological health personnel in their everyday activities.

# APPENDIX 2

## ACRONYMS

| | |
|---|---|
| ASPR: | Assistant Secretary of Preparedness and Response (of the U.S. Department of Health and Human Services) |
| CBRN: | Chemical, Biological, Radiological and Nuclear |
| CMRT: | Consequence Management Response Team (of the Department of Energy) |
| CRCF: | Community Residential Care Facilities |
| DHHS: | (U.S.) Department of Health and Human Services |
| DOE: | (U.S.) Department of Energy |
| EMAC: | Emergency Mutual Aid Compact |
| EMP: | Electromagnetic Pulse |
| EPA: | (U.S.) Environmental Protection Agency |
| EPZ: | Emergency Planning Zone |
| FNF: | Fixed Nuclear Facility |
| FRMAC: | Federal Radiological Monitoring and Assessment Center |
| IND: | Improvised Nuclear Device |
| IRCT: | Incident Response Coordination Teams (of the Department of Health and Human Services) |
| KI: | Potassium Iodide |
| NDMS: | National Disaster Medical System |
| NREES: | Nuclear Response and Emergency Environmental Surveillance Section (of SCDHEC) |
| NRF: | National Response Framework |
| PAPR: | Powered Air Purifying Respirator |
| PAR: | Protective Action Recommendations |
| PPE: | Personal Protective Equipment |

| | |
|---|---|
| PSAP: | Public Service Answering Point |
| RDD: | Radiological Dispersing Device |
| REMM: | Radiation Emergency Medical Management |
| RITN: | Radiation Injury Treatment Network |
| RTR: | Radiation TReatment, TRiage, and TRansport system |
| SCDA: | S.C. Department of Agriculture |
| SCHA: | S.C. Hospital Association |
| SCOREP: | S.C. Operational Radiological Emergency Plan |
| SMNS: | Special Medical Needs Shelters |
| SNS: | Strategic National Stockpile |

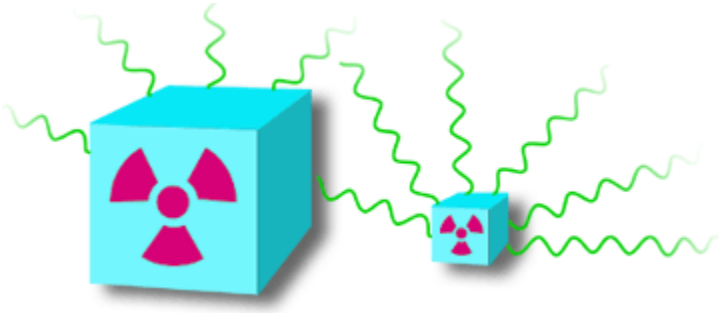
# APPENDIX 3

## UNITS OF MEASURE

The amount of radioactivity in a quantity of material can be determined by noting how many curies of the material are present. This information should be found on labels and/or shipping papers.

More curies = a greater amount of radioactivity

A large amount of material can have a very small amount of radioactivity; a very small amount of material can have a lot of radioactivity.



For example, uranium-238 has 0.00015 curies of radioactivity per pound (0.15 millicuries), while cobalt-60 has nearly 518,000 curies per pound.

In the International System of units (SI), the becquerel (Bq) is the unit of radioactivity. One Bq is 1 disintegration per second (dps). One curie is 37 billion Bq. Since the Bq represents such a small amount, you are likely to see a prefix used with Bq, as shown below:

- 1 MBq (27 microcuries)
- 1 GBq (27 millicuries)
- 37 GBq (1 curie)
- 1 TBq (27 curies)

## SI Units and Prefixes

The International System of Units has been given official status and recommended for universal use by the General Conference on Weights and Measures.

**Radiation Measurements**

| | Radioactivity | Absorbed Dose | Dose Equivalent | Exposure |
|---|---|---|---|---|
| **Common Units** | curie (Ci) | rad | rem | roentgen (R) |
| **SI Units** | becquerel (Bq) | gray (Gy) | sievert (Sv) | coulomb/kilogram (C/kg) |

Following is a list of prefixes and their meanings that are often used in conjunction with SI units:

| Multiple | Prefix | Symbol |
|---|---|---|
| $10^{12}$ | tera | T |
| $10^{9}$ | giga | G |
| $10^{6}$ | mega | M |
| $10^{3}$ | kilo | k |
| $10^{-2}$ | centi | c |
| $10^{-3}$ | milli | m |
| $10^{-6}$ | micro | µ |
| $10^{-9}$ | nano | n |

## Conversions

### Conversion Equivalence

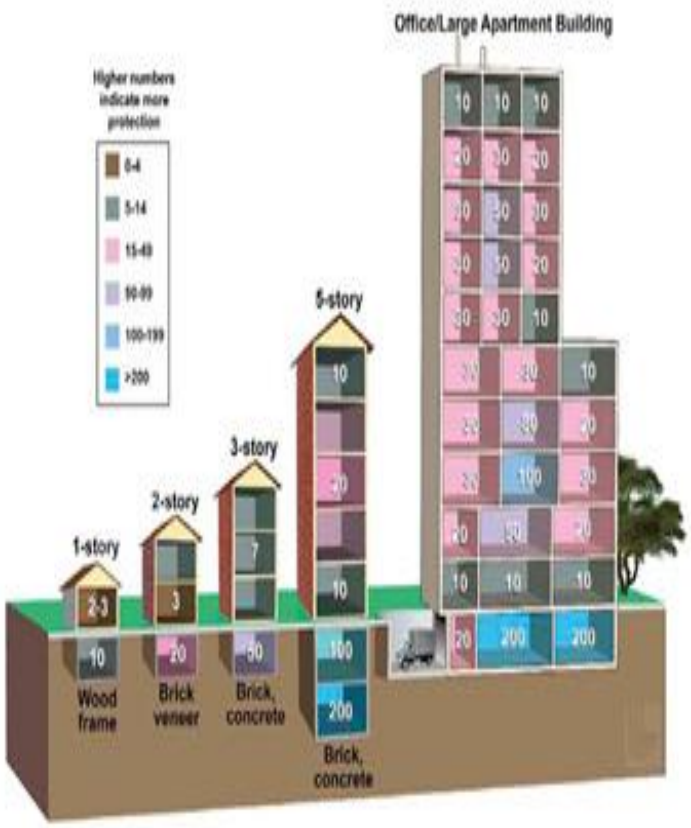
| 1 curie = 3.7 x $10^{10}$ disintegrations per second | | 1 becquerel = 1 disintegration per second |
|---|---|---|
| 1 millicurie (mCi) | = | 37 megabecquerels (MBq) |
| 1 rad | = | 0.01 gray (Gy) |
| 1 rem | = | 0.01 sievert (Sv) |
| 1 roentgen (R) | = | 0.000258 coulomb/kilogram (C/kg) |
| 1 megabecquerel (MBq) | = | 0.027 millicuries (mCi) |
| 1 gray (Gy) | = | 100 rad |
| 1 sievert (Sv) | = | 100 rem |
| 1 coulomb/kilogram (C/kg) | = | 3,880 roentgens |

## Conversion Factors

| To convert from | To | Multiply by |
|---|---|---|
| Curies (Ci) | becquerels (Bq) | $3.7 \times 10^{10}$ |
| millicuries (mCi) | megabecquerels (MBq) | 37 |
| microcuries (µCi) | megabecquerels (MBq) | 0.037 |
| millirads (mrad) | milligrays (mGy) | 0.01 |
| millirems (mrem) | microsieverts (µSv) | 10 |
| milliroentgens (mR) | microcoulombs/kilogram (µC/kg) | 0.258 |
| | | |
| becquerels (Bq) | curies (Ci) | $2.7 \times 10^{-11}$ |
| megabecquerels (MBq) | millicuries (mCi) | 0.027 |
| megabecquerels (MBq) | microcuries (µCi) | 27 |
| milligrays (mGy) | millirads (mrad) | 100 |
| microsieverts (µSv) | millrems (mrem) | 0.1 |
| microcoulombs/kilogram (µC/kg) | milliroentgens (mR) | 3.88 |

# Appendix 5:

## Relative protection factors afforded by homes, workplaces and nearby buildings




| Radiation Protection Factors for Different Shelter Types Structure | Protection Factor |
|---|---|
| Under three-feet of earth, sub-basements of | 1,000 or greater |
| multistory buildings | |
| Central areas of upper floors (excluding top three | 100–1,000 |
| floors) of multistory buildings | |
| Basements of houses | 10–20 |
| Frame house | 1.5–3 |

# Appendix 6:

# List and description of drugs used to treat radiation exposure

**Isotopes of Interest: Properties and Treatment**

| Isotope Name & Symbol | Ionizing Radiation Type | Radiological Half-life | Biologic Half-life (days) | Exposure Type | Mode of Contamination | Focal Accumulation in Body | Treatment |
|---|---|---|---|---|---|---|---|
| Americium (Am-241) | α | 458 years | 73,000 | Internal | Inhalation, skin wounds | Lungs, liver, bones, bone marrow | Chelation with DTPA‡ |
| Californium (Cf-252) | α, γ | 2.6 years | N/A | Internal | Lungs, GI tract | Bones, liver | Chelation with DTPA† |
| Cesium (Cs-137) | β, γ | 30 years | 70 | External, Internal | Lungs, GI tract, wounds, follows potassium | Renal excretion | Ion exchange with Prussian blue‡ |
| Cobalt (Co-60) | β, γ | 5.26 years | 9.5 | External, Internal | Lungs | Liver | Gastric lavage; Limited animal data suggest that DTPA, EDTA, L-cysteine, NAC (N-Acetyl-Cysteine), and glutathione may be effective in increasing urinary excretion. § |
| Curium (Cm-244) | α, γ, neutron | 18 years | 7,300 (liver) 18,250 (bones) | Internal | Inhalation, GI tract | Liver, bones (soluble Cm compounds) | Chelation with DTPA‡ |
| Iodine (I-131) | β, γ | 8.1 days | 138 | Internal | Inhalation, GI tract, wounds | Thyroid | Potassium iodide‡, propylthiouracil†, methimazole†, sodium iodide† |
| Iridium (Ir-192) | β, γ | 74 days | 50 | External, Internal | Not available | Spleen | Not available |

| Isotope Name & Symbol | Ionizing Radiation Type | Radiological Half-life | Biologic Half-life (days) | Exposure Type | Mode of Contamination | Focal Accumulation in Body | Treatment |
|---|---|---|---|---|---|---|---|
| Phosphorus (P-32) | β | 14.3 days | 1,155 | Internal | Inhalation, GI tract, wounds | Bones, bone marrow, rapidly replicating cells | Lavage, Aluminum hydroxide†, Dibasic phosphates† |
| Plutonium (Pu-239) | α | $2.2 \times 10^4$ years | 73,000 | Internal | Limited lung absorption, high retention | Lung, bones, bone marrow, liver, gonads | Chelation with DTPA† |
| Polonium (Po-210) | α | 138.4 days | 60 | Internal | Inhalation, GI tract, wounds | Spleen, kidneys, lymph nodes, bone marrow, liver, mucus lining cells of the lung | Lavage, Dimercaprol† |
| Radium (Ra-226) | α, β, γ | 1,602 years | 16,400 | External, Internal | GI tract | Bones | $MgSO_4$ lavage†, Ammonium chloride†, Calcium†, Alginates†, Calcium gluconate† |
| Strontium (Sr-90) | β | 28 years | 18,000 | Internal | Moderate GI tract | Bones - similar to calcium | Stable strontium†, Calcium†, Ammonium chloride†, Calcium gluconate†, Sodium alginate†, Aluminum-containing antacids† |

| Isotope Name & Symbol | Ionizing Radiation Type | Radiological Half-life | Biologic Half-life (days) | Exposure Type | Mode of Contamination | Focal Accumulation in Body | Treatment |
|---|---|---|---|---|---|---|---|
| Thorium (Th-232) | α | $1.41 \times 10^{10}$ years | 8,030 (bones) 700 (liver, total body) | Internal | Inhalation, GI tract | Bones | Chelation with DTPA† |
| Tritium (H-3) | β | 12.5 years | 12 | Internal | Inhalation, GI tract, wounds | Total body | Dilution with controlled water intake, Diuretics |
| Uranium (U-235) | α | $7.1 \times 10^{8}$ years | 15 | Internal | GI tract | Kidneys, bones | Sodium bicarbonate† |
| Yttrium (Y-90) | β | 64 hours | N/A | Internal | Inhalation, GI tract | Bones | Chelation with DTPA† |

† Not FDA approved for this indication / Off-label use

‡ FDA approved for this indication

§ References:


1. Llobet JM, Domingo JL, Corbella J. Comparison of antidotal efficacy of chelating agents upon acute toxicity of Co(II) in mice. Res Commun Chem Pathol Pharmacol. 1985 Nov;50(2):305-8. [PubMed Citation]
2. Llobet JM, Domingo JL, Corbella J. Comparison of the effectiveness of several chelators after single administration on the toxicity, excretion and distribution of cobalt. Arch Toxicol. 1986 Apr;58(4):278-81. [PubMed Citation]
3. Generic procedures for medical response during a nuclear or radiological emergency (PDF - 2225 KB) (IAEA April 2005)


¶ For Yttrium-90 radioactive properties and health concerns information, see Strontium-90 Human Health Fact Sheet

* Adapted from "Radiation Bioterrorism", Tochner ZA, Lehavi O, Glatstein E, Chapter 207 in Harrison's Principles of Internal Medicine. Kasper DL, Braunwald E, Fauci AS, Hauser SL, Longo DL, Jameson JL, eds. 16th Edition, pp 1294-1300, McGraw-Hill, 2005